Environmental Services

PIPELINE REVEGETATION RESEARCH: ALASKA HIGHWAY TEST SITE PROGRESS REPORT - 1979

Foothills Pipe Lines (South Yukon) Ltd.

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THE ALASKA HIGHWAY GAS PIPELINE PROJECT

Foothills Pipe Lines (Yukon) Ltd.

WHITEHORSE:
308 STEELE STREET
Y1A 2C5

CALGARY:
1600 BOW VALLEY SQUARE II
205 - FIFTH AVENUE S.W.,
CALGARY, ALBERTA
T2P 2W4

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ALASKA HIGHWAY TEST SITES
PROGRESS REPORT 1979

Prepared for:

FOOTHILLS PIPE LINES (YUKON) LTD.
Calgary, Alberta

Prepared by:

M. Vaartnou
VAARTNOU & SONS ENTERPRISES LTD.
Calgary, Alberta

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SUMMARY

In May, 1978 a revegetation research program was initiated along the route planned for the Yukon segment of the proposed Alaska Highway Gas Pipeline. Results of an earlier vegetation survey (Foothills 1978) were used to divide the route into seven revegetation sections and trial plots were established in each. Plots were located near Beaver Creek, Destruction Bay, Haines Junction, Marsh Lake, Johnson's Crossing, Swift River and Watson Lake. Two distinct tests, entitled primary and secondary tests, were established at each location.

At each primary site the variables under study were:

1) the comparative success of agronomic cultivar and northern ecotype seed mixtures,
2) success obtained with three different seeding times,
3) the effect of a cellufibre mulch and
4) the benefits accruing from two fertilizer treatments.

At each secondary site sufficient amounts of N and P were added to eliminate a possible shortage of these nutrients as the factor limiting plant growth. After this fertilization the effects of three other treatments were monitored. These latter treatments were:

1) the addition of a micronutrient fertilizer,
2) the addition of a potassium sulfate fertilizer and
3) the addition of a hay mulch.

The entire program was designed to be monitored for several years so that the effect of climatic fluctuation on plant survival could be ascertained.

Results to date indicate that climatic variability along the route will be a major determining factor in revegetation success. Specifically, the lack of precipitation during the growing season in some

sections will delay plant emergence and establishment unless techniques are used to ameliorate existing microclimates. The use of a hay mulch appears a prerequisite for plant establishment in xeric regions and also is beneficial in more mesic areas. The cellufibre mulch has not been beneficial for plant establishment.

Results of the fertilizer tests indicate that, of the formulations tested, a blend of sulfur coated urea and superphosphate, mixed to provide a formulation of 19-26-0, gives optimum results. The addition of micronutrients has not been beneficial while potassium sulfate has only increased growth at one site deficient in potassium. The effect of seeding time and seed mix composition is not clear at present as insufficient time has passed for establishment of definite trends. Individual species success has varied from location to location but the following trends have appeared. First year cover is dominated by several species of wheatgrass (*Agropyron* spp.), timothy (*Phleum pratense*) and fowl bluegrass (*Poa palustris*). In the second year these species remain in the plots but the amount of cover provided by the wheatgrasses and timothy is reduced as red fescue (*Festuca rubra*) and red top (*Agrostis gigantea*) become co-dominant with the fowl bluegrass. The legumes included in the seed mixtures have not been successful. Only alsike clover (*Trifolium hybridum*) has provided more than 10% of the ground cover on any plot and this limited success has only occurred at some of the more mesic locations.

A delimitation of the precise seed mixture for each revegetation section is premature but preliminary recommendations are adumbrated for each section.

1.0 INTRODUCTION

In 1977 the National Energy Board of Canada approved the construction of the Alaska Highway Natural Gas Pipeline which will cross southern Yukon Territory from Beaver Creek to Watson Lake. The construction of this pipeline will result in some disturbance to the physical and biotic environment. Such perturbation will be minimized, but, as with any industrial project, some components of the environment will be altered. One such biological component is the flora, as clearing of a pipeline right-of-way and construction of ancillary facilities will result in disturbance of the existing vegetation.

In the preparation of an environmental impact assessment for submission to the National Energy Board it became apparent that revegetation information applicable to southern Yukon was insufficient to ensure successful restoration of vegetation to the pipeline right-of-way at a reasonable cost. Also, long term revegetation success could not be guaranteed, even at unacceptable cost, since no applicable field testing of agronomic cultivars or native species had been undertaken in this region in previous years. In 1977, little conclusive information was available regarding appropriate species, fertilizer requirements, use of mulches, optimal planting season or optimal planting methods applicable to revegetation of disturbed lands in southern Yukon Territory. Consequently, the revegetation program described herein was initiated to alleviate some of these gaps in applied ecological knowledge.

In late 1977, the pipeline corridor was divided into seven physiographic sections for revegetation purposes (Foothills 1978). Subsequently, in 1978, a revegetation test site was established in each section. These seven sites, located proximal to Beaver Creek, Destruction Bay, Haines Junction, Marsh Lake, Johnson's Crossing, Swift River and Watson Lake respectively, were collectively entitled the Alaska Highway Revegetation Test Sites (Figure 1). In 1978, the seedlings emergent on plots seeded at these sites were evaluated

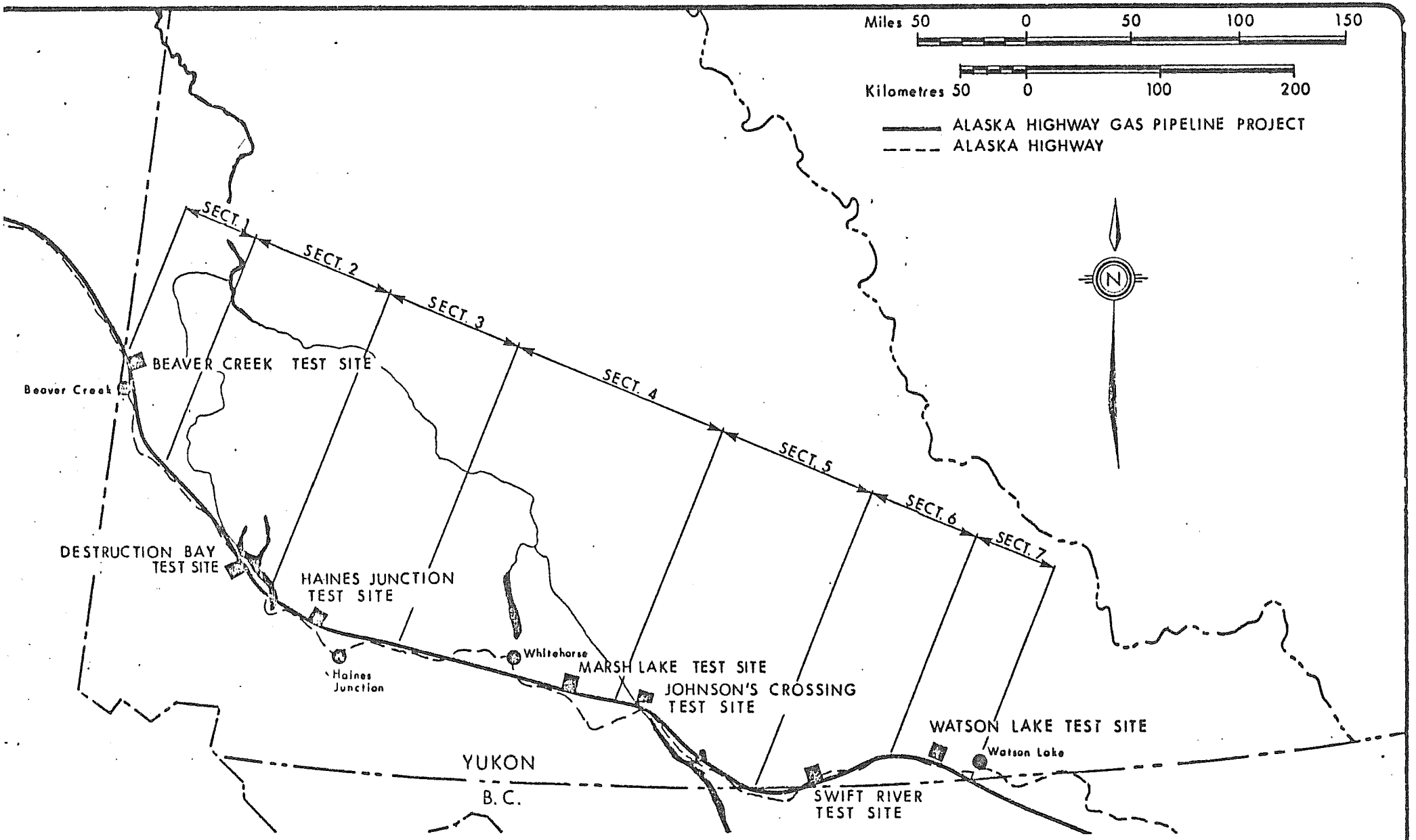

FIGURE 1

ALASKA HIGHWAY REVEGETATION SECTIONS AND TEST SITES

(ADAPTED FROM FOOTHILLS -1978)

YK-05-0100-35

for early establishment, cover production and overall vigour (Foothills 1979a). The influence of different mulches and fertilizers on first year growth was also assessed. In September, 1978 and early May, 1979 additional plots were seeded with identical seed mixtures so that the effect of planting date could be determined.

The purpose of all of Foothill's Pipe Lines (Yukon) Ltd.'s revegetation research programs is to obtain information required for optimum revegetation of disturbed areas. The Alaska Highway Test Sites were established in 1978 with the objective of obtaining short and long term data regarding grass and legume performance in areas such as biocompetitive ability, disease resistance, winter survival and adaptation to local environmental factors such as soil conditions. When these test sites were established few records regarding species performance were available for this region. However, some information was available from the other Foothills revegetation programs at Haines Junction (Foothills 1979b) and northern British Columbia (Foothills 1979c). These programs, initiated in 1977 and 1976 respectively, provided some information regarding species performance on various soil types in specific climatic regions.

However, the dearth of information regarding revegetation in southern Yukon Territory resulted in the establishment of the Alaska Highway Revegetation Research Program with the following general objectives:

a) Evaluation and selection of appropriate species for each section of the pipeline route.

b) Delimitation of the optimum time for seeding.

c) Evaluation of the usefulness of hay and cellufibre mulches.

d) Selection of a suitable type of fertilizer for each section.

1.1 REVEGETATION SECTIONS

In the fall of 1977 the area through which the Yukon portion of the Alaska Highway Gas Pipeline will pass was divided into seven revegetation sections (Foothills 1978). These sections were delimited on the basis of physiographic, edaphic and climatic variation along the route. These parameters were used to delineate the revegetation sections because changes in physiography, soil type and climatic factors such as precipitation and length of frost-free period may necessitate the use of different seed mixtures and/or revegetation methods in each section. A brief summary of factors which are relevant to the revegetation of each section follows below.

1.1.1 Section 1 - Alaska Border to Pickhandle Lake

The Beaver Creek test site was chosen as representative of the region between the Alaska border and Pickhandle Lake (Pipeline KP 0-88). This section of the proposed pipeline route traverses considerable hilly terrain. It is the coldest of the seven regions and discontinuous permafrost is extensive. Precipitation is adequate, (Table 1) especially during the growing season, and few dry locations will be encountered in this section.

1.1.2 Section 2 - Pickhandle Lake to Congdon Creek

The Destruction Bay test site was chosen to represent the region between Pickhandle Lake and Congdon Creek (Pipeline KP 88-205). In comparison to Section 1, topography of this section is fairly uniform. Summer and winter temperatures are slightly lower in this section and precipitation is much less. Consequently, drought during the growing season may retard germination and make seedling survival difficult in some years.

TABLE 1

CLIMATE OF YUKON TERRITORY

(Reproduced from Oswald and Senyk, 1977)

				TEMP (0°C)				PRECIP. (mm)	
	Lat.	Long.	Elev. (m)	Annual	May-Sept.	Jan.	July	Annual	June-Aug.
Haines Rd. M75	59°47'	136°36'	884	-3	6	-20	9	761	143
Watson Lake*	60°07'	128°49'	685	-3	11	-25	15	434	147
Carcross	60°11'	134°41'	661	-1	9	-19	13	226	69
Tuchita	60°55'	129°15'	759	-5	9	-31	13	605	155
Teslin*	60°10'	132°45'	701	-1	10	-20	13	326	99
Johnsons x	60°29'	133°20'	690	-3	9	-26	13	346	132
Whitehorse*	60°43'	135°04'	698	-1	11	-19	14	260	98
Haines Jct.*	60°45'	137°35'	599	-3	9	-21	12	281	90
Tungsten	61°57'	128°15'	1143	-6	7	-27	11	605	214
Ross River	61°59'	132°27'	698	-7	9	-35	13	253	102
Burwash	61°22'	139°03'	801	-5	8	-30	12	283	144
Anvil	62°22'	133°23'	1173	-4	7	-25	11	368	135
Carmacks	62°06'	136°18'	521	-5	10	-34	14	247	107
Ft. Selkirk*	62°49'	137°22'	437	-5	11	-30	15	276	113
Beaver Ck.	62°23'	140°53'	663	-7	9	-34	13	412	229
Mayo*	63°36'	135°53'	495	-4	11	-27	15	293	117
Dempster	64°27'	138°13'	991	-7	7	-28	11	453	157
Dawson City*	64°04'	139°26'	324	-5	11	-29	16	325	140
Old Crow	67°34'	137°13'	55	-10	4	-25	11	173	99
Komokuk B.*	69°35'	140°11'	9	-11	2	-24	7	125	71

* Based on 25-year or more data.

1.1.3 Section 3 - Congdon Creek to Pine Lake

The Haines Junction site was established to study growth between Congdon Creek and Pine Lake (Pipeline KP 205-309). This section is characterized by slightly undulating topography. Summer temperatures are similar to those of the preceding sections but winters can be as much as 10°C warmer. Precipitation is low, especially from June to August, when it is most essential for revegetation. In order to facilitate successful germination and early development of seedlings, the time of seeding must be carefully considered.

1.1.4 Section 4 - Pine Lake to Squanga Lake

The Marsh Lake test site was chosen to represent the region between Pine Lake and Squanga Lake (Pipeline KP 309-504). Topography of the section is quite variable as large level stretches are interspersed with rolling hills near the Sifton Range, Mt. Ingram, Haeckel Hill, Mt. Michie and the McClintock River. This section has the highest temperatures and lowest precipitation of the southern Yukon. These factors, and the frequently alkaline soil, suggest that more revegetation difficulties may occur in this section than any in any other section.

1.1.5 Section 5 - Squanga Lake to Morley Lake

The Johnson's Crossing test site was chosen to represent the region from Squanga Lake to Morley Lake (Pipeline KP 504-624). In this section large areas of gently sloping hills are crossed. Summer precipitation and temperatures are similar to those encountered from Pickhandle Lake to Congdon Creek. Consequently, drought may occur in some growing seasons but the higher snowfall may increase the moisture available in spring for seedling germination and emergence.

1.1.6 Section 6 - Morley Lake to Boulder Creek

The Swift River test site was established as representative of the region from Morley Lake to Boulder Creek (Pipeline KP 624-728). This section includes the Cassiar Mountains and has the most variable topography on the proposed route. Some peat bogs and sedge fens may be crossed but sandy hills and gravel ridges will also be encountered. In a few locations the right-of-way may pass through the subalpine. Temperatures vary considerably and the growing season and frost-free periods change from year to year as early fall and/or late spring frosts have been known to occur. Precipitation data for this section is limited and varies greatly depending upon elevation, aspect, etc.

1.1.7 Section 7 - Boulder Creek to British Columbia Border

The Watson Lake test site was chosen as representative of the area from Boulder Creek to the British Columbia border (Pipeline KP 728-812). In most cases the hills and river banks of this region are gently sloping. Winter temperatures are colder than from Congdon Creek to Squanga Lake but summers are warmer. The growing season is longer here than in any other section. Year round precipitation is high, and although much of it occurs as snow, summer rainfall will normally be adequate for germination and establishment of grasses.

1.2 LITERATURE REVIEW

Extensive northern revegetation literature reviews have recently been compiled by Johnson and Van Cleve (1976) and Peterson and Peterson (1977). The literature review herein is confined to material relevant to plant selection, nutrient regime and fertilization, mulches and time of seeding as these are the parameters under investigation in this study.

1.2.1 Plant Selection

In revegetation, one major area of interest which can be profoundly influenced by man is choice of appropriate species. In recent years the use of native or introduced species has been a focal point of discussion. Consequently it is important to understand the distinction between native and introduced species. In general, an introduced or exotic species may be defined as one which does not occur in pristine plant communities in a specific area. In contrast, native species are those which are part of the natural assemblage of vegetation within a certain area. However, these definitions are of limited use because problems arise when one attempts to delimit the time span required for a species to have occupied a region before it can be considered native (Hulten 1968). Some introduced species, such as smooth brome (*Bromus inermis*), are already present in much of the sub-arctic although this species originated in central Europe and was only introduced to North America in the 19th century (Newell 1973). There are also agronomic cultivars such as Polar brome (*Bromus inermis* x *B. Pumpellianus*) which are actually hybrids between native and introduced species (Hodgson et al 1971). Therefore, there is not always a clear division between introduced and native species. Also, it has been demonstrated that depending upon their provenance, both introduced (Klebesadel 1970a) and native (Clausen et al 1948, Clebsch and Billings 1976) species vary in growth habit in different environments. Semantic difficulties can be minimized by use of the terms "northern ecotype" and "agronomic cultivar" to differentiate the classes of plants available for revegetation.

ECOTYPE - An ecological unit which covers the product arising as a result of the genotypical response of an eco-species to a particular habitat (Turesson 1922).

CULTIVAR - A commercially available strain of a species which has been developed by man for any of several specific traits such as forage quality, drought resistance or cold tolerance.

It is important to be aware of the problems and advantages posed by the use of both introduced and native species in revegetation. Many introduced species are agronomic cultivars which have been under cultivation for many years. This period of selection and observation has provided important data on the autecologies of these cultivars. Knowledge of such factors as response to fertilization (Klebesadel 1970b, Laughlin 1962, Laughlin et al 1973), time of floral initiation (Clarke and Elliott 1974, Hodgson 1966), winter survival (Klebesadel 1970b and 1971, Klebesadel et al 1964), and seed production (Klebesadel 1970a and b and 1971, Klebesadel et al 1962) are of vital importance in predicting the success of a species for revegetation and in knowing for what management goals it is best suited. Selective breeding is significant for revegetation since it eliminates some genetic variability by selecting for desired traits. This allows better prediction of success with the cultivar on a specific site, but it may also limit the range of conditions over which the cultivar can be used. In contrast, seed from native populations has shown wide genetic variability (Mitchell and McKendrick 1975).

However, the use of agronomic cultivars in revegetation programs may pose problems in that they may have become adapted to high nutrient levels during their period of intensive agronomic selection. Their continued success under nutrient poor conditions in the arctic and the subarctic could require repeated fertilization. This may partially explain why the percentage of cover on some northern revegetation plots has declined from the third to the fifth year after planting (Van Cleve 1975, Younkin and Friesen 1976). Fertilization in turn may also increase susceptibility to winter kill and snow mold (Mitchell 1972). Although some adapted northern agronomic cultivars may

overcome these problems, there is also the problem of introducing a species into a new habitat. In the past, this has sometimes led to establishment of new 'weed' species (Elton 1958). Although invasion in this sense does not appear likely under the more severe arctic conditions, it could occur in the subarctic. Still other problems with agronomics may include impact upon herbivores (Mitchell and McKendrick 1974 and 1975) and aesthetic problems, since agronomics may be conspicuous due to different phenologies or other characteristics.

Northern ecotypes have adapted physiologically and morphologically to the severe climatic conditions they encounter (Billings 1974, Billings and Mooney 1968, Savile 1972). They require physiological summer cold hardiness to survive frosts during the growing season and winter cold hardiness to survive extreme sub-zero temperatures. Other conditions to which northern ecotypes have adapted include snow abrasion and subsequent desiccation. Many northern plants combat these hazards by having low growth forms, such as cushions or rosettes, and by growing in depressions where snow accumulates to protect them (Savile 1972).

Arctic and subarctic plants are also physiologically and morphologically adapted to absorb nutrients at low temperatures, and some seem to be adapted to the low nutrient regimes of the soil (Chapin 1974a and b). Arctic plants characteristically have a high ratio of belowground to aboveground biomass (Dennis and Johnson 1970, Shaver and Billings 1975). This is important since many disturbances, such as light fires, may only remove aboveground vegetation. Also, the belowground biomass is important since arctic plants, and to a somewhat lesser extent subarctic plants, rely heavily upon vegetative reproduction. Therefore, roots and rhizomes are often capable of initiating or increasing vegetative cover (Billings 1974, Foothills 1979b and 1980, Savile 1972).

A factor of practical importance is that for many, although not all, agronomic cultivars there already are large commercial seed supplies.

This means that large areas may be seeded almost immediately, whereas native northern ecotypes lack commercial seed supplies and some may be poor seed producers (Klebesadel 1973, Mitchell 1972, Van Cleve 1972). This latter assertion applies for bluejoint (*Calamagrostis canadensis*), (Younkin 1974), arcticgrass (*Arctagrostis latifolia*) (Younkin 1974) and sweetgrass (*Hierochloe odorata*) (Klebesadel 1974) but it must be recognized that there are many other species and numerous northern ecotypes which produce seed in quantities sufficient to make commercial utilization feasible. Native seed can be obtained for northern revegetation purposes, but because of the lack of a definite market, specific seed required must be grown on a contract basis, and a lead time of two to four years, depending upon ecotype desired, is necessary.

1.2.2 Nutrient Requirements

Two other important factors in revegetation are the soil nutrient regime and plant nutrient requirements. Arctic soils, and to a somewhat lesser extent subarctic soils, are acknowledged to be nutrient deficient (Dadykin 1958, Foothills 1979d, Haag 1974, Mitchell 1972, Savile 1972). In some cases in the arctic, nitrogen has been deduced to be the limiting factor for plant growth (Haag 1972 and 1974, Savile 1972) whereas in other instances phosphorus was probably limiting (Mitchell 1972). There are two important aspects of the nutrient regime: the amount of nutrients and the rate of nutrient cycling. It is the interaction between these two which determines the nutrient availability for the plant. From the plant's perspective, the nutritional status of the soils is very much interconnected with the low soil temperatures characteristic of soils in permafrost areas. Permafrost reduces the total amount of available nutrients by immobilizing nutrients beneath the active layer and can also reduce rates of mineral weathering, organic matter decomposition and release of important nutrient elements such as nitrogen by decreasing chemical reactions and microbial metabolic rates. Thus nutrient recycling is reduced and more nutrients

are immobilized so that they are unavailable to plants. The importance of these limitations varies according to such factors as solubility and the degree of biotic control in the cycling of the particular nutrient. Also, differences in nutrient cycling systems may occur between native and reclaimed plant communities (Ziemkiewicz 1979).

Another consideration regarding nutrients is that disturbances which remove most of the topsoil will concomitantly remove most of the available nutrients. Similarly, in cases where the topsoil is buried beneath or is mixed with the subsoil, as in some strip mining or in covering a pipeline, the growth medium may be especially nutrient poor. Nutrient uptake by native plants may not be inhibited by low soil temperatures (Chapin 1974a and b), but low temperatures do appear to inhibit uptake and growth in introduced species (McCown 1972 and 1973). Furthermore, there is some evidence that even native plant species may be affected by low temperatures that limit phosphorus metabolism and hence, indirectly, limit growth (Haag 1974). Soil textural properties are also very important, since coarse soils can not retain as large a supply of nutrients as can fine-textured soils.

In the subarctic, muskeg communities underlain by permafrost may be particularly nutrient poor (Heilman 1968). A study of a young subarctic aspen stand showed that nitrogen, phosphorus, and potassium fertilization all increased diameter growth significantly and that nitrogen also increased the tip growth (Van Cleve 1972). Hence nutrients may also be limiting in the subarctic despite the higher temperatures and longer growing seasons. Consequently fertilization is often considered the most important single technological advance in revegetation. Many researchers claim that fertilization is necessary for establishment and growth of agronomic cultivars (Hernandez 1973, Mitchell 1972, Van Cleve and Manthei 1971, Younkin 1972). Especially in cases where the organic mat has been removed, the loss of the nutrient pool as well as the low rate of microbial decomposition accentuate the need for fertilization (Van Cleve 1973).

Sampling and analysis of soils in the corridor of the Yukon segment of the Alaska Highway Gas Pipeline route indicated that nitrogen and phosphorus levels were consistently low while potassium levels varied from location to location (Foothills 1979d). However, as Berg (1978) points out, field calibration* is necessary as both soil (Rieger 1974) and plant (Billings 1973 and 1974, Billings and Mooney 1968, Bliss 1971) processes vary from those found in more moderate regions.

Various investigators connected with the Canadian Arctic Gas consortium established fertilizer studies at Prudhoe Bay (Mitchell and McKendrick 1974 and 1975), Tuktoyaktuk (Hernandez 1973, Younkin 1972), Inuvik (Hernandez 1973, Younkin 1974) and Sans Sault (Dabbs et al 1974, Younkin and Friesen 1976). Similar results were obtained in all of these studies; in cold, low nutrient soils, phosphorus, closely followed by nitrogen, appears to be the nutrient most limiting to plant growth. This is similar to the findings of Dadykin (1958) and others which suggest that at low temperatures, nitrogen assimilation may be reduced due to a reduction in phosphorus uptake and the resultant reduction in the formation of the high energy phosphate bonds necessary for nitrogen metabolism.

However, recommendations for fertilizer type and amount vary considerably among these investigators. Figures reported include 39, 79 and 79 kg/ha of N, P_2O_5 and K_2O, respectively at San Sault (Dabbs et al 1974), 56, 112 and 90 kg/ha of N, P_2O_5 and K_2O, respectively at Prudhoe Bay (Mitchell and McKendrick 1974 and 1975) and 112 and 235 kg/ha of N and P_2O_5, respectively in the Mackenzie Delta (Hernandez 1973). In a more southerly study at Haines Junction successful seedling emergence was achieved with 16-20-0 commercial fertilizer applied at 160 kg/ha (Foothills 1979b).

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* Calibration = the relationship found in field studies between soil test values and yield response from incremental rates of the nutrient applied in the field.

Other problems associated with fertilization include rapid nitrogen depletion (Mitchell and McKendrick 1975) through NH_4^+ volatilization losses or NO_3^- leaching losses. Therefore, refertilization may be necessary to sustain growth in future years.

1.2.3 Time of Seeding

Timing of seeding affects germination and overwintering success. During the dry part of the summer the surface of some soils tends to become very dry and occasionally quite hot. If seeds are broadcast just prior to this time and germinate under such harsh conditions they may often experience heavy mortality (Hernandez 1973, Mitchell and McKendrick 1974). Seeding late in the growing season may increase winterkill, since plants may not have time to become "winter-hardy" after they germinate and before frosts occur (Klebesadel 1970b). Snow and early spring seeding can utilize the moisture available from snow melt. Thus the growing season can be extended since seeds will be encouraged to germinate once temperatures rise to appropriate levels. Early spring seeding may prove very beneficial for species which require considerable moisture for germination but which lose viability if subjected to the prolonged cold and moist period resulting from fall seeding. Also, early spring seeding may prove very useful in regions which experience prolonged late spring and early summer droughts.

One study indicated that seeding on snow produced higher cover than seeding in May or September (Foothills 1979c) while another indicated no substantial differences between May and September seeding (Foothills 1980). Consequently, snow seeding may be preferable but relevant information is very limited at the present time.

1.2.4 Mulches

The direct application of mulch or other soil amendments may be justified in revegetation of critical difficult areas. Mulches modify the microclimate by increasing infiltration, decreasing run-off and by reducing temperature fluctuations. Mulches may also protect young seedlings from the effect of wind or moving soil particles and may prevent soil loss. In the southern United States grasses emerged at lower moisture levels when a mulch was applied but these benefits were greater during periods of high temperatures than low temperatures (Moldenhauer 1959). On an alpine site in northern Idaho, native hay held down by chicken wire increased grass establishment (Gates 1962). In same study the use of sawdust, evergreen boughs or asphalt emulsions did not increase stand establishment. On coal spoil banks jute netting or straw held down by wire netting increased stand establishment six times but costs exceeded $1500.00 per acre ($3706.00 per hectare) (Jacoby 1969). Other materials used as mulches include wood fibre, excelsior mats and polyethylene sheets. Frequently the hay, straw or wood fibre is held in place with an organic glue such as Terratack II or Ecology Control or by chemicals such as polyvinyl acetate. Kay (1976) compared costs and found figures ranging from $600.00 to $6700.00 per acre ($1482.00 to $16,555.00 per hectare). Gaskin et al (1978) found that straw tacked down with Terratack I, a gum derived from guar (*Cyamposis tetragonoloba* D.C.) was more effective than jute netting in prevention of soil loss in Alaska. They also tested various combinations of hay, hydro mulch, peat moss and a wood fibre cellulose blanket. Results were similar in terms of growth and soil loss but costs exceeded $6000.00 per hectare.

2.0 OBJECTIVES

The success of any revegetation program is dependent upon a variety of factors - both biotic and abiotic. Some of the latter, such as length of frost free period and amount of precipitation during the growing season are beyond man's direct control. However others, such as choice of plants, soil nutrient levels and microclimate can be manipulated in an effort to maximize the probability of success.

The study described herein has the general objective of gaining information applicable to revegetation of the Alaska Highway Gas Pipeline route. However, within this overall purpose there are specific variables which are under study.

2.1 PLANT SELECTION

The use of native ecotypes or agronomic cultivars is a constant topic of debate throughout revegetation literature. Most agronomic cultivars have failed in northern regions while northern ecotypes have often performed better (Mitchell and McKendrick 1975). However, these two classes of plants had not been field tested along the Alaska Highway. Consequently, a major objective of this program was and is to evaluate initial and long term success of seed mixtures composed of (a) agronomic cultivars and (b) northern ecotypes. The success of individual species within the mixtures is also under study. After evaluation of results appropriate seed mixtures can be selected for each of the revegetation sections.

2.2 FERTILIZATION

As discussed in Section 1.2.2 fertilization is considered essential for revegetation success in more northerly areas, but site-specific studies had not been conducted along the Alaska Highway corridor. Consequently, at each primary site growth resulting from application of slow and rapid release fertilizers is under study. Unfertilized control plots

are also included at each primary site. At each secondary site the addition of potassium sulfate and a complete micronutrient fertilizer is under study. Results will determine the formulation of the fertilizers applied in each region.

2.3 MULCHES

At each primary site the effect of a cellufibre mulch is being monitored and at each secondary site the use of hay as a mulch is under study. Results will determine if any benefits accrue from either mulch and final recommendations will incorporate these observations.

2.4 TIME OF SEEDING

At each primary site three different seeding times are under study. If results indicate that a specific time of seeding provides superior results then revegetation can be undertaken at this time. If differences are slight then revegetation can proceed whenever most convenient from a logistic viewpoint.

In 1979, the objectives of the program were to complete plot establishment with the early spring seeding of the primary sites and to evaluate plant growth and development at all locations.

3.0 METHODS

The test sites were established proximal to the Alaska Highway on areas previously disturbed by construction but which will be free of future disturbance for a minimum of five years. Slope and soil type were factors considered but the availability of the land was the prime consideration. The primary objective in site selection was to locate, in each physiographic region, a site which was representative of conditions in that region. Consequently, uniformity of soil or aspect within a site was not considered a major objective in site selection. In all cases the growth medium consisted of "C" horizon as the "A" and "B" horizons had been removed by the previous disturbance.

3.1 PRIMARY SITE ESTABLISHMENT

3.1.1 Plot Design

At each location 480 sq. m. of land was designated as the primary test site. A split plot technique was used to study the effect of treatment variables. Four main plots were delimited and these were then divided into two subplots and three sub-subplots. Each treatment was replicated twice. The size of each sub-subplot was two by five meters. The treatments at each site were as follows:

a) Main Plots

1) Seeded in late May, 1978 - no mulch applied
2) Seeded in late May, 1978 - mulch applied
3) Seeded in September, 1978 - no mulch applied
4) Seeded in early May, 1979 - no mulch applied

b) Subplots

1) Seeded to an agronomic cultivar seed mix
2) Seeded to a northern ecotype seed mix

c) Sub-Subplots

1) 19-26-0 fertilizer applied
2) 34-0-0 & 0-45-0 fertilizer applied
3) no fertilization

A typical field plan is found in Figure 2 while exact plot layouts, which differ slightly among the sites, are found in Appendix A.

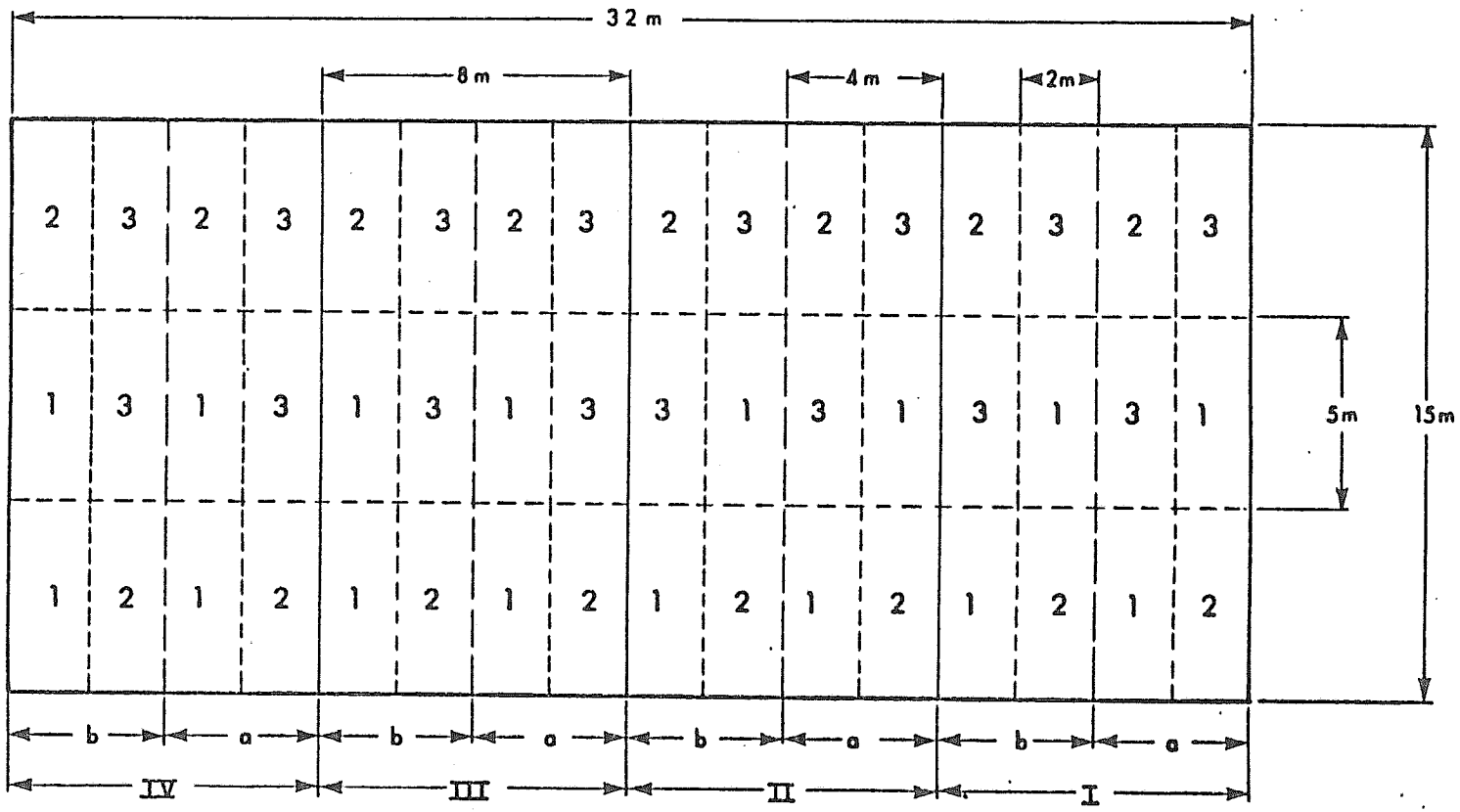
3.1.2 Seedbed Preparation

The amount of seedbed preparation varied from location to location, depending upon the amount of existing vegetation, dead branches and rocks. However, the basic procedure was similar throughout.

Initially rocks, large shrubs and dead branches were removed by hand. Subsequently each site was rototilled to eliminate the majority of the prevailing vascular plants indigenous to each location. Depending upon the amount of existing vegetation, one to three passes at an approximate depth of 8 cm were required for uprooting of native plants. At those locations where native ground cover had been extensive the uprooted vegetation was then raked off by hand.

3.1.3 Seed Mixes

The seed mixtures, which vary from location to location, are listed in Appendix B. At each location, one half of the plots were seeded to a mixture of agronomic cultivars of grasses and legumes. The remaining plots were seeded to a mixture of native species and naturalized landraces of grasses and legumes. This procedure was repeated on each seeding date.



I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX

b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 2

EXAMPLE FIELD PLAN OF A PRIMARY TEST SITE

3.1.4 Fertilizer Treatments

Two different fertilizer treatments were tested. Each fertilizer was applied to one third of the plots and the remaining plots were left as unfertilized controls. The two fertilizers tested are described below.

a) A special blend of sulfur coated urea and superphosphate, mixed to obtain a formulation of 19-26-0, was applied to obtain approximate rates of 80 kg/ha and 120 kg/ha of N and P respectively.

b) A combination of ammonium nitrate (34-0-0) and triple superphosphate (0-45-0) was applied at 80 kg/ha N and 120 kg/ha P respectively.

The plots seeded in late May, 1978 and early May, 1979 were fertilized at the time of seeding while the plots seeded in September, 1978 were fertilized in early May, 1979.

3.1.5 Mulch

One half of the plots seeded in May, 1978 were mulched with a cellufibre mulch applied at approximately 550 kg/ha. No hydroseeder was available so the mulch was applied by hand and water was then applied to retain the mulch on the soil surface. Originally this mulch was also to be applied to the plots seeded in September, 1978 but field observations in the summer of 1978 indicated no discernible benefit from the mulch. Consequently, the decision was made to omit the mulch treatment at the time of the September seeding. Instead the remaining plots were seeded in the early spring of 1979 so that any benefits accruing from utilization of the moisture from snow melt could be more clearly ascertained.

3.1.6 Method of Establishment

After removal of native vegetation the plots were seeded and fertilized by hand. Subsequently each plot was lightly raked so as to mix the seed, fertilizer and soil. During each of these operations care was taken to avoid mixing of treatments. The soil was then compacted with a roller and the cellufibre mulch was applied to the appropriate plots using methods described in Section 3.1.5.

3.2 ESTABLISHMENT OF SECONDARY SITES

3.2.1 Plot Design

At each location, 240 sq. m. of land, located adjacent to the primary site, was designated as the secondary site. A randomized block design was used with each block three by ten metres. Each treatment was replicated twice. The following treatments were used:

a) Hay mulch
b) Micronutrient fertilizer
c) Potassium sulfate fertilizer
d) Control

A typical site plan is found in Figure 3 while exact plot layouts, which differ slightly among the sites, are found in Appendix A.

3.2.2 Seedbed Preparation

Seedbed preparation was identical to that described for the primary sites in Section 2.1.2.

3.2.3 Seed Mixes

Seed mixtures differed among sites but in all cases consisted of a combination of northern ecotypes and agronomic cultivars of grasses

and legumes. The seeding rate was approximately 40 kg/ha at all sites. The composition of the mix used at each site is found in Appendix B.

3.2.4 Treatments

The effects of three treatments on plant growth were tested at the secondary sites. One treatment consisted of the application of a hay mulch upon completion of seeding. This was applied by hand to a depth of 1 cm and was stabilized with a semi-refined seaweed extract commercially known as Terra-Tack II.

A second treatment involved application of a potassium sulfate fertilizer at 150 kg/ K_2O per hectare while a third consisted of the application of a special micronutrient fertilizer. This latter fertilizer consisted of 30 kg Mg, 35 kg S, 1 kg B, 2.5 kg Cu, 4 kg Zn, 4 kg Mn, 30 kg Fe and 4 kg Mo per hectare.

A fourth treatment consisted of an unamended control plot.

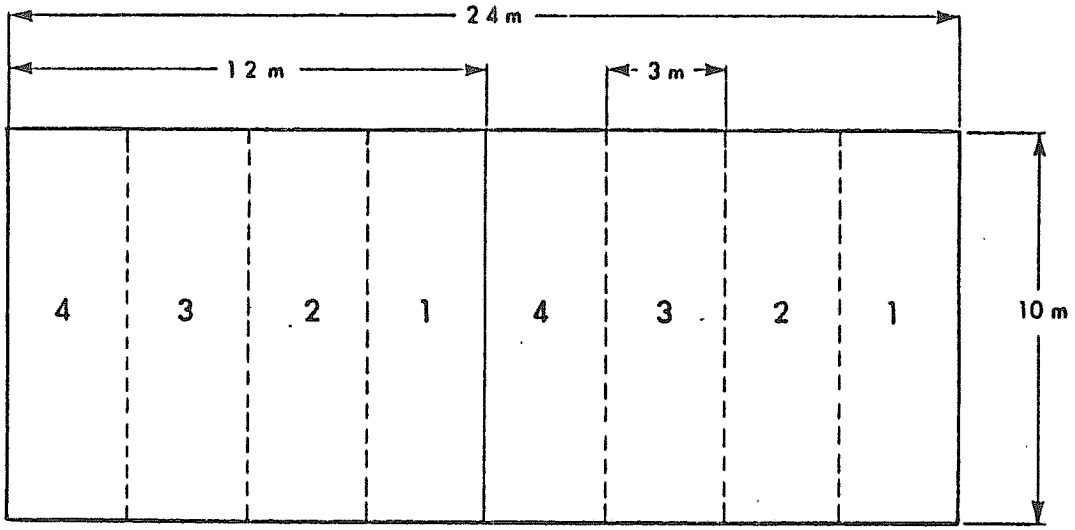
3.2.5 Method of Establishment

After removal of native vegetation the secondary sites were hand seeded and fertilized with 19-26-0 fertilizer at approximately 80 kg/ha N and 120 kg/ha P. This was done to minimize any inherent macronutrient deficiencies at the sites. The two special fertilizer treatments (see Section 3.2.4) were then applied to the appropriate plots and the soil was raked and lightly compacted. Finally the hay mulch and tackifier were applied to the appropriate plots.

3.3 EVALUATION

3.3.1 Total Ground Cover

Total ground cover obtained with each treatment was visually estimated. A 1 sq. m. quadrat was randomly placed twice within each replicate



1. HAY MULCH
2. MICRONUTRIENT FERTILIZER
3. SULFATE OF POTASH FERTILIZER
4. CONTROL

SCALE - 1:200

FIGURE 3

EXAMPLE FIELD PLAN OF A SECONDARY TEST SITE

and a visual estimate of ground cover was made each time. These estimates were then averaged and rounded to the nearest 5% to obtain the final ground cover figures.

3.3.2 Species Composition

The amount of cover provided by each seeded species was also estimated. For this estimate the entire plot was assessed visually and the estimates for each replicate were averaged to obtain the mean cover provided by each species. These figures were then rounded to the nearest 5%.

3.3.3 Vigour

The collective vigour ratings for each treatment were obtained by calculating the proportional vigour contribution of each species and then totalling these values. A simplified example follows:

EXAMPLE:

Species	Proportion of Cover	Vigour	Proportional Vigour (Vigour x Cover)
Agrostis gigantea	.25	5	1.25
Festuca rubra	.35	4	1.40
Poa palustris	.20	5	1.00
Trifolium hybridum	.20	5	1.00
COLLECTIVE			4.65 = 5

These values were then rounded to the nearest integer.

The individual species vigour ratings were based upon the gross morphology and phenology of each species. Twenty plants of each species were assessed except in situations where twenty plants had failed to emerge. In this latter case all plants of the species were assessed. Plant

characters considered in this visual rating included leaf colour, leaf width and length, tillers, signs of disease and seed production.

The numerical 1, 2, 3 and 4 values should generally be interpreted as corresponding to the words poor, fair, average and strong respectively. The 5 rating denotes successful phenological development of the entry. This was only used for entries which were rated 4 for gross morphology and which had produced seed on a minimum of 50% of plants.

4.0 RESULTS

4.1 PRIMARY SITES

4.1.1 Beaver Creek

In 1979 plant growth remained strong at the Beaver Creek primary site. Ground cover generally increased on all plots established in May, 1978. Differences attributable to the experimental treatments were largely confined to the effect of fertilizer as no substantial differences in cover occurred between the mulched and unmulched plots and differences between seed mixes were confined to the plots fertilized with the combination of 34-0-0 & 0-45-0 fertilizer. With this fertilizer combination the northern ecotype seed mix produced mean cover of 73% while the agronomic cultivar seed mix produced mean cover of 45%. However, the overriding factor was fertilizer effect as plants on plots fertilized with 19-26-0 produced mean cover of 95% while plants on the plots fertilized with 34-0-0 & 0-45-0 produced mean cover of 69% and those on the unfertilized control plots produced mean cover of 55%.

A similar trend was apparent on the plots established in September, 1978 and May, 1979. Mean ground cover on the plots seeded in September, 1978 was 78 and 40% for the plots fertilized with 19-26-0 fertilizer and the combination of 34-0-0 & 0-45-0 respectively. Mean ground cover on the unfertilized control plots seeded in September was 25%. On plots seeded in May, 1979 mean ground cover of 50% occurred on the plots fertilized with 19-26-0. On the plots seeded in May, 1979 which were fertilized with 34-0-0 & 0-45-0 mean cover of 15% was attained while mean cover of 3% was attained on the unfertilized controls. No substantial differences in cover production occurred between seed mixes.

Vigour of the plants was high as plants on the plots seeded in May, 1978 and fertilized with 19-26-0 were rated at 5 while vigour of the

plants on the other plots established in May, 1978 varied from 3 to 5. Vigour of the plants on plots seeded in September, 1978 was also high as plants on plots fertilized with 19-26-0 were rated at 4 while plants on plots fertilized with the combination of 34-0-0 & 0-45-0 and plants on the unfertilized control plots were rated at 3. Plant vigour on the plots seeded in May, 1979 was slightly lower as plants on the plots fertilized with 19-26-0 were rated at 3 or 4 while plants emergent on plots receiving the other fertilizer treatments were rated at 2. Few signs of winterkill or insect damage were observed on any plants at the Beaver Creek site.

On the plots seeded in May, 1978 to the agronomic seed mix the majority of cover was provided by three grasses; timothy (*Phleum pratense*), red top (*Agrostis gigantea*) and red fescue (*Festuca rubra*) and one legume, alsike clover (*Trifolium hybridum*). However, on some plots Canada bluegrass (*Poa compressa*) and streambank wheatgrass (*Agropyron riparium*) provided 10% of the cover. Proportional species emergence on the plots established in September, 1978 and May, 1979 was similar but timothy (*Phleum pratense*) generally provided more cover and alsike clover (*Trifolium hybridum*) generally provided less than on the plots seeded in May, 1978.

On plots seeded in May, 1978 to the northern ecotype seed mix the proportion of cover provided by each species was more even as eight of ten species provided at least 10% of the cover on some plots. The two species which failed to make a substantial contribution were alfalfa (*Medicago sativa*) and Kentucky bluegrass (*Poa pratensis*). On the plots established in September, 1978 and May, 1979 cover was dominated by fowl bluegrass (*Poa palustris*) which provided from 25 to 65%.

Complete results obtained with each treatment at Beaver Creek are found in Table 2 while the proportion of the cover provided by each species is found in Tables 1-8 in Appendix C.

TABLE 2

GROUND COVER AND PLANT VIGOUR ON THE TEST PLOTS AT THE BEAVER CREEK PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	50	55	4	60	95	5	35	40	3
Agronomic Mix - No Mulch	30	55	5	70	95	5	45	50	3
Northern Mix - Mulch	45	45	3	70	95	5	40	75	4
Northern Mix - No Mulch	40	65	4	65	95	5	40	70	4
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		25	3		75	4		40	3
Northern Mix		25	3		80	4		40	3
EARLY MAY, 1979 SEEDING									
Agronomic Mix		5	2		40	3		15	2
Northern Mix		<5	2		60	4		15	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

4.1.2 Destruction Bay

In 1979 ground cover at Destruction Bay decreased up to 55% on the plots established in May, 1978. This occurred because the site was heavily grazed in the spring by horses and cattle and these animals preferred the seeded species to ubiquitous invader species such as foxtail barley (*Hordeum jubatum*). Consequently, all plots established in May, 1978 were dominated by this vagile invader. In 1979 the seeded species produced ground cover ranging from 10 to 50%. No substantial differences in cover occurred between the seed mixes but mulch and fertilizer effects were recorded. In all cases plants on the unmulched plots produced more cover than plants on the mulched plots and plants on plots fertilized with 19-26-0 fertilizer produced more cover than plants on plots fertilized with the combination of 34-0-0 & 0-45-0 or plants on the unfertilized control plots. The maximum cover attained with any combination of experimental variables was 50%. This occurred on the unmulched plots which were seeded to the agronomic mix and fertilized with 19-26-0.

Plant development was successful on the plots established in September, 1978 and May, 1979 as plants on these plots were not grazed. Consequently, higher ground cover values were recorded on these plots than on the plots established in May, 1978. No major differences in plant cover or vigour occurred between the two seed mixes but differences in cover did occur as a result of the different fertilizer treatments. A higher plant cover was achieved on plots treated with either fertilizer than on the unfertilized control plots. The highest cover value of 70% was achieved on the plots seeded to the northern ecotype mix and fertilized with 19-26-0 in September, 1978.

The vigour of the plants growing on the plots established in May, 1978 which were fertilized with either 19-26-0 or the combination of 34-0-0 & 0-45-0 was high as the collective vigour rating of plants on all such plots was 3 despite the pressure caused by grazing. Plant vigour

on the unfertilized plots established in May, 1978 was generally lower and all plants except those on the mulched plots seeded to the agronomic mix were rated at 2. The plants on these latter plots were rated at 3.

Plant vigour on the fertilized plots established in September, 1978 and May, 1979 was also high as plants on six of eight treatment combination plots were rated at 3 and plants on the plots seeded to the northern ecotype mix which were fertilized with 19-26-0 were rated at 4. Plants on the unfertilized plots were slightly weaker and vigour ratings varied from 2 to 3. Few signs of winter diseases or insect damage were observed on any plants at Destruction Bay.

Ground cover on the plots seeded in May, 1978 to the agronomic seed mix was dominated by slender wheatgrass (*Agropyron pauciflorum*), which provided from 60 to 75% of the cover, and red fescue (*Festuca rubra*), which provided from 20 to 35%. No other species provided more than 5% cover and most were only recorded in trace amounts. Species emergence on the plots seeded to the agronomic mix in September, 1978 and May, 1979 was very similar as, of the other species in the agronomic mix, only timothy (*Phleum pratense*) consistently provided as much as 5% of the cover.

Cover on the plots seeded in May, 1978 to the northern ecotype mix was dominated by slender wheatgrass (*Agropyron pauciflorum*) which provided from 45 to 55%, depending upon the treatment. However, four other species frequently provided at least 10% of the cover on any given plot. These latter species were streambank wheatgrass (*Agropyron riparium*), red fescue (*Festuca rubra*) and two bluegrasses (*Poa glauca* and *P. palustris*). Individual species emergence on the plots seeded in September, 1978 and May, 1979 to the northern ecotype mix was similar as the five species most successful on the plots seeded in May, 1978 again provided the large majority of the cover in approximately the same ratio.

No legumes were successful in either the agronomic or northern seed mixes, regardless of seeding date. In fact, the decrease in plant cover on the plots seeded in May, 1978 was frequently attributable to the disappearance of the legumes and timothy (*Phleum pratense*) which had emerged in 1978.

Complete results obtained with each treatment at Destruction Bay are found in Table 3 while the proportion of the cover provided by each species is found in Tables 9-16 in Appendix C.

4.1.3 Haines Junction

In 1979, ground cover on the plots seeded in May, 1978 was similar to that recorded in the fall of 1978. Ground cover decreased marginally on the unfertilized plots while ground cover on the fertilized plots increased slightly from 1978 to 1979. This site was also grazed by horses and the seeded species were more palatable than the native vegetation which is dominated by sweetgrass (*Hierochloe odorata*). Consequently, increases in ground cover resulting from development of the seeded species were less than what would have been the case without this grazing pressure. Ground cover differences attributable to the use of the mulch or to the composition of the seed mixes were marginal but plants on plots seeded to the agronomic mix achieved slightly higher ground cover than plants on plots seeded to the northern ecotype mix. Similarly, plants on mulched plots achieved slightly higher ground cover than plants on the unmulched plots. However, the largest effects attributable to experimental variables occurred in response to fertilization. Plants on plots fertilized with 19-26-0 attained mean ground cover of 40% and plants on the plots fertilized with the combination of 34-0-0 & 0-45-0 attained mean ground cover of 31%. In contrast, plants on the unfertilized control plots only attained mean ground cover of 11%. The highest ground cover was attained by plants growing on mulched plots which had been fertilized with 19-26-0 and seeded to the agronomic seed mix. Mean ground cover on these latter plots was 50%.

TABLE 3

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE DESTRUCTION BAY PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	55	20	3	85	30	3	70	15	3
Agronomic Mix - No Mulch	35	35	2	50	50	3	40	35	3
Northern Mix - Mulch	25	10	2	75	35	3	75	20	3
Northern Mix - No Mulch	20	15	2	65	40	3	45	30	3
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		20	3		65	3		60	3
Northern Mix		15	2		70	4		65	3
EARLY MAY, 1979 SEEDING									
Agronomic Mix		10	2		45	3		45	3
Northern Mix		15	3		55	4		55	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

Seedling development on the plots seeded in September, 1978 and May, 1979 was slow regardless of seeding date or fertilizer treatment. Highest ground cover values of 10% were attained on plots fertilized with 19-26-0 and seeded to either seed mix in September, 1978. Ground cover obtained with all other combinations of experimental variables was 5% or less.

Plant development on the fertilized plots established in May, 1978 was adequate despite the effects of grazing. The collective vigour of the plants on each fertilized plot was 3. Plant development on the unfertilized plots established in May, 1978 was less vigorous and all collective vigour ratings of plants on the unfertilized plots were 2. Plant vigour on the plots established in September, 1978 and May, 1979 was generally low as all except plants growing on plots subject to one specific combination of experimental variables were rated at 1 or 2. The exception was the plants on plots fertilized with 19-26-0 and seeded to the northern seed mix in September, 1978. Plants on these latter plots were rated at 3 for vigour.

In 1979 ground cover on the plots seeded in May, 1978 to the agronomic seed mix was dominated by red fescue (*Festuca rubra*) and crested wheatgrass (*Agropyron cristatum*) which together provided at least 60% of the cover on all plots. Streambank wheatgrass (*Agropyron riparium*) and sheep fescue (*Festuca ovina*) each provided at least 10% cover on nearly all plots while the other grasses were present in lesser amounts. The legumes still had no emergence. The major differences in cover composition between 1978 and 1979 were the increased cover provided by red fescue (*Festuca rubra*) and the decreased cover production of streambank wheatgrass (*Agropyron riparium*) in 1979. In 1978 the amount of cover provided by each of these species had been the inverse of that provided in 1979.

Individual species emergence on the plots seeded to the agronomic mix in September, 1978 and May, 1979 was dominated by two wheatgrasses (*Agropyron cristatum* and *A. riparium*), red fescue (*Festuca rubra*) and timothy (*Phleum pratense*). These four species collectively provided 95% of the cover on all plots.

Plant cover on the plots seeded in May, 1978 to the northern ecotype mix was dominated by four wheatgrasses (*Agropyron* spp.) and red fescue (*Festuca rubra*). However, the wheatgrasses generally decreased in relative cover production from 1978 to 1979 while the fescue increased to the point that it now provided as much as 35% of the cover on some plots. The only other species to provide more than trace amounts of cover was glaucous bluegrass (*Poa glauca*), which provided up to 10%.

On the plots seeded in September, 1978 and May, 1979 to the northern ecotype mix, ground cover was also dominated by the four wheatgrasses (*Agropyron* spp.) and red fescue (*Festuca rubra*) but the fescue was even more dominant as it provided from 45 to 60% of the ground cover. No legumes emerged on any plot seeded to the northern ecotype seed mix.

Complete results obtained with each treatment at Haines Junction are found in Table 4 while the proportion of the ground cover provided by each species is found in Tables 17-24 in Appendix C.

4.1.4 Marsh Lake

The seed mixtures seeded in May, 1978 to the Marsh Lake plots produced minimal amounts of plant cover in 1978 as no plot had 5% ground cover. In 1979 ground cover on the fertilized plots increased as values ranged from a high of 30% on the mulched plots fertilized with the combination of 34-0-0 & 0-45-0 and seeded to the agronomic mix to less than 5% on

TABLE 4

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE HAINES JUNCTION PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	25	15	2	40	50	3	25	40	3
Agronomic Mix - No Mulch	15	10	2	35	40	3	20	20	3
Northern Mix - Mulch	15	10	2	30	40	3	25	30	3
Northern Mix - No Mulch	15	10	2	25	30	3	20	25	3
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		5	2		10	2		5	2
Northern Mix		<5	2		10	3		5	2
EARLY MAY, 1979 SEEDING									
Agronomic Mix		<5	1		5	2		<5	1
Northern Mix		<5	1		5	2		<5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

the unmulched plots seeded to the northern ecotype mix. Differences attributable to the experimental variables were slight but, in general, superior results were attained on plots which were either mulched, seeded to the agronomic mix or fertilized with the combination of 34-0-0 & 0-45-0. The unfertilized plots still had less than 5% ground cover regardless of other experimental variables.

First year plant growth on the plots seeded in September, 1978 and May, 1979 was minimal as only plants on plots fertilized with 19-26-0 produced as much as 5% ground cover.

Seedling vigour was low on all plots as no plants on any plot attained a collective vigour rating of 3 and most were rated at 1. Mild fertilizer effects were apparent as all plots on which the plants were rated at 2 had received one or other of the fertilizer applications.

Ground cover on the plots seeded in May, 1978 to the agronomic mix was dominated by crested wheatgrass (*Agropyron cristatum*), red top (*Agrostis gigantea*) and red fescue (*Festuca rubra*). These three species increased in cover production from 1978 to 1979. In contrast, streambank wheatgrass (*Agropyron riparium*) and timothy (*Phleum pratense*) decreased in cover production from 1978 to 1979.

Seedling emergence on the plots seeded to the agronomic mix in September, 1978 and May, 1979 was dominated by two wheatgrasses (*Agropyron cristatum* and *A. riparium*), red top (*Agrostis gigantea*) and red fescue (*Festuca rubra*). These four species collectively produced at least 90% of the cover on every plot.

On plots seeded to the northern ecotype mix in May, 1978 ground cover was dominated by four wheatgrasses (*Agropyron* spp.) and red fescue (*Festuca rubra*) as these five species collectively provided at least 90% of the cover on all plots. In general the fescue increased in

TABLE 5

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE MARSH LAKE PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	<5	<5	1	<5	20	2	<5	30	2
Agronomic Mix - No Mulch	<5	<5	1	<5	10	2	<5	15	2
Northern Mix - Mulch	<5	<5	1	<5	10	2	<5	5	2
Northern Mix - No Mulch	<5	<5	1	<5	<5	1	<5	<5	1
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		<5	1		5	2		<5	1
Northern Mix		<5	1		5	1		<5	1
EARLY MAY, 1979 SEEDING									
Agronomic Mix		<5	1		<5	1		<5	1
Northern Mix		<5	1		<5	2		<5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

cover production from 1978 to 1979 at the expense of the wheatgrasses. Proportionate seedling emergence on the plots seeded to the northern mix on September 1978 and May, 1979 was similar to the cover on plots seeded in May, 1978 as no other species provided even 5% of the cover on any plot.

Legume growth at this site was limited regardless of experimental variables. Some alfalfa seedlings (*Medicago sativa*) emerged but these only provided as much as 5% of the cover on two plots seeded to the northern mix and four plots seeded to the agronomic mix. Alsike clover (*Trifolium hybridum*) emergence was limited to trace amounts.

Complete results obtained with each treatment at Marsh Lake are found in Table 5 while the proportion of the cover provided by each species is found in Tables 25-32 in Appendix C.

4.1.5 Johnson's Crossing

In 1979 plant growth on the plots seeded in May, 1978 at the Johnson's Crossing site was excellent as ground cover increased substantially on all plots. No differences in ground cover were attributable to the variation in seed mixes or to the use of the mulch but substantial differences in ground cover occurred as a result of the different fertilizer treatments. Mean ground cover values of 91 and 52% were recorded on the plots which had been fertilized with 19-26-0 and the combination of 34-0-0 & 0-45-0 respectively while mean ground cover was only 25% on the unfertilized control plots. In particular, the increase in ground cover on the plots fertilized with 19-26-0 was dramatic as the mean cover on these plots had been only 14% in 1978.

A similar trend was evident on the plots seeded in September, 1978 and May, 1979 as plots fertilized with 19-26-0 had the highest ground cover values. However, substantial differences in ground cover production also occurred between the plants on plots seeded in September, 1978 and plants on plots seeded in May, 1979. Plants on the plots

seeded in September attained cover values anywhere from two to eighteen times higher than those of plants on plots seeded in early May, 1979. The highest ground cover of 90% was achieved on the plots fertilized with 19-26-0 and seeded to the northern ecotype mix in September, 1978. The lowest ground cover of less than 5% occurred on the unfertilized plots seeded in early May, 1979. No differences in ground cover production were attributable to differences in the seed mixtures on the plots seeded at these latter seeding times.

Vigour of the plants on the fertilized plots seeded in May, 1978 was high as the plants on plots fertilized with 19-26-0 were rated 5 while the plants on plots fertilized with the 34-0-0 & 0-45-0 combination were rated at 4. Plants on the unfertilized plots seeded in May, 1978 had vigour of 2 or 3. Vigour of the plants growing on the fertilized plots seeded in September, 1978 was also high as the plants on plots fertilized with 19-26-0 were rated at 4 while the plants on the plots fertilized with the combination of 34-0-0 & 0-45-0 were rated at 3. Vigour of the plants on the other plots seeded in September, 1978 and of plants on all plots seeded in May, 1979 was less as all were rated at 2 except for those plants emergent on the plots which were seeded to the agronomic mix in May, 1979 and fertilized with 19-26-0. These latter plants were rated at 3.

Ground cover on the plots seeded to the agronomic mix in May, 1978 was dominated by red fescue (*Festuca rubra*), timothy (*Phleum pratense*), red top (*Agrostis gigantea*) and alsike clover (*Trifolium hybridum*). Of these species, the former two had also provided substantial cover in 1978 but the latter two increased their cover production considerably in 1979. This increase occurred mainly at the expense of streambank wheatgrass (*Agropyron riparium*), which suffered large losses, and Canada bluegrass (*Poa compressa*), which decreased in cover to a lesser extent. The causal agent for the bluegrass losses could not be ascertained but the wheatgrass losses were attributed to damage caused by the northern snow mold pathogen* (*Sclerotinia borealis*).

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* All disease and pathogen identification is tentative as field observations were not confirmed with laboratory studies.

On plots seeded to the agronomic mix in September, 1978 and May, 1979 seedling emergence was dominated by timothy (*Phleum pratense*) and red fescue (*Festuca rubra*). No other species provided even 5% of the cover on any plot seeded at these latter dates.

Ground cover on the plots seeded to the northern ecotype mix in May, 1978 was dominated by red top (*Agrostis gigantea*), red fescue (*Festuca rubra*), fowl bluegrass (*Poa palustris*) and alsike clover (*Trifolium hybridum*) as all increased in cover production from 1978 to 1979. The three wheatgrasses (*Agropyron* spp.) and Canada bluegrass (*Poa compressa*) decreased in proportionate cover from 1978 to 1979 with northern snow mold again a possible causal agent. However, while proportionate cover provided by these latter species decreased the absolute number of shoots did not decrease.

On the plots seeded to the northern ecotype mix in September, 1978 and May, 1979 ground cover was dominated by slender wheatgrass (*Agropyron pauciflorum*) and red fescue (*Festuca rubra*) which collectively accounted for 70 to 85% of the ground cover on each plot. Fowl bluegrass (*Poa palustris*) was the only other consistently successful species as it provided from 5 to 20% of the ground cover on each plot.

Complete results obtained with each treatment at Johnson's Crossing are found in Table 6 while the proportion of the ground cover provided by each species is found in Tables 33-40 in Appendix C.

4.1.6 Swift River

In 1979 plant development increased on the plots seeded at Swift River in May, 1978 as ground cover, which had ranged from less than 5 to 10% in 1978, ranged from 10 to 35% in 1979. No differences were attributable to variation in seed mixes or the use of the mulch but plant cover was greater on plots which had received one or other fertilizer treatment than on the unfertilized control plots. Mean cover values were 33 and 29% for the plots which were fertilized with the 19-26-0 and the 34-0-0 & 0-45-0 combination respectively while mean cover on the unfertilized control plots was only 14%.

TABLE 6

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE JOHNSON'S CROSSING PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	5	30	2	15	90	5	30	50	4
Agronomic Mix - No Mulch	<5	30	2	15	95	5	15	55	4
Northern Mix - Mulch	<5	20	3	15	90	5	20	50	4
Northern Mix - No Mulch	<5	20	2	10	90	5	5	55	4
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		15	2		85	4		50	3
Northern Mix		10	2		90	4		55	3
EARLY MAY, 1979 SEEDING									
Agronomic Mix		<5	2		40	3		5	2
Northern Mix		<5	2		5	2		<5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

Growth on the plots seeded in September, 1978 and May, 1979 was similar as no differences in emergence occurred between seed mixes but mean cover values resulting from the fertilizer treatments were 28, 14 and less than 5% for plots fertilized with 19-26-0, for plots fertilized with the 34-0-0 & 0-45-0 combination and for the unfertilized control plots, respectively. The Swift River site was the only site which had substantially greater cover in 1979 than in 1978 from plants in their first year of development.

The vigour of the plants on fertilized plots, regardless of seeding date, was adequate as most were rated at 3. Plant vigour on the unfertilized plots was less as most were rated at 2.

Ground cover on the plots seeded to the agronomic mix in May, 1978 was dominated by slender wheatgrass (*Agropyron pauciflorum*) and smooth brome (*Bromus inermis*) which collectively provided at least 85% of the cover on all plots. These species had been dominant in 1978 also, but to a lesser extent, as streambank wheatgrass (*Agropyron riparium*) and timothy (*Phleum pratense*), which had also provided substantial cover in 1978, decreased to trace amounts in 1979.

On the plots seeded to the agronomic mix in September, 1978 and May, 1979 cover was dominated by slender wheatgrass (*Agropyron pauciflorum*), timothy (*Phleum pratense*) and red fescue (*Festuca rubra*). Smooth brome (*Bromus inermis*) also provided over 10% cover on two plots.

Ground cover on the plots seeded to the northern ecotype mix in May, 1978 was dominated by slender wheatgrass (*Agropyron pauciflorum*) which provided from 35 to 65%. Cover provided by other species varied considerably from plot to plot but generally smooth brome (*Bromus inermis*), red fescue (*Festuca rubra*) and fowl bluegrass (*Poa palustris*) were also successful. Slender wheatgrass (*Agropyron pauciflorum*) increased it's proportionate cover substantially but proportionate cover losses varied among the other species, depending upon the plot.

Individual species emergence on the plots seeded to the northern ecotype mix in September, 1978 and May, 1979 was not consistent but, in general, fowl bluegrass (*Poa palustris*) and timothy (*Phleum pratense*) produced most cover. Other species which attained 10% cover in several plots were slender wheatgrass (*Agropyron pauciflorum*), red fescue (*Festuca rubra*) and smooth brome (*Bromus inermis*).

Complete results obtained with each treatment at Swift River are found in Table 7 while the proportion of the ground cover provided by each species is found in Tables 41-48 in Appendix C.

4.1.7 Watson Lake

In 1979 cover increased on all plots seeded in May, 1978 at the Watson Lake site. Differences attributable to the use of the mulch or seed mix variation were minor and inconsistent but the effect of the fertilizer treatments was magnified in 1979. Mean cover was 80 and 41% on plots fertilized with the 19-26-0 fertilizer and the 34-0-0 & 0-45-0 combination respectively. On the unfertilized control plots mean cover was 16%. In 1978 cover had been 50, 26 and 5% on these plots respectively. The highest cover values occurred in 1979 on mulched and unmulched plots seeded to the agronomic mix and fertilized with 19-26-0. These had 85% cover in 1979. Plots receiving similar treatments but which were seeded to the northern ecotype mix had mean cover of 80% in 1979.

Plant cover on the plots seeded in September, 1978 and May, 1979 was similar to that at the Johnson's Crossing site as no differences occurred between seed mixes but plots fertilized with 19-26-0 had substantially more cover than those fertilized with the 34-0-0 & 0-45-0 combination or those which were not fertilized. The effect of seeding time was even more pronounced as the September, 1978 seeding produced considerably more ground cover than the early May, 1979 seeding. For example, the plots fertilized with 19-26-0 which were seeded in September, 1978 had a mean cover of 80% while those seeded in early May, 1979 only had a mean cover of 23%. Although mean cover values were lower on the plots

TABLE 7

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE SWIFT RIVER PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	<5	15	2	<5	30	3	<5	30	3
Agronomic Mix - No Mulch	<5	15	2	10	35	3	10	35	3
Northern Mix - Mulch	<5	15	2	5	35	3	5	25	3
Northern Mix - No Mulch	<5	10	2	<5	30	3	<5	25	3
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		5	2		25	3		10	2
Northern Mix		5	2		30	3		15	3
EARLY MAY, 1979 SEEDING									
Agronomic Mix		5	1		30	3		15	2
Northern Mix		<5	1		25	3		15	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

fertilized with the 34-0-0 & 0-45-0 combination and on the unfertilized control plots the cover differences between seeding times were of a similar magnitude on these latter plots.

Plant vigour on all plots seeded in May, 1978 which were fertilized with 19-26-0 was high as all were rated at 5. Plant vigour on the plots fertilized with the 34-0-0 & 0-45-0 combination was also high as the plants emergent from the northern mix were rated at 4 while those emergent from the agronomic mix were rated at 3. Vigour of the plants seeded in September, 1978 was high but plants seeded on May, 1979 were less vigorous. For instance, plants in plots fertilized with 19-26-0 which were seeded in September, 1978 were rated at 4 while those in plots seeded in early May, 1979 were rated at 3 or 2. For all seeding dates the vigour of the plants in the unfertilized control plots was weaker than that of the plants in plots which received either fertilizer treatment.

Cover on the plots seeded to the agronomic mix in May, 1978 was fairly evenly divided among five of the nine seeded species. These were slender wheatgrass (*Agropyron pauciflorum*), red top (*Agrostis gigantea*), red fescue (*Festuca rubra*), smooth brome (*Bromus inermis*) and timothy (*Phleum pratense*). The identical species had been dominant in 1978 but the proportion of timothy declined in 1979 and that of red fescue and smooth brome increased.

Cover on the plots seeded to the agronomic mix in September, 1978 and May, 1979 was dominated by timothy (*Phleum pratense*) which provided from 40 to 75% of the cover on each plot. The only other species to consistently provide 10% cover was slender wheatgrass (*Agropyron pauciflorum*).

Cover on the plots seeded to the northern ecotype mix in May, 1978 was dominated by five of the eleven species. These were red top (*Agrostis*

gigantea), smooth brome (*Bromus inermis*), red fescue (*Festuca rubra*), timothy (*Phleum pratense*) and fowl bluegrass (*Poa palustris*). The only other species to provide 5% cover on any plot were the two wheatgrasses (*Agropyron pauciflorum* and A. *riparium*).

Cover on the plots seeded to the northern ecotype mix in September, 1978 and May, 1979 was dominated by timothy (*Phleum pratense*) which provided from 30 to 70%, depending upon the plot. However, fowl bluegrass (*Poa palustris*) and slender wheatgrass (*Agropyron pauciflorum*) provided from 5 to 35% each, depending upon the plot, while Canada bluegrass (*Poa compressa*) provided 10% of the cover on two plots.

The entries at this site showed definite signs of winter injury and summer leaf and stem diseases. The early spring evaluation indicated that three species in the agronomic mix; streambank wheatgrass (*Agropyron riparium*), timothy (*Phleum pratense*) and Kentucky bluegrass (*Poa pratensis*) had suffered considerable overwintering damage. Similarly, two species in the northern ecotype mix; timothy (*Phleum pratense*) and Canada bluegrass (*Poa compressa*) had also suffered damage. In the case of the streambank wheatgrass (*Agropyron riparium*) signs indicated northern snow mold damage (Pathogen - *Sclerotinia borealis*) but no obvious signs of pathogens were discernible on the other species. It is possible that the cause of injury and some mortality was intra or extracellular ice crystal formation and subsequent disruption of protoplasmic activity.

The fall evaluation disclosed the presence of several pathogens on a variety of species. The most striking was the severity of loose smut damage on both agronomic and northern wheatgrasses (*Agropyron* spp.). This pathogen (*Ustilago* sp.) had attacked all visible seed stalks and had completely eliminated any possibility of natural reseeding in 1980. The other signs of disease were much less conspicuous but signs of ergot (*Claviceps purpurea*) were found on the agronomic cultivar of red fescue (*Festuca rubra*) and on both agronomic and northern smooth

bromes (*Bromus inermis*). Also, powdery mildew (*Erysiphe graminis*) was present on the agronomic cultivar of Kentucky bluegrass (*Poa pratensis*). These latter two pathogens had not inflicted serious damage on the host plants as yet but may weaken the hosts to the point that they succumb more readily to northern winter stress.

Complete results obtained with each treatment at Watson Lake are found in Table 8 while the proportion of the ground cover provided by each species is found in Tables 49-56 in Appendix C.

4.2 SECONDARY SITES

1979 results from the secondary test sites indicated that if adequate N and P is applied then two factors have a large influence on the success of artificial revegetation in the Alaska Highway corridor. The first is an uncontrollable abiotic factor, precipitation, and the second is the influence of a hay mulch, especially in areas subject to drought during the growing season.

Prior to the addition of the experimental treatments at each site all plots were fertilized with 19-26-0 fertilizer. This is the fertilizer treatment most successful on the primary sites and, not surprisingly, plant cover and plant vigour values on the control plots at the secondary sites were comparable to those achieved on the plots fertilized with 19-26-0 at the primary sites. At the secondary sites ground cover on the control plots ranged form 5% at Marsh Lake to 95% at Beaver Creek. Plant vigour varied from 2 at Marsh Lake to 5 at Beaver Creek. Cover increased from 1978 to 1979 at five of the secondary sites, remained similar at Haines Junction and decreased at Destruction Bay This was similar to results from the primary sites as the lack of cover increase at Destruction Bay and Haines Junction was attributable to the grazing pressure at these locations (see Sections 4.1.2 and 4.1.3).

The effects on plant growth of the potassium sulfate and micronutrient fertilizers were negligible as cover and vigour ranges were similar to those discussed above for the control plots at all sites except at

TABLE 8

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE WATSON LAKE PRIMARY SITE

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	Cover[a] (%)		Vigour[b] (1-5)	Cover (%)		Vigour (1-5)	Cover (%)		Vigour (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
LATE MAY, 1978 SEEDING									
Agronomic Mix - Mulch	5	20	2	55	85	5	25	35	3
Agronomic Mix - No Mulch	<5	10	2	40	85	5	30	45	3
Northern Mix - Mulch	5	10	2	45	70	5	20	35	4
Northern Mix - No Mulch	5	25	3	60	80	5	30	50	4
SEPTEMBER, 1978 SEEDING									
Agronomic Mix		10	2		80	4		40	3
Northern Mix		10	1		80	4		40	3
EARLY MAY, 1979 SEEDING									
Agronomic Mix		<5	1		25	2		5	1
Northern Mix		<5	1		20	3		5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1=minimum; 5=maximum development.

the Watson Lake site. The only instance of a substantial increase or decrease attributable to either of these treatments occurred at Watson Lake. Here, the potassium sulfate increased plant cover from 55 to 85%. Cover differences between the control and either treatment at all other sites were 5% or less. Vigour values were identical at all sites for plants on plots of both fertilizer treatments and the control except at Watson Lake where the potassium sulfate increased vigour from 4 to 5.

In contrast to the lack of effect from the fertilizer treatments the addition of the hay mulch substantially improved growth at most sites. This was most evident at Marsh Lake as plants on plots subject to the hay mulch treatment had 55% cover and vigour of 4 while plants on plots of all other treatments had less than 5% ground cover and vigour of 2. Smaller increases in ground cover and plant vigour also occurred at five of the other six sites. The one exception was the Beaver Creek site which had 95% cover and vigour of 5 for all treatments. The plots which had the hay mulch added had the highest ground cover of any plots at either the primary or secondary site at all locations.

Individual species success and incidence of disease closely paralleled that which occurred on the primary site at each location. Complete results obtained with each treatment are found in Table 9 while the proportion of cover provided by each species is found in Tables 1-7 in Appendix D.

TABLE 9

GROUND COVER AND PLANT VIGOUR ON THE PLOTS AT THE ALASKA HIGHWAY SECONDARY REVEGETATION SITES

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
SITE	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
BEAVER CREEK	65	95	5	60	95	5	50	95	5	70	95	5
DESTRUCTION BAY	70	15	3	75	30	3	75	30	3	80	50	4
HAINES JUNCTION	30	25	3	20	30	3	15	25	3	30	40	3
MARSH LAKE	<5	<5	2	<5	<5	2	<5	<5	2	<5	55	4
JOHNSON'S CROSSING	10	65	5	10	80	5	5	75	5	25	90	5
SWIFT RIVER	<5	30	3	<5	40	3	<5	35	3	15	55	4
WATSON LAKE	30	55	4	55	85	5	30	60	4	45	85	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

5.0 DISCUSSION

The program discussed herein has now been underway for two growing seasons and several trends, consistent throughout the pipeline corridor, have been noted. Rigorous conclusions regarding individual species or seed mix success are premature but other factors influencing the restoration of reasonable ground cover have been clarified to a considerable extent.

Climate, or more specifically precipitation during the growing season, had a marked influence on seedling emergence and establishment. The candidate plants at the three mesic sites (Beaver Creek, Johnson's Crossing and Watson Lake) have had much greater success than those at the more xeric locations. This has been true regardless of experimental variable and is extremely pronounced when success at the most mesic site (Beaver Creek) is compared to success at the most xeric site (Marsh Lake). However, despite the large differences in cover production, levels from 30 to 50% were attained even at the semi-xeric Destruction Bay, Haines Junction and Swift River sites. Only at Marsh Lake were ground cover percentages consistently under 30% on the primary site plots which had been established for two growing seasons. Consequently, even though precipitation is an abiotic factor beyond man's control, it would appear that reasonable initial ground cover can be attained in most areas. An attempt to quantify the concept of a "reasonable or adequate ground cover" is somewhat arbitrary but must include consideration of the surrounding native flora and the projected post-construction land use. For instance, in the United States desert shrub lands 5% cover from vascular species is more than adequate but in a Canadian national park recreation area 90% cover may be insufficient. Along the pipeline route the major objective of a revegetation program is the minimization of soil erosion while other objectives include the restoration of a self-supporting ecosystem and aesthetic enhancement in high profile areas. To attain the first two goals it is deemed that, within two years, 50% cover should be achieved in mesic regions while in xeric regions, less subject to water induced erosion, 30%

cover should be attained. Highly erodible slopes and locations where aesthetic values are a prime consideration will need site-specific treatment as cover exceeding 75% may be required.

In xeric regions, such as the Marsh Lake site, microclimate amelioration will likely be necessary if a rapid return of ground cover is required. This leads directly to the first of the treatments under study within the program - the use of mulches. In general, mulches are used to provide physical erosion control or to ameliorate growing conditions for young seedlings. The latter results from an improvement in moisture regime through increased infiltration and decreased evaporation and runoff, a reduction in temperature fluctuation and physical protection of the young seedlings from abrasion. In this study a cellufibre mulch was tested for all fertilizer and seed mixture combinations at the primary sites and a hay mulch/tackifier combination was tested at the secondary sites. Two year results indicated that the cellufibre mulch has had little if any value in promotion of seedling establishment. Only at scattered locations along the corridor have any benefits occurred from this mulch and these were minimal, occurring only in the second year. Thus it appears that the use of a cellufibre mulch will not enhance a revegetation program in the Alaska Highway corridor. An untested exception may be steep slopes which require hydroseeding because of equipment constraints. On such slopes the mulch slurry may assist in retention of the seed on the slope but at present no other benefits appear likely.

In contrast, the use of a hay mulch, retained with an organic tackifier (Terratack II), has proven beneficial throughout the corridor. In particular, a mean ground cover of 55% was attained at the Marsh Lake secondary site with this treatment while no other treatment resulted in even 5% cover after two growing seasons. Results at the more mesic sites were less dramatic but ground cover increases of 25% or more were common throughout the corridor. Thus it appears that the use of a hay mulch will consistently aid establishment and in some xeric regions this treatment may be a requisite if rapid ground cover restoration is desired.

A second factor under study has been the effect of various fertilizer additions. At the primary sites two different methods of nitrogen application have been compared with unfertilized controls. The two treatments were a blend of sulfur coated urea and superphosphate and a combination of ammonium nitrate and triple superphosphate applied to obtain equivalent rates of nitrogen and phosphorus. Two observations were consistent throughout the corridor. The first was the benefit obtained from N and P fertilization, as both treatments were superior to the controls. This was not surprising as most northern studies indicate a lack of available N and P in northern soils (Mitchell and McKendrick 1975, Rieger 1974) and similar trends were reported for soils of the Alaska Highway (Foothills 1979d). Of more importance was the superior growth obtained with the blend of sulfur coated urea and superphosphate.

At nearly every location the use of this latter formulation resulted in greater ground cover and increased vigour in comparison to that obtained from the combination of ammonium nitrate and triple superphosphate. These differences were likely caused by the fate of the nitrogen in the two fertilizer formulations. The sulfur coating around the urea acts as a retardant in the release of the nitrogen while in the case of NH_4NO_3 both ammonium and nitrate are immediately accessible to the elements. Consequently the N in the sulfur coated urea is available for plant growth when needed while the N in the ammonium nitrate may be lost. This loss of N may occur through leaching of NO_3^- or through volatilization of NH_4^+. Both mechanisms probably occur in Yukon Territory but volatilization losses may be the more important, especially on alkaline soils. Consequently, it appears that if fertilization is carried out at the time of seeding then a slow release fertilizer will prove beneficial through an avoidance of nutrient losses prior to seedling emergence.

The other fertilization aspect of the program consisted of testing the effect of micronutrient and potassium additions. Micronutrients are

essential in small quantities for plant growth but little information regarding micronutrient levels in Yukon soils is available. Consequently a complete micronutrient amendment was added to secondary site plots which had also sufficient N and P added to eliminate these macronutrients as possible limiting factors. Results throughout the corridor indicated no benefit from the micronutrient fertilizer.

In more southerly regions a shortage of K is often cited as the factor limiting plant growth. Along the Alaska Highway corridor potassium levels were generally adequate but soil analysis results indicated a deficiency at some locations (Foothills 1979d). Consequently a second treatment at the secondary sites consisted of the addition of potassium sulfate to plots previously fertilized with adequate N and P. Results were consistent with those anticipated from the earlier soil analysis (Foothills 1979d). This analysis indicated low K values at the Swift River and Watson Lake secondary sites. However, three months after fertilization with the potassium sulfate, residual effects were only noticeable at the Watson Lake site. Plant response to the residual effect was demonstrated at the Watson Lake site in 1979 as a substantial increase in cover and vigour from K fertilization only occurred at that site. At the sites where K values were adequate, and at the Swift River site where no residual effect was in evidence, the addition of the potassium sulfate did not increase cover or vigour values over those obtained on the control plots. Thus K fertilization may prove beneficial in specific locations but K values must be determined after termination of pipeline construction activity as no correlation was found between nutrient levels in undisturbed soils and adjacent soils which had been mixed after completion of disturbance (Foothills 1979d).

The influence of seeding date has not been consistent throughout the program. In general, the late May and September seedings achieved similar amounts of ground cover in the first growing season but the amount of cover attained with the early May seeding varied considerably. This latter seeding resulted in slightly higher first year cover at the

Swift River site but also resulted in reduced first year cover at the Johnson's Crossing and Watson Lake sites. In the Trans-Alaska Pipeline System revegetation program an attempt was made to allow for this seasonal variation by dividing the year into times for permanent, dormant, temporary or no seeding (Johnson et al 1977). However, this resulted in considerable reseeding of previously seeded areas. Thus, while it appears that site-specific microenvironmental conditions may substantially affect the success of variations in seeding time, longer term data are required before conclusions can be finalized.

At the present time seed mix and individual species success can not be definitively assessed because the candidate species have not been exposed to a range of winter conditions which may yet have substantial effects upon plant growth and survival. To date, however, the agronomic cultivar and northern ecotype mix have performed well when fertilized with the sulfur coated urea and superphosphate blend. Emergence from both mixes was similar at all sites and few losses occurred over the first winter. Winter disease symptoms associated with the northern snowmold pathogen (*Sclerotinia borealis*) were noticed at most sites but these were minimal except at Johnson's Crossing and Watson Lake. However, even though damage and losses occurred at these latter sites, overall cover increased substantially as unaffected entries greatly increased in vigour. Stem and leaf diseases were mainly confined to the Watson Lake site as signs of *Erysiphe graminis*, *Ustilago* sp. and *Claviceps purpurea* were observed here. Of these pathogens only the loose smut fungus (*Ustilago* sp.) was virulent, and where present it had destroyed most seed stalks on both agronomic and northern wheatgrasses (*Agropyron* spp.).

Individual species success varied among sites but a general trend appeared throughout. The wheatgrasses (*Agropyron* spp.) and timothy (*Phleum pratense*), which had provided the majority of first year cover in 1978, now provided proportionately less. These species had seldom decreased in total cover but had not developed as rapidly as some other

species. Consequently, species such as red fescue (*Festuca rubra*), red top (*Agrostis gigantea*) and fowl bluegrass (*Poa palustris*) now provided a larger proportion of the cover at most sites. Therefore, while the precise species mixtures will vary among revegetation sections, it is probable that all of the above species should be included to ensure both rapid ground cover establishment and a long term maintenance-free ground cover. The performance of the legumes was still weak as only alsike clover (*Trifolium hybridum*) provided substantial cover on any plots and this only occurred on a limited number of plots at the more mesic sites. A final assessment of the individual species used in the seed mixes must await future results.

In summation, it has become apparent that ground cover can be reestablished along the Alaska Highway Gas Pipeline route but precipitation will be a major determining factor in the speed of establishment. A slow release fertilizer and a hay mulch will facilitate growth. Due to the brief period of field testing completed to date and the anticipated effects of continued exposure to severe winter conditions a definitive selection of species for revegetation is not considered appropriate. Subsequent results will be used in formulation of a precise mixture, by weight, for each of the seven revegetation sections. At that time, other species, adapted to specific climatic or edaphic conditions, may be included wherever appropriate. However, based on field results to date and information from other northern revegetation programs, an initial assessment indicates that the species listed in Table 10 are most appropriate for revegetation of the Yukon section of the Alaska Highway Gas Pipeline route.

TABLE 10

PRELIMINARY SEED MIXTURE RECOMMENDATIONS FOR THE SEVEN ALASKA HIGHWAY GAS PIPELINE REVEGETATION SECTIONS

SECTION ONE ALASKA BORDER TO PICKHANDLE LAKE (Pipeline KP 0-88)	SECTION TWO PICKHANDLE LAKE TO CONGDON CREEK (Pipeline KP 88-205)	SECTION THREE CONGDON CREEK TO PINE LAKE (Pipeline KP 205-309)
Agropyron pauciflorum	*Agropyron pauciflorum*	*Agropyron cristatum*
Agropyron sp. (*violaceum*)	*Agropyron riparium*	*Agropyron pauciflorum*
Agrostis gigantea	*Agropyron* sp. (*violaceum*)	*Agropyron riparium*
Alopecurus pratensis	*Festuca rubra*	*Agropyron* sp. (*violaceum*)
Festuca rubra	*Phleum pratense*	*Festuca rubra*
Phleum pratense	*Poa glauca*	*Poa compressa**
Poa palustris	*Poa palustris*	*Poa glauca*
Trifolium hybridum	*Trifolium hybridum*	*Poa pratensis**

SECTION FOUR PINE LAKE TO SQUANGA LAKE (Pipeline KP 309-504)	SECTION FIVE SQUANGA LAKE TO MORLEY LAKE (Pipeline KP 504-624)	SECTION SIX MORLEY LAKE TO BOULDER CREEK (Pipeline KP 624-728)	SECTION SEVEN BOULDER CREEK TO B.C. BORDER (Pipeline KP 728-812)
Agropyron cristatum	*Agropyron pauciflorum*	*Agropyron pauciflorum*	*Agropyron pauciflorum*
Agropyron pauciflorum	*Agropyron* sp. (*violaceum*)	*Agropyron riparium*	*Agropyron* sp. (*violaceum*)
Agropyron riparium	*Agrostis gigantea*	*Agropyron* sp. (*violaceum*)	*Agrostis gigantea*
Agropyron sp. (*violaceum*)	*Festuca rubra*	*Bromus inermis*	*Bromus inermis*
Agrostis gigantea	*Phleum pratense*	*Festuca rubra*	*Festuca rubra*
Festuca rubra	*Poa compressa*	*Phleum pratense*	*Phleum pratense*
Poa compressa	*Poa palustris*	*Poa compressa*	*Poa palustris*
Poa glauca	*Trifolium hybridum*	*Poa palustris*	*Trifolium hybridum*

* Included because of its performance in the Haines Junction Revegetation Program (Foothills 1980).

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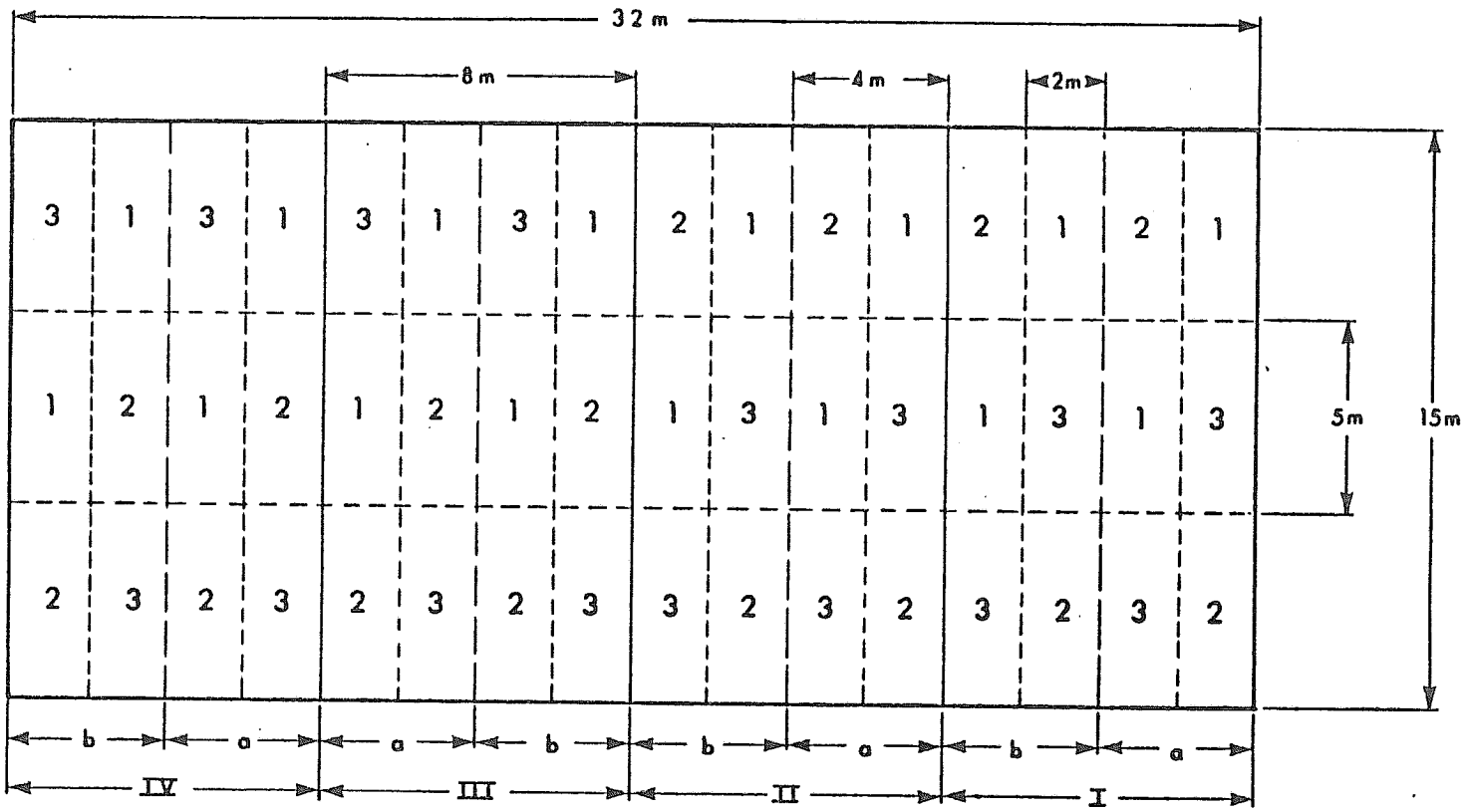
APPENDIX A

FIELD PLANS OF THE ALASKA HIGHWAY REVEGETATION TEST SITES

LIST OF FIGURES



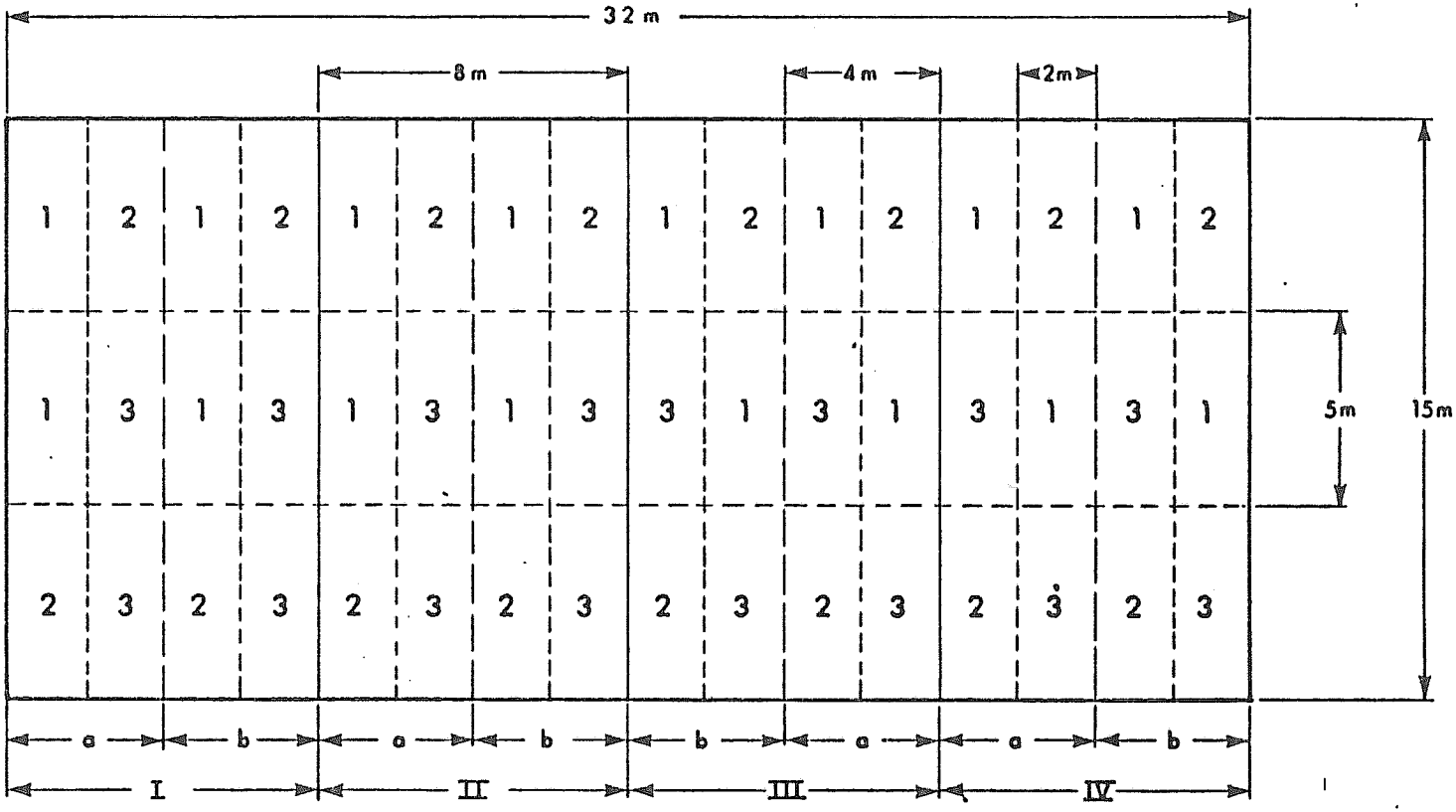
I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX

b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 1

BEAVER CREEK PRIMARY SITE FIELD PLAN

(HIGHWAY KP 1936.7)

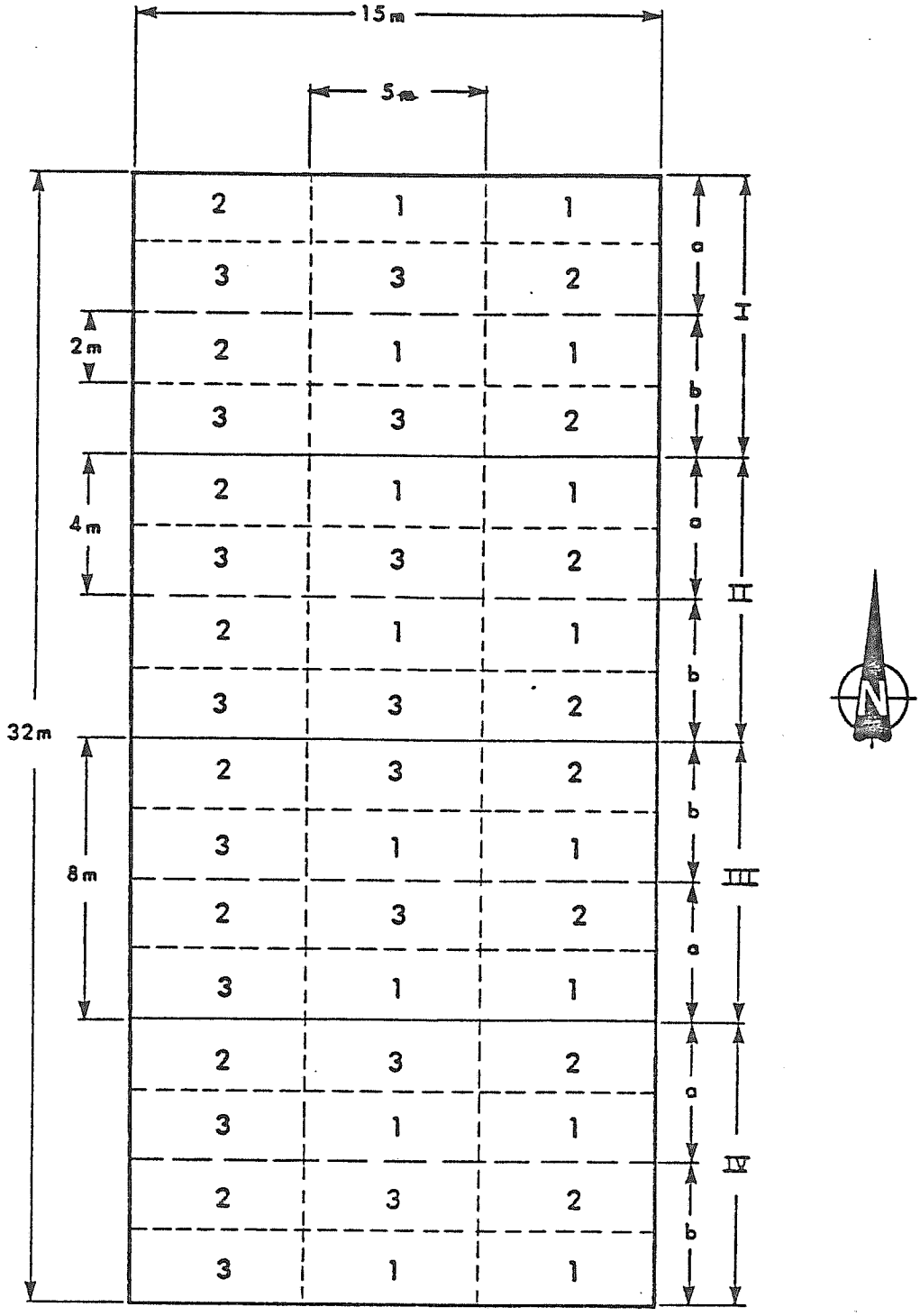


I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX
b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 2

DESTRUCTION BAY PRIMARY SITE FIELD PLAN

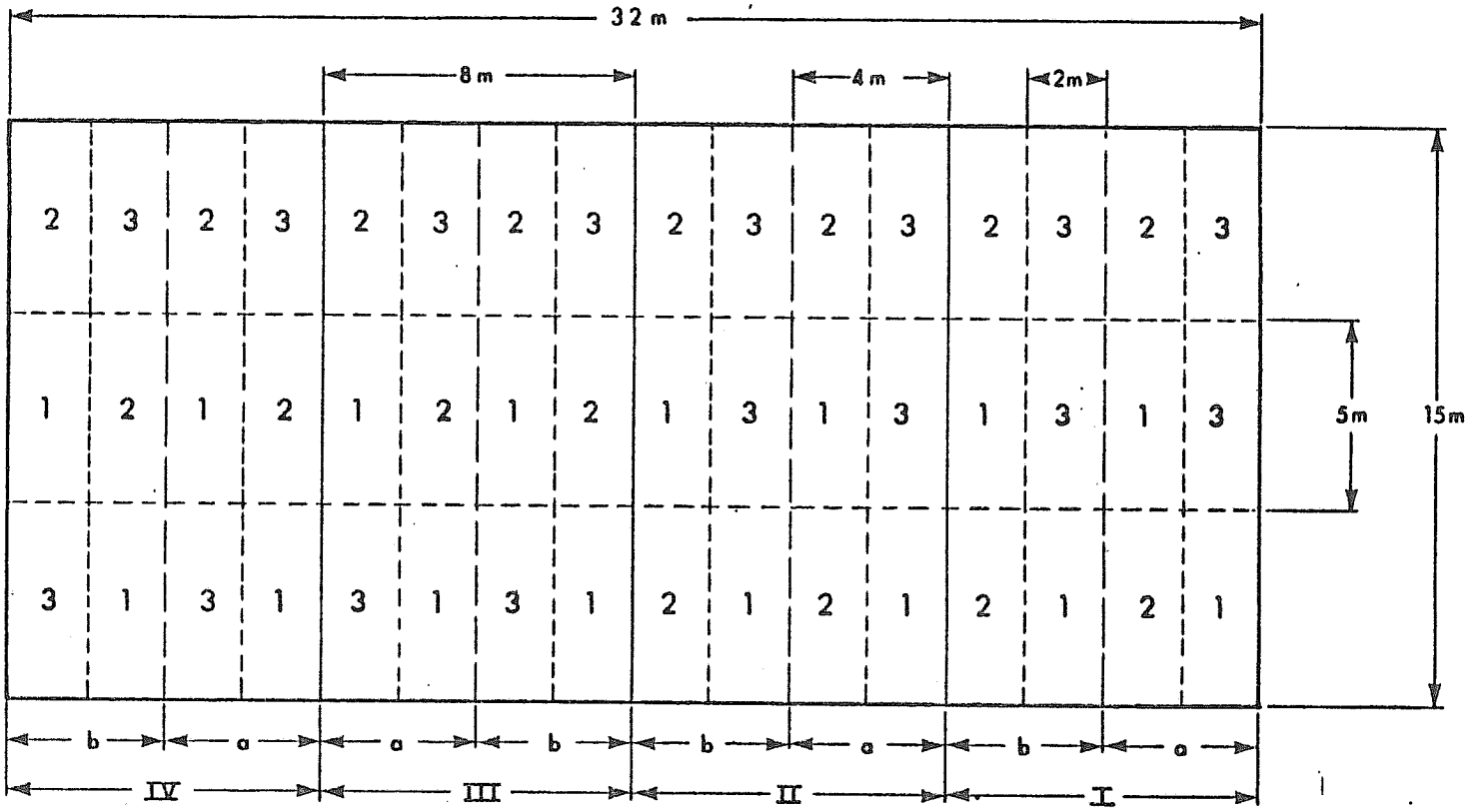
(HIGHWAY KP 1740.2)



I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX

b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 3
HAINES JUNCTION PRIMARY SITE FIELD PLAN
(HIGHWAY KP 1651.6)



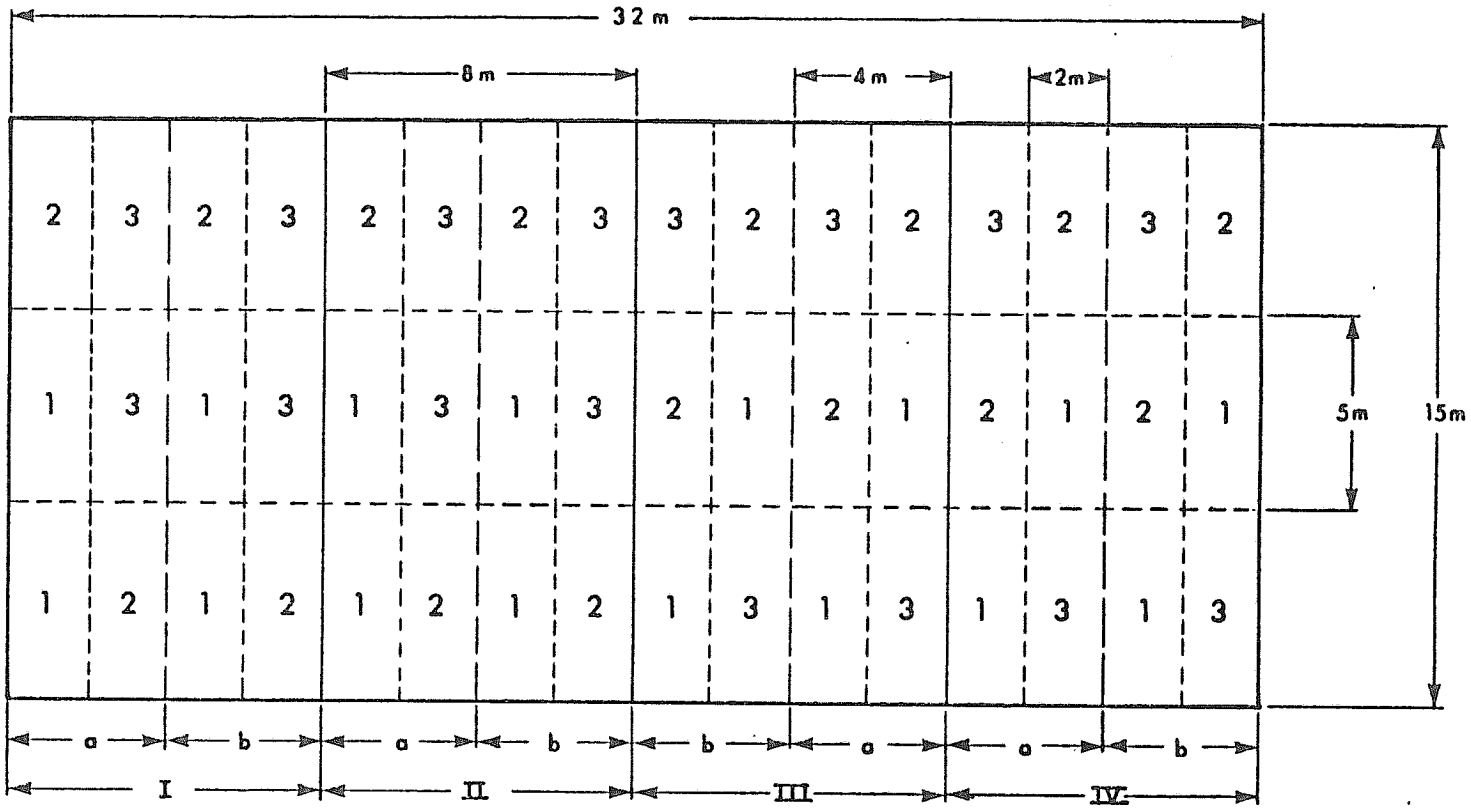
I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX

b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 4

MARSH LAKE PRIMARY SITE FIELD PLAN

(HIGHWAY KP 1420.4)



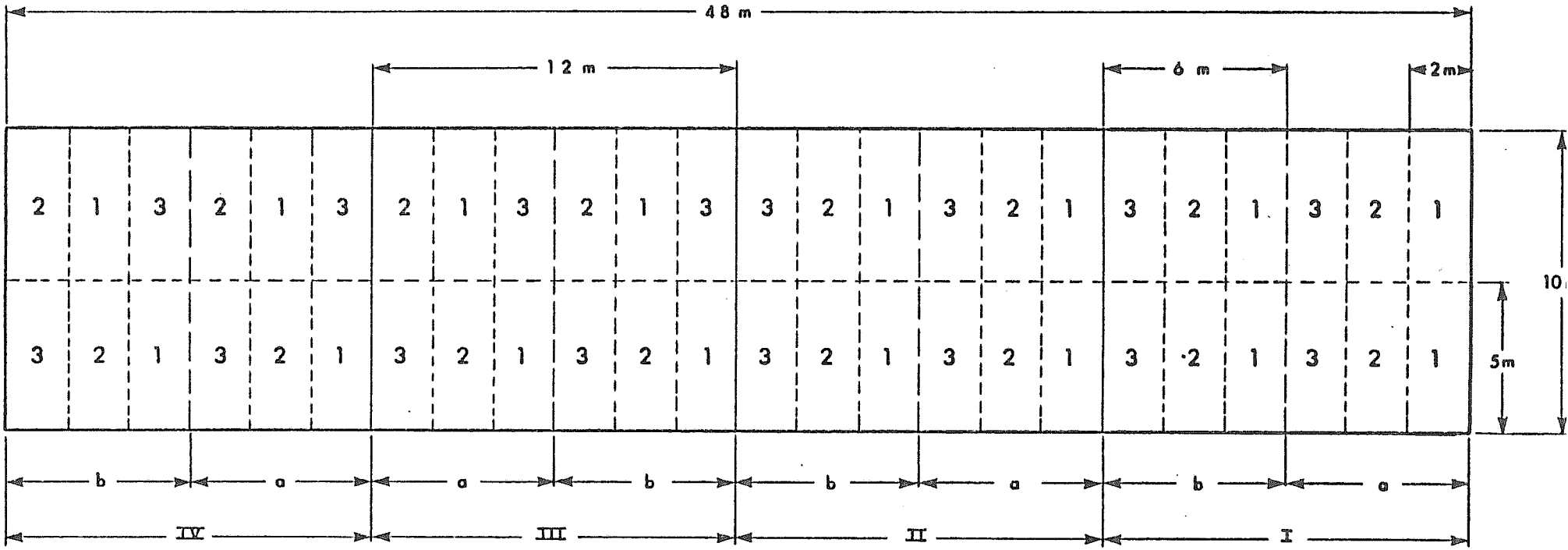
I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX

b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 5

JOHNSON'S CROSSING PRIMARY SITE FIELD PLAN

(HIGHWAY KP 1347.5)



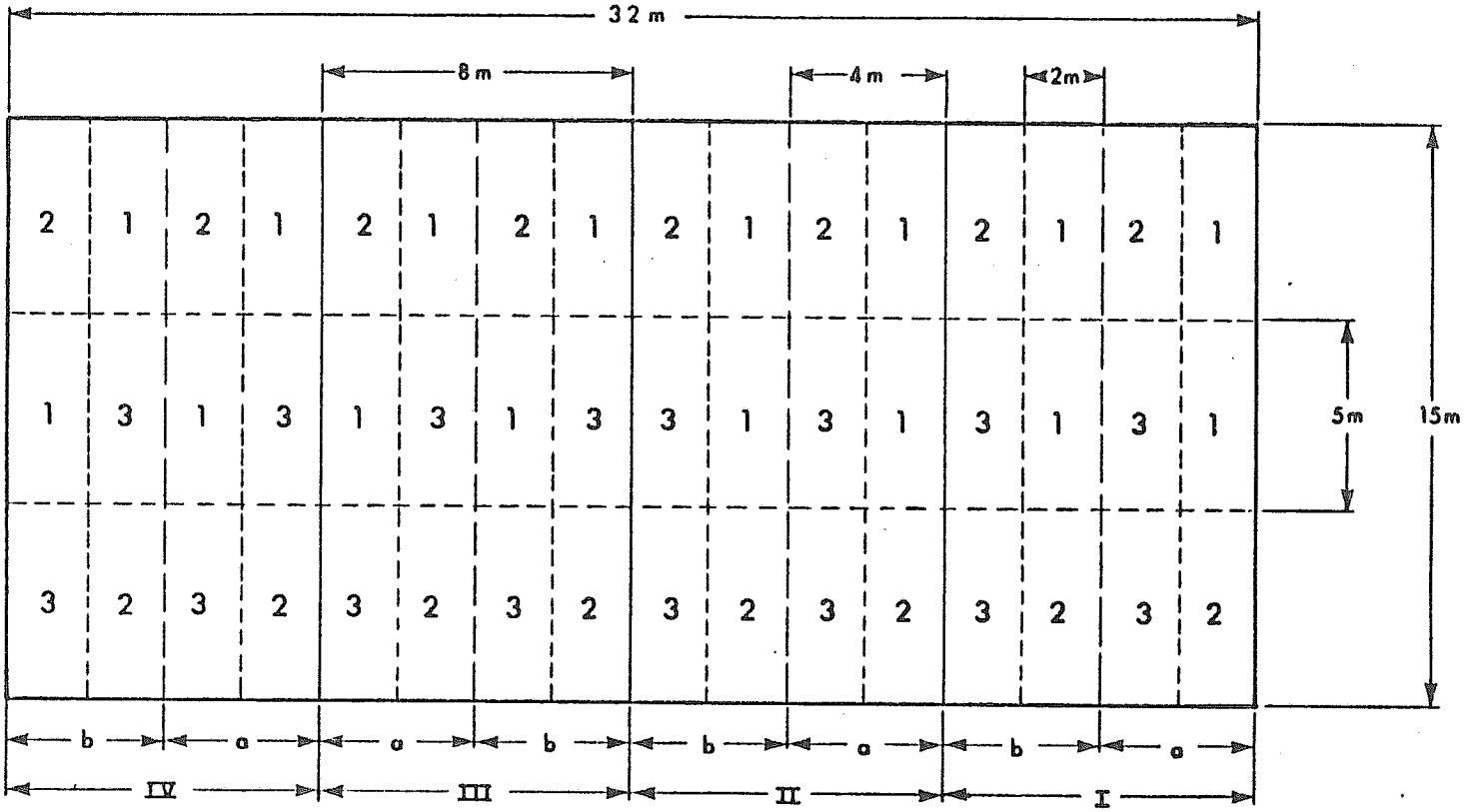
I. SEEDED LATE MAY, 1978-NO MULCH
II. SEEDED LATE MAY, 1978- MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX

b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0+0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 6

SWIFT RIVER PRIMARY SITE FIELD PLAN

(HIGHWAY KP 1155.8)

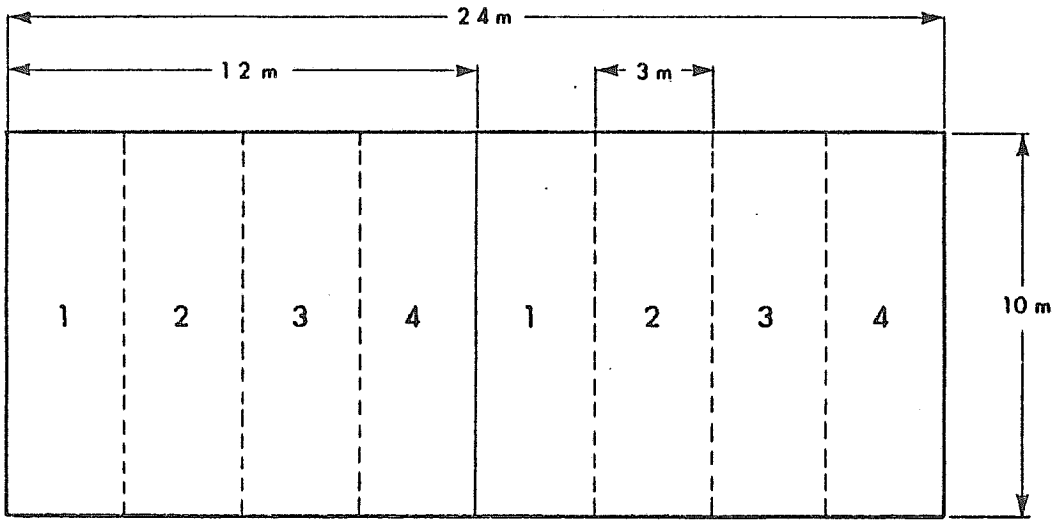


I. SEEDED LATE MAY, 1978 - NO MULCH
II. SEEDED LATE MAY, 1978 - MULCH
III. SEEDED SEPTEMBER, 1978
IV. SEEDED EARLY MAY, 1979
a. NATIVE SEED MIX
b. AGRONOMIC SEED MIX
1. NO FERTILIZATION
2. 19-26-0 FERTILIZER
3. 34-0-0 + 0-45-0 FERTILIZER
SCALE - 1:200

FIGURE 7

WATSON LAKE PRIMARY SITE FIELD PLAN

(HIGHWAY KP 1077.9)



1. HAY MULCH
2. MICRONUTRIENT FERTILIZER
3. SULFATE OF POTASH FERTILIZER
4. CONTROL

SCALE - 1:200

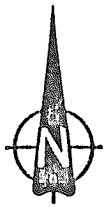


FIGURE 8

BEAVER CREEK SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1936.7)

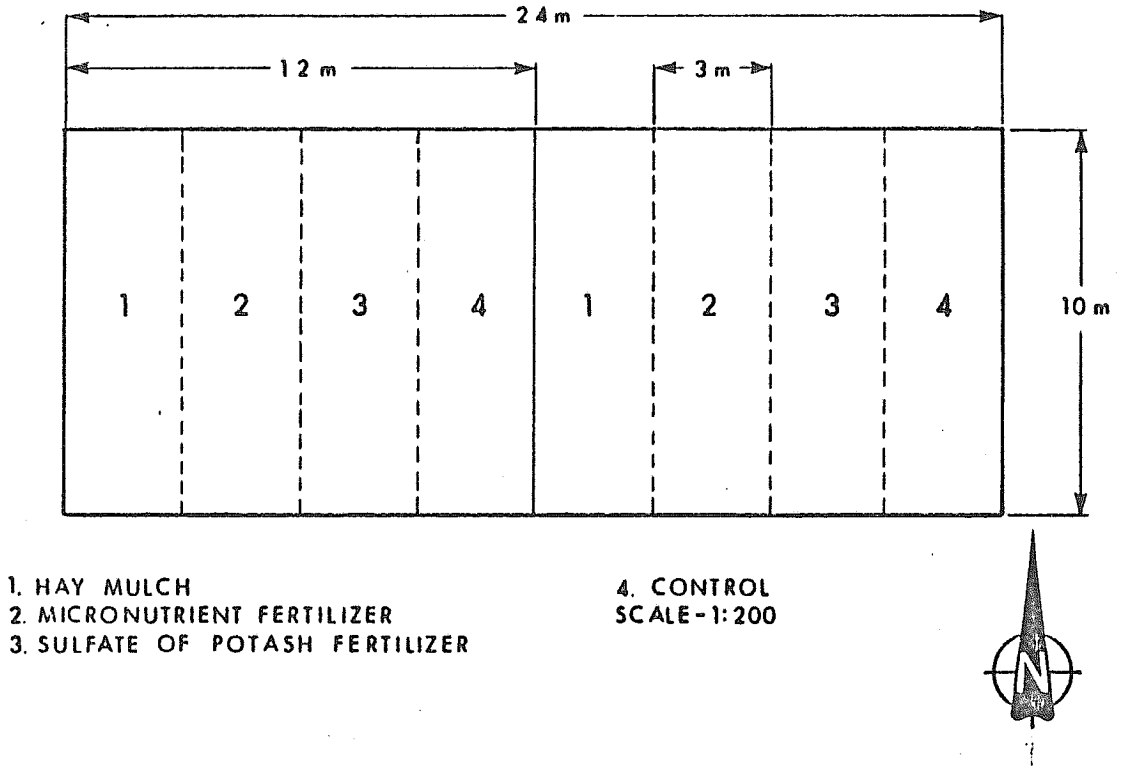
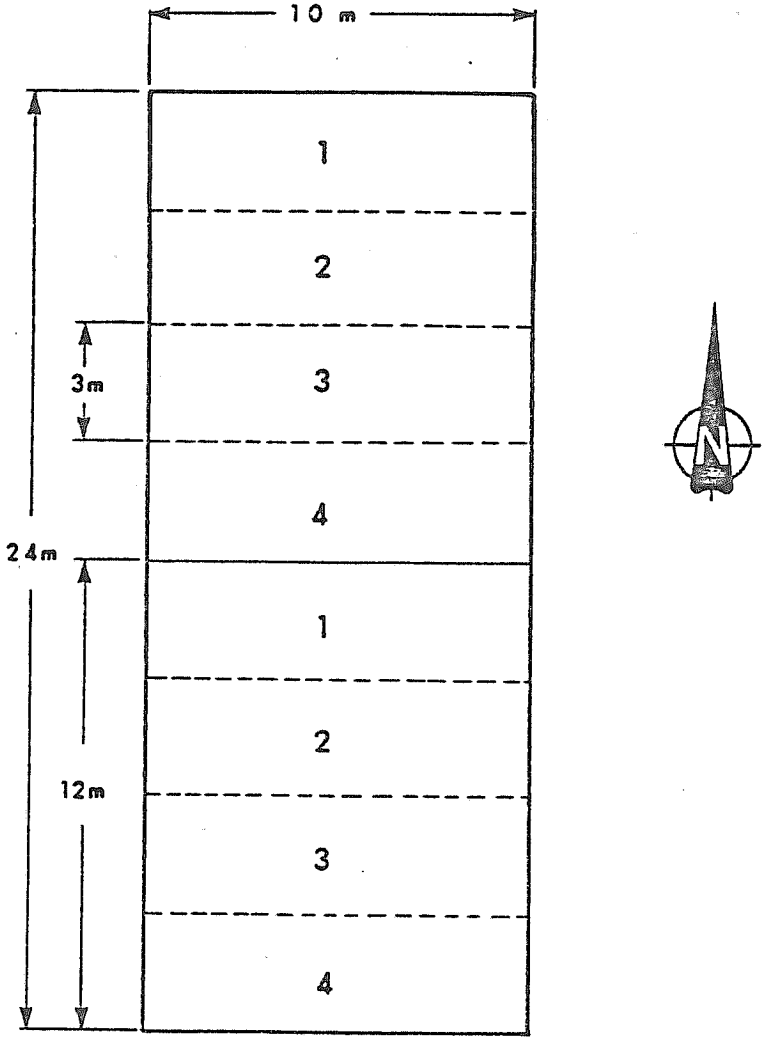


FIGURE 9

DESTRUCTION BAY SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1740.2)



1. HAY MULCH
2. MICRONUTRIENT FERTILIZER
3. SULFATE OF POTASH FERTILIZER
4. CONTROL

SCALE - 1:200

FIGURE 10

HAINES JUNCTION SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1651.6)

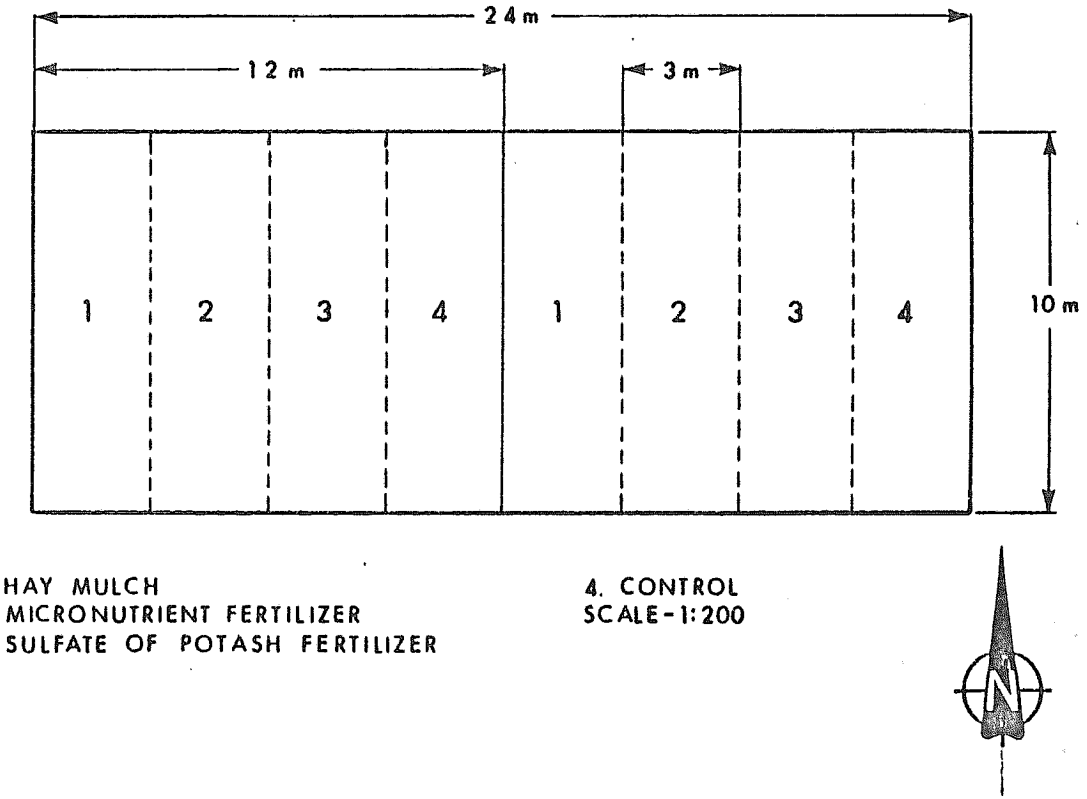
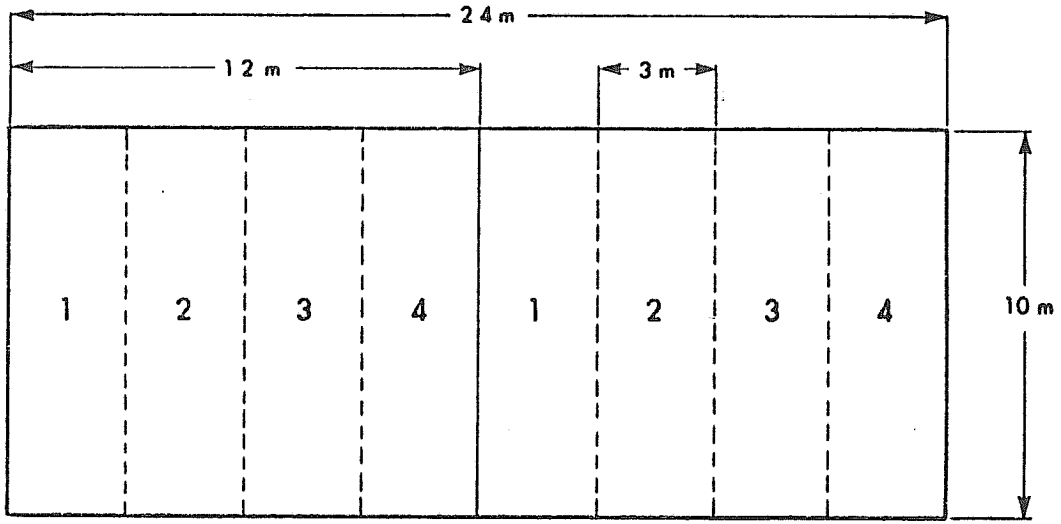


FIGURE 11

MARSH LAKE SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1420.4)



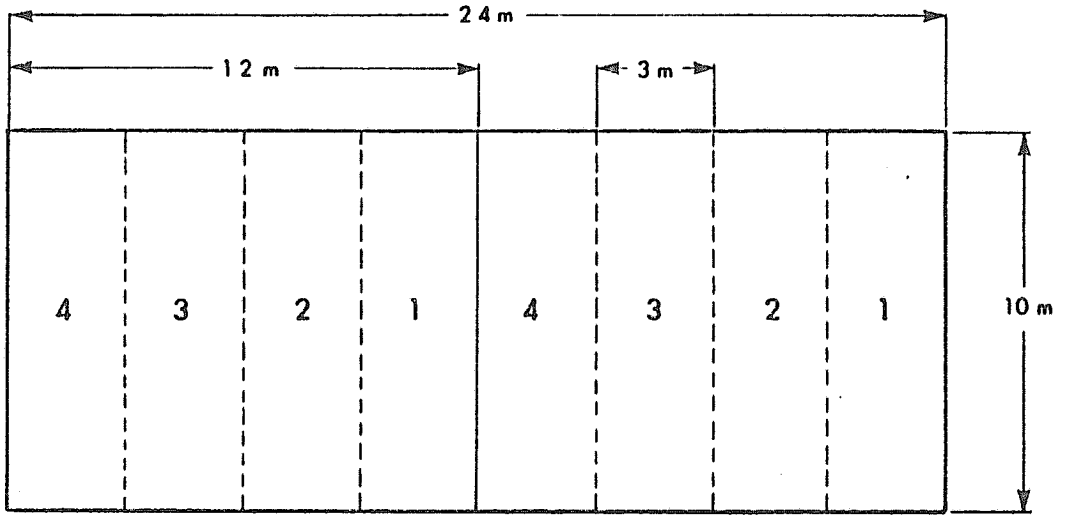
1. HAY MULCH
2. MICRONUTRIENT FERTILIZER
3. SULFATE OF POTASH FERTILIZER
4. CONTROL

SCALE - 1:200

FIGURE 12

JOHNSON'S CROSSING SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1347.5)



1. HAY MULCH
2. MICRONUTRIENT FERTILIZER
3. SULFATE OF POTASH FERTILIZER
4. CONTROL

SCALE - 1:200

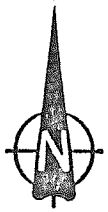
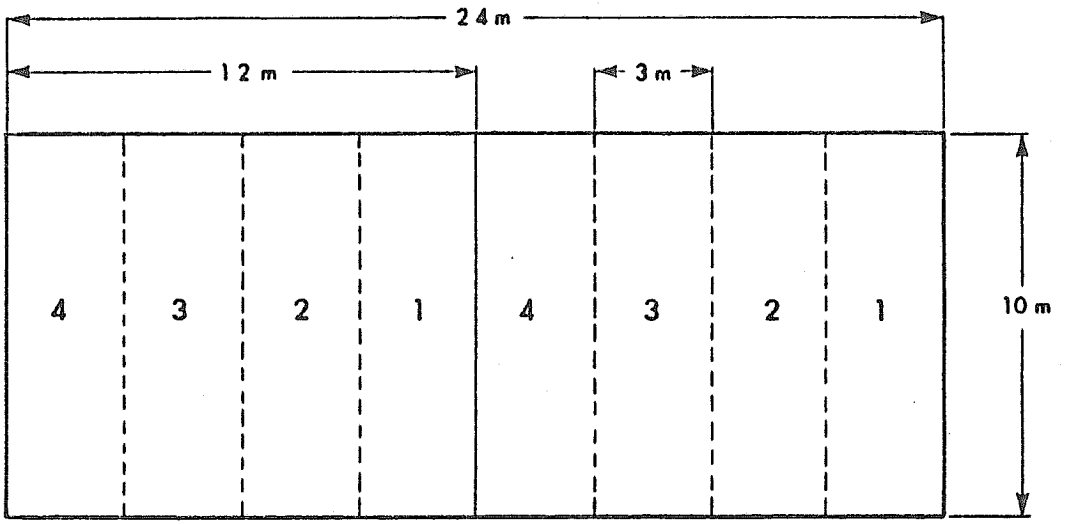


FIGURE 13

SWIFT RIVER SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1155.8)



1. HAY MULCH
2. MICRONUTRIENT FERTILIZER
3. SULFATE OF POTASH FERTILIZER
4. CONTROL

SCALE - 1:200

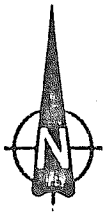


FIGURE 14

WATSON LAKE SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1077.9)

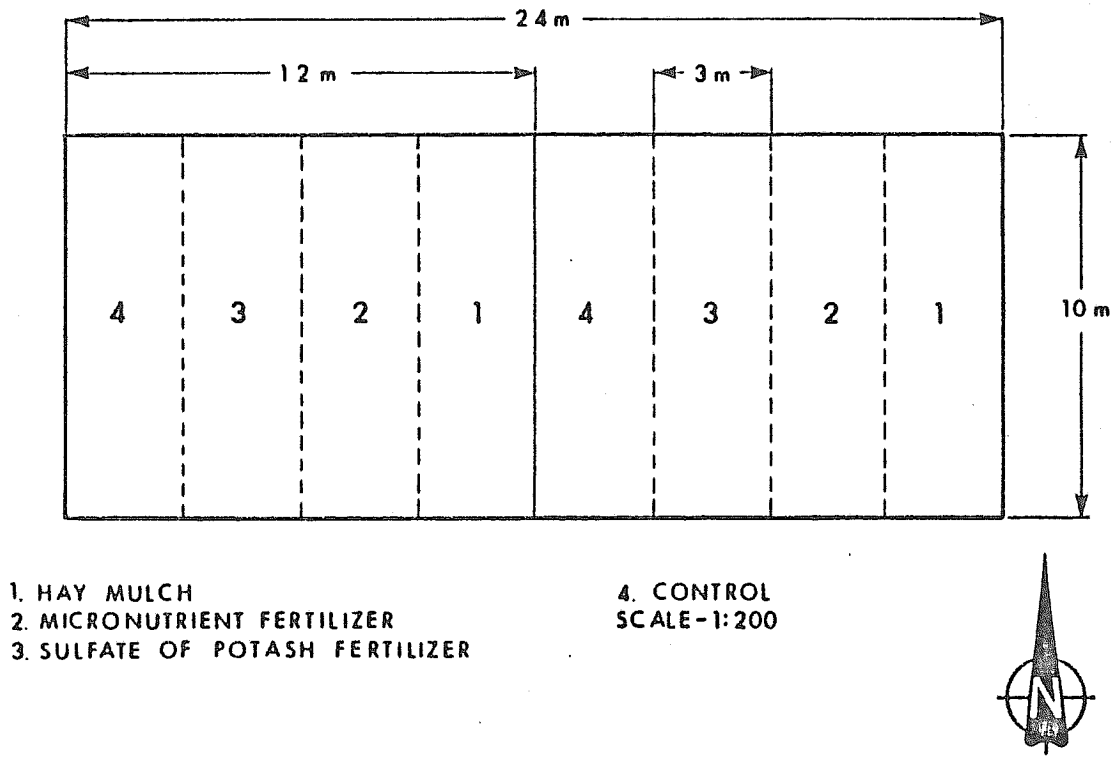


FIGURE 14

WATSON LAKE SECONDARY SITE FIELD PLAN

(HIGHWAY KP 1077.9)

APPENDIX B

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE ALASKA HIGHWAY REVEGETATION TEST SITES

LIST OF TABLES

TABLE 1

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE BEAVER CREEK SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron riparium	20	Sodar
Agrostis gigantea	5	Common
Festuca rubra	20	Boreal
Medicago sativa	5	Kane
Phleum pratense	20	Champ
Poa compressa	10	Canon
Poa pratensis	15	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron pauciflorum	20	Teslin
Agropyron riparium	15	Beaverlodge
Agrostis gigantea	5	High Level
Alopecurus pratensis	5	Smithers
Festuca rubra	15	Haines Junction
Medicago sativa	5	Haines Junction
Phleum pratense	15	High Level
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron riparium cv. *Sodar*	15	Commercial
Agropyron sp. (*violaceum*)	25	Haines Junction
Agrostis gigantea	5	High Level
Alopecurus pratensis	5	Smithers
Festuca rubra	10	Haines Junction
Medicago sativa cv. *Kane*	5	Commercial
Phleum pratense	15	High Level
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum cv. *Aurora*	5	Commercial

TABLE 2

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE DESTRUCTION BAY SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron pauciflorum	25	Revenue
Agrostis gigantea	5	Common
Festuca rubra	20	Boreal
Medicago sativa	5	Drylander
Phleum pratense	30	Champ
Poa pratensis	10	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron pauciflorum	25	Teslin
Agropyron riparium	15	Beaverlodge
Agrostis gigantea	5	High Level
Deschampsia caespitosa	10	Haines Junction
Festuca rubra	10	Haines Junction
Medicago falcata	5	Haines Junction
Poa alpigena	5	Beaver Creek
Poa glauca	10	Whitehorse
Poa palustris	10	Teslin
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron riparium cv. Sodar	15	Commercial
Agropyron sp. (*violaceum*)	20	Haines Junction
Agrostis gigantea	5	High Level
Deschampsia caespitosa	10	Haines Junction
Festuca rubra	15	Haines Junction
Medicago sativa cv. Kane	5	Commercial
Poa alpigena	5	Beaver Creek
Poa glauca	10	Whitehorse
Poa palustris	10	Teslin
Trifolium hybridum cv. Aurora	5	Commercial

TABLE 3

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE HAINES JUNCTION SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron cristatum	40	Summit
Agropyron riparium	15	Sodar
Agrostis gigantea	5	Common
Festuca ovina	5	Durar
Festuca rubra	10	Boreal
Medicago sativa	5	Drylander
Phleum pratense	10	Champ
Poa pratensis	5	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron cristatum	25	Haines Junction
Agropyron pauciflorum	10	Teslin
Agropyron riparium	10	Beaver Creek
Agropyron subsecundum	5	Teslin
Deschampsia caespitosa	10	Haines Junction
Festuca rubra	15	Haines Junction
Medicago sativa	5	Haines Junction
Poa glauca	15	Whitehorse
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron cristatum	20	Haines Junction
Agropyron pauciflorum	10	Teslin
Agropyron riparium cv. *Sodar*	10	Commercial
Agropyron sp. (*violaceum*)	15	Kluane Lake
Deschampsia caespitosa	10	Haines Junction
Festuca rubra	10	Haines Junction
Medicago sativa cv. *Kane*	5	Commercial
Poa glauca	15	Whitehorse
Trifolium hybridum cv. *Aurora*	5	Commercial

TABLE 4

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE MARSH LAKE SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron cristatum	35	Summit
Agropyron riparium	15	Sodar
Agrostis gigantea	5	Common
Festuca ovina	5	Durar
Festuca rubra	10	Boreal
Medicago sativa	5	Drylander
Phleum pratense	10	Champ
Poa compressa	5	Canon
Poa pratensis	5	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron cristatum	20	Haines Junction
Agropyron pauciflorum	10	Teslin
Agropyron riparium	20	Beaverlodge
Agropyron subsecundum	5	Teslin
Deschampsia caespitosa	5	Haines Junction
Festuca rubra	5	Haines Junction
Festuca saximontana	5	High Level
Medicago sativa	5	Haines Junction
Poa compressa	5	High Level
Poa glauca	10	Whitehorse
Poa pratensis	5	Haines Junction
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron cristatum	10	Haines Junction
Agropyron pauciflorum	10	Teslin
Agropyron riparium cv. *Sodar*	15	Commercial
Agropyron sp. (*violaceum*)	20	Kluane Lake
Deschampsia caespitosa	5	Haines Junction
Festuca ovina cv. *Durar*	5	Commercial
Festuca rubra	5	Haines Junction
Medicago sativa cv. *Drylander*	5	Commercial
Poa compressa	5	High Level
Poa glauca	10	Whitehorse
Poa pratensis	5	Haines Junction
Trifolium hybridum cv. *Aurora*	5	Commercial

TABLE 5

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE JOHNSON'S CROSSING SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron riparium	30	Sodar
Agrostis gigantea	5	Common
Festuca rubra	20	Boreal
Medicago sativa	5	Kane
Phleum pratense	15	Champ
Poa compressa	10	Canon
Poa pratensis	10	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron pauciflorum	10	Teslin
Agropyron riparium	10	Beaverlodge
Agropyron sp. (*violaceum*)	20	Kluane Lake
Agrostis gigantea	5	High Level
Festuca rubra	10	Haines Junction
Medicago sativa	5	Haines Junction
Poa alpigena	5	Beaver Creek
Poa compressa	5	High Level
Poa glauca	10	Whitehorse
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron pauciflorum	15	Teslin
Agropyron riparium cv. *Sodar*	10	Commercial
Agropyron sp. (*violaceum*)	20	Kluane Lake
Agrostis gigantea	5	High Level
Festuca rubra	10	Haines Junction
Medicago sativa cv. *Drylander*	5	Commercial
Poa alpigena	5	Beaver Creek
Poa compressa	5	High Level
Poa glauca	5	Whitehorse
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum cv. *Aurora*	5	Commercial

TABLE 6

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE SWIFT RIVER SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron pauciflorum	15	Revenue
Agropyron riparium	10	Sodar
Agrostis gigantea	5	Common
Bromus inermis	20	Carlton
Festuca rubra	10	Boreal
Medicago sativa	5	Kane
Phleum pratense	20	Champ
Poa pratensis	10	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron pauciflorum	20	Teslin
Agropyron riparium	10	Beaverlodge
Agrostis gigantea	5	High Level
Bromus inermis	10	Fort St. John
Festuca rubra	10	Haines Junction
Festuca saximontana	5	High Level
Medicago sativa	5	Haines Junction
Phleum pratense	10	High Level
Poa compressa	5	High Level
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron riparium cv. *Sodar*	10	Commercial
Agropyron sp. (*violaceum*)	10	Kluane Lake
Agrostis gigantea	5	High Level
Bromus inermis	15	Fort St. John
Festuca ovina cv. *Durar*	5	Commercial
Festuca rubra	10	Haines Junction
Medicago sativa cv. *Drylander*	5	Commercial
Phleum pratense	15	High Level
Poa compressa	5	High Level
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum cv. *Aurora*	5	Commercial

TABLE 7

WEIGHT AND PROVENANCE OF THE COMPONENTS OF THE SEED MIXES SEEDED AT THE WATSON LAKE SITE

PRIMARY SITE MIXES

AGRONOMIC CULTIVAR MIX

SPECIES	% (by weight)	CULTIVAR
Agropyron pauciflorum	20	Revenue
Agropyron riparium	10	Sodar
Agrostis gigantea	5	Common
Bromus inermis	30	Carlton
Festuca rubra	10	Boreal
Medicago sativa	5	Kane
Phleum pratense	10	Champ
Poa pratensis	5	Nugget
Trifolium hybridum	5	Aurora

NORTHERN ECOTYPE MIX

SPECIES	% (by weight)	ORIGINAL COLLECTION AREA
Agropyron pauciflorum	20	Teslin
Agropyron riparium	10	Beaverlodge
Agrostis gigantea	5	High Level
Bromus inermis	15	Fort St. John
Festuca rubra	10	Haines Junction
Medicago sativa	5	Haines Junction
Phleum pratense	10	High Level
Poa compressa	5	High Level
Poa palustris	10	Teslin
Poa pratensis	5	Haines Junction
Trifolium hybridum	5	Commercial

SECONDARY SITE MIX

SPECIES	% (by weight)	PROVENANCE
Agropyron riparium cv. *Sodar*	10	Commercial
Agropyron sp. (*violaceum*)	15	Kluane Lake
Agrostis gigantea	5	High Level
Bromus inermis	20	Fort St. John
Festuca rubra	10	Haines Junction
Medicago sativa cv. *Drylander*	5	High Level
Phleum pratense	10	Teslin
Poa compressa	5	High Level
Poa palustris	10	Teslin
Poa pratensis cv. *Nugget*	5	Commercial
Trifolium hybridum cv. *Aurora*	5	Commercial

APPENDIX C

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE ALASKA HIGHWAY REVEGETATION PRIMARY TEST SITES

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

TABLE 1

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE BEAVER CREEK SITE ON MAY 28, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	50	55	4	60	95	5	35	40	3
INDIVIDUAL SPECIES									
Agropyron riparium	10	5	3	10	5	4	20	T[c]	1
Agrostis gigantea	5	20	4	5	15	5	5	10	3
Festuca rubra	5	25	4	5	20	4	5	30	4
Medicago sativa	10	T	1	10	T	3	10	T	1
Phleum pratense	25	30	4	20	25	5	45	55	3
Poa compressa	10	0	-	5	T	4	5	T	3
Poa pratensis	5	T	2	5	T	4	5	T	1
Trifolium hybridum	30	20	5	40	35	5	5	5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 2

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE BEAVER CREEK SITE ON MAY 28, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	30	55	5	70	95	5	45	50	3
INDIVIDUAL SPECIES									
Agropyron riparium	5	5	3	5	10	4	10	10	2
Agrostis gigantea	5	15	5	5	10	5	5	35	5
Festuca rubra	5	25	4	0	25	4	5	25	3
Medicago sativa	25	T[c]	2	10	T	1	10	5	1
Phleum pratense	15	30	5	30	25	5	30	20	3
Poa compressa	10	0	-	5	0	-	10	0	-
Poa pratensis	5	T	2	5	T	2	5	T	1
Trifolium hybridum	30	25	5	40	30	5	25	5	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 3

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE BEAVER CREEK SITE ON SEPTEMBER 30, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	25	3	75	4	40	3
INDIVIDUAL SPECIES						
Agropyron riparium	5	3	5	3	10	3
Agrostis gigantea	20	2	5	3	15	3
Festuca rubra	30	3	15	4	25	4
Medicago sativa	T[c]	1	T	1	T	1
Phleum pratense	30	3	65	4	30	3
Poa compressa	5	4	10	5	5	3
Poa pratensis	5	2	T	3	5	2
Trifolium hybridum	5	2	T	3	10	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 4

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE BEAVER CREEK SITE ON MAY 18, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	5	2	40	3	15	2
INDIVIDUAL SPECIES						
Agropyron riparium	5	3	T[c]	2	5	3
Agrostis gigantea	10	2	10	3	5	2
Festuca rubra	20	2	15	3	10	3
Medicago sativa	10	1	T	2	T	1
Phleum pratense	25	2	40	3	60	2
Poa compressa	10	3	20	4	15	3
Poa pratensis	T	1	T	1	T	1
Trifolium hybridum	10	2	15	3	5	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 5

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE BEAVER CREEK SITE ON MAY 28, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	45	45	3	70	95	5	40	75	4
INDIVIDUAL SPECIES									
Agropyron pauciflorum	5	5	4	5	5	4	20	5	4
Agropyron riparium	20	5	3	0	T[c]	3	5	10	4
Agrostis gigantea	5	25	3	10	10	5	5	15	4
Alopecurus pratensis	5	5	3	5	15	4	10	15	4
Festuca rubra	10	10	3	0	10	4	5	10	4
Medicago sativa	20	T	1	25	T	3	5	T	3
Phleum pratense	10	10	2	10	10	4	25	10	3
Poa palustris	5	25	5	10	15	5	10	5	5
Poa pratensis	0	T	2	0	T	3	0	T	3
Trifolium hybridum	20	10	3	35	35	5	15	30	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 6

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE BEAVER CREEK SITE ON MAY 28, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	40	65	4	65	95	5	40	70	4
INDIVIDUAL SPECIES									
Agropyron pauciflorum	10	5	4	15	10	4	10	5	3
Agropyron riparium	5	T[c]	3	0	T	4	5	5	3
Agrostis gigantea	5	10	5	5	15	5	5	25	4
Alopecurus pratensis	10	15	4	5	15	4	10	5	4
Festuca rubra	5	10	4	5	10	4	5	10	4
Medicago sativa	20	T	2	15	T	3	20	T	3
Phleum pratense	10	20	4	15	15	5	15	15	4
Poa palustris	10	25	5	20	15	5	10	25	5
Poa pratensis	0	T	3	0	T	3	0	T	3
Trifolium hybridum	25	15	4	20	20	5	20	10	4

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 7

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE BEAVER CREEK SITE ON SEPTEMBER 30, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	25	3	80	4	40	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	T[c]	2	5	3	T	3
Agropyron riparium	T	2	5	3	T	3
Agrostis gigantea	10	3	5	4	5	3
Alopecurus pratensis	10	3	5	3	5	3
Festuca rubra	10	4	5	4	10	4
Medicago sativa	T	1	T	1	T	1
Phleum pratense	10	2	5	3	5	3
Poa palustris	60	3	65	4	70	3
Poa pratensis	T	2	5	3	T	2
Trifolium hybridum	T	2	T	2	5	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 8

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE BEAVER CREEK SITE ON MAY 18, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	2	60	4	15	2
INDIVIDUAL SPECIES						
Agropyron pauciflorum	10	2	T[c]	2	5	1
Agropyron riparium	T	3	T	3	T	1
Agrostis gigantea	5	3	10	4	5	2
Alopecurus pratensis	5	2	5	3	10	2
Festuca rubra	20	3	10	3	10	3
Medicago sativa	T	1	T	2	T	1
Phleum pratense	15	2	25	4	40	2
Poa palustris	30	2	25	4	25	3
Poa pratensis	0	-	T	2	T	1
Trifolium hybridum	15	2	25	4	5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 9

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE DESTRUCTION BAY SITE ON MAY 26, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	55	20	3	85	30	3	70	15	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	40	60	3	55	60	3	40	65	3
Agrostis gigantea	5	5	2	10	T[c]	2	5	T	2
Festuca rubra	5	30	3	5	35	3	5	30	3
Medicago sativa	10	T	1	5	T	2	10	T	2
Phleum pratense	15	5	3	20	5	2	15	5	2
Poa pratensis	15	T	2	5	T	3	20	0	-
Trifolium hybridum	10	T	2	0	T	1	5	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 10

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE DESTRUCTION BAY SITE ON MAY 26, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	35	35	2	50	50	3	40	35	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	30	60	2	40	60	3	40	75	3
Agrostis gigantea	5	T[c]	2	5	5	3	5	T	2
Festuca rubra	5	35	3	5	30	3	5	20	3
Medicago sativa	10	T	1	5	T	1	10	T	2
Phleum pratense	15	5	2	20	5	2	15	5	2
Poa pratensis	25	T	2	20	T	2	20	T	2
Trifolium hybridum	10	0	-	5	T	1	5	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 11

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE DESTRUCTION BAY SITE ON SEPTEMBER 29, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	20	3	65	3	60	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	80	3	75	3	75	3
Agrostis gigantea	0	-	T[c]	3	T	3
Festuca rubra	15	3	20	3	20	3
Medicago sativa	0	-	0	-	0	-
Phleum pratense	5	2	5	2	5	2
Poa pratensis	0	-	T	2	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 12

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE DESTRUCTION BAY SITE ON MAY 17, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	10	2	45	3	45	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	70	2	70	3	65	3
Agrostis gigantea	T[c]	3	T	3	T	2
Festuca rubra	25	3	20	3	25	3
Medicago sativa	0	-	0	-	0	-
Phleum pratense	5	2	5	2	5	1
Poa pratensis	T	2	5	3	5	3
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 13

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE DESTRUCTION BAY SITE ON MAY 26, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	25	10	2	75	35	3	75	20	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	35	45	2	50	50	3	25	45	3
Agropyron riparium	30	10	2	0	10	2	10	5	1
Agrostis gigantea	5	T[c]	3	10	T	2	10	T	1
Deschampsia caespitosa	0	0	-	0	0	-	0	0	-
Festuca rubra	5	20	3	10	15	3	10	20	3
Medicago falcata	5	T	1	5	T	1	10	T	1
Poa glauca	5	15	3	0	15	3	5	20	3
Poa palustris	15	10	2	20	10	3	20	10	2
Poa sp.	0	0	-	0	0	-	0	0	-
Trifolium hybridum	0	0	-	5	0	-	10	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 14

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE DESTRUCTION BAY SITE ON MAY 26, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	20	15	2	65	40	3	45	30	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	35	45	2	50	50	3	25	55	3
Agropyron riparium	30	15	2	15	10	2	5	15	2
Agrostis gigantea	5	T[c]	3	5	T	3	5	T	2
Deschampsia caespitosa	0	T	1	0	T	1	0	T	1
Festuca rubra	5	15	3	0	15	2	10	15	2
Medicago falcata	10	T	1	5	T	1	20	T	1
Poa glauca	0	20	3	0	15	3	0	10	3
Poa palustris	15	5	2	20	10	2	15	5	1
Poa sp.	0	0	-	0	0	-	0	0	-
Trifolium hybridum	0	0	-	5	T	1	20	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 15

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE DESTRUCTION BAY SITE ON SEPTEMBER 29, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	15	2	70	4	65	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	50	2	50	4	60	3
Agropyron riparium	15	2	10	3	5	3
Agrostis gigantea	T[c]	1	T	3	T	1
Deschampsia caespitosa	0	-	T	2	T	1
Festuca rubra	15	3	15	4	10	3
Medicago falcata	T	1	0	-	0	-
Poa glauca	10	2	15	4	10	3
Poa palustris	10	2	10	3	15	2
Poa sp.	0	-	0	-	0	-
Trifolium hybridum	T	1	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 16

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE DESTRUCTION BAY SITE ON MAY 17, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	15	3	55	4	55	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	60	3	60	4	65	3
Agropyron riparium	15	3	10	4	5	4
Agrostis gigantea	T[c]	1	T	1	T	2
Deschampsia caespitosa	0	-	0	-	T	1
Festuca rubra	15	3	15	3	15	3
Medicago falcata	0	-	0	-	0	-
Poa glauca	5	2	5	3	10	2
Poa palustris	5	3	10	3	5	4
Poa sp.	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 17

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE HAINES JUNCTION SITE ON MAY 25, 1978

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	25	15	2	40	50	3	25	40	3
INDIVIDUAL SPECIES									
Agropyron cristatum	40	35	2	35	30	3	35	30	3
Agropyron riparium	30	20	1	20	10	1	15	5	1
Agrostis gigantea	5	10	2	5	5	3	5	10	3
Festuca ovina	10	5	3	10	10	3	5	5	2
Festuca rubra	10	25	4	15	35	4	25	40	3
Medicago sativa	0	0	-	0	0	-	0	0	-
Phleum pratense	5	5	1	10	5	1	10	5	1
Poa pratensis	0	T[c]	2	5	5	2	5	5	2
Trifolium hybridum	0	0	-	0	0	-	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 18

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE HAINES JUNCTION SITE ON MAY 25, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	15	10	2	35	40	3	20	20	3
INDIVIDUAL SPECIES									
Agropyron cristatum	45	45	2	35	40	3	50	40	3
Agropyron riparium	25	15	1	25	10	1	15	5	2
Agrostis gigantea	0	T[c]	2	5	5	2	0	5	2
Festuca ovina	10	10	3	5	10	3	5	5	2
Festuca rubra	15	20	3	15	30	3	15	35	3
Medicago sativa	0	0	-	0	0	-	0	0	-
Phleum pratense	5	10	1	15	5	1	10	5	1
Poa pratensis	0	T	2	0	T	1	5	5	2
Trifolium hybridum	0	0	-	0	0	-	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 19

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE HAINES JUNCTION SITE ON SEPTEMBER 29, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	5	2	10	2	5	2
INDIVIDUAL SPECIES						
Agropyron cristatum	30	2	35	2	30	2
Agropyron riparium	10	3	15	2	15	2
Agrostis gigantea	5	1	T[c]	1	0	-
Festuca ovina	T	1	T	2	T	1
Festuca rubra	45	2	35	3	40	3
Medicago sativa	0	-	0	-	0	-
Phleum pratense	10	2	15	2	15	2
Poa pratensis	T	1	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 20

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE HAINES JUNCTION SITE ON MAY 17, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	5	2	<5	1
INDIVIDUAL SPECIES						
Agropyron cristatum	35	1	30	2	30	1
Agropyron riparium	25	1	20	2	30	1
Agrostis gigantea	T[c]	1	5	1	T	1
Festuca ovina	5	1	T	1	T	1
Festuca rubra	20	2	30	3	30	2
Medicago sativa	0	-	0	-	0	-
Phleum pratense	15	2	15	2	10	2
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 21

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE HAINES JUNCTION SITE ON MAY 25, 1978

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	15	10	2	30	40	3	25	30	3
INDIVIDUAL SPECIES									
Agropyron cristatum	20	20	2	30	25	3	30	25	3
Agropyron pauciflorum	30	20	2	25	15	4	30	30	3
Agropyron riparium	25	10	1	15	5	2	10	10	2
Agropyron subsecundum	10	15	3	20	15	3	20	15	3
Deschampsia caespitosa	0	T[c]	1	0	T	1	0	0	-
Festuca rubra	10	25	3	10	35	4	10	20	4
Medicago sativa	0	0	-	0	0	-	0	0	-
Poa glauca	5	10	2	0	5	3	0	T	2
Trifolium hybridum	0	0	-	0	0	-	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 22

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE HAINES JUNCTION SITE ON MAY 25, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	15	10	2	25	30	3	20	25	3
INDIVIDUAL SPECIES									
Agropyron cristatum	25	15	2	25	15	3	15	15	3
Agropyron pauciflorum	30	25	2	35	25	3	35	25	3
Agropyron riparium	25	15	1	20	10	2	15	5	1
Agropyron subsecundum	10	20	2	10	10	3	5	10	3
Deschampsia caespitosa	0	0	-	0	0	-	0	T[c]	1
Festuca rubra	10	25	3	10	30	4	25	35	3
Medicago sativa	0	0	-	0	0	-	0	0	-
Poa glauca	0	T	2	0	10	3	5	10	3
Trifolium hybridum	0	0	-	0	0	-	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 23

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE HAINES JUNCTION SITE ON SEPTEMBER 29, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	2	10	3	5	2
INDIVIDUAL SPECIES						
Agropyron cristatum	15	1	20	3	25	2
Agropyron pauciflorum	10	1	10	3	20	2
Agropyron riparium	10	1	15	3	10	3
Agropyron subsecundum	5	1	5	2	T[c]	1
Deschampsia caespitosa	0	-	0	-	0	-
Festuca rubra	60	2	50	3	45	2
Medicago sativa	0	-	0	-	0	-
Poa glauca	0	-	T	1	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 24

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE HAINES JUNCTION SITE ON MAY 17, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	5	2	<5	2
INDIVIDUAL SPECIES						
Agropyron cristatum	15	1	20	3	15	2
Agropyron pauciflorum	15	1	10	2	10	2
Agropyron riparium	25	1	15	3	20	3
Agropyron subsecundum	5	1	10	2	5	1
Deschampsia caespitosa	0	-	0	-	0	-
Festuca rubra	40	1	45	2	50	2
Medicago sativa	0	-	0	-	0	-
Poa glauca	0	-	T[c]	1	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 25

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE MARSH LAKE SITE ON MAY 20, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	<5	1	<5	20	2	<5	30	2
INDIVIDUAL SPECIES									
Agropyron cristatum	25	35	1	30	35	2	20	40	2
Agropyron riparium	25	5	1	15	5	1	15	5	3
Agrostis gigantea	0	5	1	0	20	3	10	20	2
Festuca ovina	10	T[c]	1	10	T	1	10	T	1
Festuca rubra	15	45	2	25	35	2	20	30	3
Medicago sativa	0	T	1	0	5	1	0	T	1
Phleum pratense	25	5	1	20	T	1	15	0	-
Poa compressa	0	5	1	0	T	3	10	5	3
Poa pratensis	0	0	-	0	0	-	0	0	-
Trifolium hybridum	0	0	-	0	0	-	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 26

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE MARSH LAKE SITE ON MAY 20, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	<5	1	<5	10	2	<5	15	2
INDIVIDUAL SPECIES									
Agropyron cristatum	30	45	1	30	45	2	35	50	2
Agropyron riparium	15	20	2	10	10	3	25	10	2
Agrostis gigantea	10	T[c]	1	5	15	2	0	15	2
Festuca ovina	5	0	-	10	T	1	5	0	-
Festuca rubra	30	30	1	25	30	3	25	20	3
Medicago sativa	0	5	1	0	T	-	0	5	1
Phleum pratense	10	0	-	10	0	-	5	0	-
Poa compressa	0	T	3	10	T	3	5	T	3
Poa pratensis	0	0	-	0	0	-	0	0	-
Trifolium hybridum	0	0	-	0	T	2	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 27

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE MARSH LAKE SITE ON SEPTEMBER 26, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	5	2	<5	1
INDIVIDUAL SPECIES						
Agropyron cristatum	45	1	45	1	50	1
Agropyron riparium	15	2	10	2	10	2
Agrostis gigantea	5	1	10	2	10	1
Festuca ovina	0	-	0	-	0	-
Festuca rubra	30	1	35	2	30	2
Medicago sativa	5	1	T[c]	2	T	1
Phleum pratense	0	-	0	-	0	-
Poa compressa	0	-	0	-	0	-
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 28

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE MARSH LAKE SITE ON MAY 14, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	<5	1	<5	1
INDIVIDUAL SPECIES						
Agropyron cristatum	45	1	35	1	35	1
Agropyron riparium	10	2	10	1	10	1
Agrostis gigantea	15	2	20	2	25	2
Festuca ovina	10	1	10	1	5	1
Festuca rubra	20	1	25	1	25	1
Medicago sativa	T[c]	1	T	1	T	1
Phleum pratense	0	-	0	-	0	-
Poa compressa	T	2	T	2	T	1
Poa pratensis	0	-	0	-	T	1
Trifolium hybridum	T	1	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 29

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE MARSH LAKE SITE ON MAY 20, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	<5	1	<5	10	2	<5	5	2
INDIVIDUAL SPECIES									
Agropyron cristatum	20	25	1	20	10	1	20	5	1
Agropyron pauciflorum	35	30	2	30	30	2	25	35	2
Agropyron riparium	20	10	1	20	15	1	25	15	2
Agropyron subsecundum	15	15	1	10	20	2	10	20	2
Deschampsia caespitosa	0	0	-	0	0	-	0	0	-
Festuca rubra	5	20	1	10	20	2	15	15	2
Festuca saximontana	0	0	-	0	T[c]	1	5	5	1
Medicago sativa	0	T	1	0	5	1	0	5	1
Poa compressa	0	T	2	5	T	2	0	T	2
Poa glauca	0	0	-	0	T	2	0	0	-
Poa pratensis	0	0	-	0	0	-	0	0	-
Trifolium hybridum	5	0	-	5	T	1	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 30

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE MARSH LAKE SITE ON MAY 20, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	<5	1	<5	<5	1	<5	<5	1
INDIVIDUAL SPECIES									
Agropyron cristatum	5	5	1	10	5	1	35	5	1
Agropyron pauciflorum	60	45	1	75	40	1	50	40	1
Agropyron riparium	10	5	1	15	15	1	5	20	1
Agropyron subsecundum	20	20	1	10	30	1	10	20	1
Deschampsia caespitosa	0	0	-	0	0	-	0	0	-
Festuca rubra	0	25	2	0	10	1	0	15	2
Festuca saximontana	0	0	-	0	0	-	0	0	-
Medicago sativa	0	0	-	0	T[c]	1	0	T	1
Poa compressa	0	0	-	0	T	2	0	0	-
Poa glauca	0	0	-	0	0	-	0	0	-
Poa pratensis	0	0	-	0	0	-	0	0	-
Trifolium hybridum	5	0	-	0	T	1	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 31

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE MARSH LAKE SITE ON SEPTEMBER 26, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	5	1	<5	1
INDIVIDUAL SPECIES						
Agropyron cristatum	10	1	10	1	15	1
Agropyron pauciflorum	45	1	35	2	45	1
Agropyron riparium	10	1	10	1	10	1
Agropyron subsecundum	20	1	25	1	20	1
Deschampsia caespitosa	0	-	0	-	0	-
Festuca rubra	15	1	20	1	10	1
Festuca saximontana	T[c]	1	0	-	0	-
Medicago sativa	T	1	T	1	T	1
Poa compressa	T	1	T	2	T	2
Poa glauca	0	-	0	-	0	-
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	T	1	T	1	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 32

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE MARSH LAKE SITE ON MAY 14, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	<5	2	<5	2
INDIVIDUAL SPECIES						
Agropyron cristatum	10	1	5	1	5	1
Agropyron pauciflorum	40	1	35	2	40	2
Agropyron riparium	5	1	10	2	5	1
Agropyron subsecundum	20	1	25	1	20	1
Deschampsia caespitosa	0	-	0	-	0	-
Festuca rubra	25	1	25	2	30	2
Festuca saximontana	0	-	0	-	0	-
Medicago sativa	T[c]	1	T	1	T	1
Poa compressa	T	1	T	2	T	2
Poa glauca	T	1	T	1	0	-
Poa pratensis	T	1	T	1	T	1
Trifolium hybridum	T	1	0	-	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 33

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE JOHNSON'S CROSSING SITE ON MAY 21, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	5	30	2	15	90	5	30	50	4
INDIVIDUAL SPECIES									
Agropyron riparium	30	T[c]	1	25	T	5	20	T	3
Agrostis gigantea	5	25	2	10	15	5	5	15	5
Festuca rubra	20	35	2	20	20	4	25	30	4
Medicago sativa	0	5	2	0	5	4	0	5	3
Phleum pratense	40	25	2	30	20	5	30	30	4
Poa compressa	5	T	4	5	5	5	10	T	5
Poa pratensis	0	T	3	5	T	4	5	T	3
Trifolium hybridum	0	10	2	5	35	5	5	20	4

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 34

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE JOHNSON'S CROSSING SITE ON MAY 21, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	30	2	15	95	5	15	55	4
INDIVIDUAL SPECIES									
Agropyron riparium	35	5	1	25	T[c]	5	15	5	3
Agrostis gigantea	5	10	4	5	10	5	10	10	5
Festuca rubra	25	25	2	20	30	4	20	30	4
Medicago sativa	0	T	1	0	5	4	0	10	3
Phleum pratense	25	30	2	35	30	5	30	25	4
Poa compressa	10	5	5	10	5	5	10	5	5
Poa pratensis	0	T	2	5	T	4	5	T	3
Trifolium hybridum	0	25	3	0	20	5	10	15	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 35

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE JOHNSON'S CROSSING SITE ON SEPTEMBER 26, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	15	2	85	4	50	3
INDIVIDUAL SPECIES						
Agropyron riparium	10	3	5	3	T[c]	2
Agrostis gigantea	5	2	5	3	5	2
Festuca rubra	20	3	10	3	10	3
Medicago sativa	T	1	T	1	T	1
Phleum pratense	65	2	80	4	85	3
Poa compressa	T	3	T	3	T	3
Poa pratensis	T	1	T	2	T	1
Trifolium hybridum	T	1	T	1	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 36

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE JOHNSON'S CROSSING SITE ON MAY 14, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	2	40	3	5	2
INDIVIDUAL SPECIES						
Agropyron riparium	5	1	T[c]	1	T	1
Agrostis gigantea	5	1	5	1	5	1
Festuca rubra	40	2	30	3	50	2
Medicago sativa	T	1	T	1	T	1
Phleum pratense	45	2	55	3	35	2
Poa compressa	5	3	5	3	5	2
Poa pratensis	T	1	5	2	T	1
Trifolium hybridum	T	1	T	1	5	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 37

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE JOHNSON'S CROSSING SITE ON MAY 21, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	20	3	15	90	5	20	50	4
INDIVIDUAL SPECIES									
Agropyron pauciflorum	30	5	2	25	5	5	25	5	4
Agropyron riparium	15	5	2	10	5	5	5	10	3
Agropyron sp. (*violaceum*)	20	5	2	20	5	4	25	5	4
Agrostis gigantea	5	20	3	10	10	5	5	20	5
Festuca rubra	15	30	3	10	20	4	15	25	4
Medicago sativa	0	5	2	0	5	3	0	T	3
Poa sp.	0	T	1	0	T	1	0	T	2
Poa compressa	5	T	4	5	T	5	5	T	4
Poa glauca	0	T	3	0	T	3	0	T	2
Poa palustris	10	20	4	10	20	5	10	20	5
Poa pratensis	0	T	3	5	T	3	5	T	2
Trifolium hybridum	0	10	3	5	30	5	5	15	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 38

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE JOHNSON'S CROSSING SITE ON MAY 21, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	20	2	10	90	5	5	55	4
INDIVIDUAL SPECIES									
Agropyron pauciflorum	30	5	2	20	5	5	25	5	4
Agropyron riparium	25	15	3	10	5	5	10	5	4
Agropyron sp. (*violaceum*)	20	5	1	25	5	3	20	5	4
Agrostis gigantea	0	10	2	5	10	5	5	10	5
Festuca rubra	20	40	2	15	30	4	10	30	4
Medicago sativa	0	T[c]	1	0	T	4	0	5	3
Poa sp.	0	T	1	0	T	3	0	T	3
Poa compressa	0	T	3	10	T	5	5	T	5
Poa glauca	0	T	1	0	T	3	5	T	2
Poa palustris	5	15	3	10	30	5	15	25	5
Poa pratensis	0	T	2	5	T	3	5	5	3
Trifolium hybridum	0	10	2	0	15	5	0	10	4

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 39

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE JOHNSON'S CROSSING SITE ON SEPTEMBER 26, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	10	2	90	4	55	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	55	2	60	4	55	3
Agropyron riparium	T[c]	3	T	2	T	2
Agropyron sp. (*violaceum*)	5	1	5	3	5	2
Agrostis gigantea	5	1	5	3	5	3
Festuca rubra	25	2	15	3	25	3
Medicago sativa	T	1	T	1	T	1
Poa sp.	T	1	T	2	0	-
Poa compressa	T	3	T	4	T	3
Poa glauca	T	1	0	-	T	2
Poa palustris	10	3	15	4	10	4
Poa pratensis	T	1	T	2	T	2
Trifolium hybridum	T	1	T	1	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 40

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE JOHNSON'S CROSSING SITE ON MAY 14, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	2	5	2	<5	2
INDIVIDUAL SPECIES						
Agropyron pauciflorum	15	1	25	2	20	1
Agropyron riparium	T[c]	1	T	1	T	1
Agropyron sp. (*violaceum*)	T	1	5	1	5	1
Agrostis gigantea	T	1	5	1	5	2
Festuca rubra	70	2	45	2	50	2
Medicago sativa	T	1	T	1	T	1
Poa sp.	0	-	0	-	0	-
Poa compressa	T	2	T	3	T	1
Poa glauca	0	-	0	-	T	1
Poa palustris	5	2	15	3	20	2
Poa pratensis	T	1	T	1	T	1
Trifolium hybridum	10	1	5	1	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 41

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE SWIFT RIVER SITE ON MAY 23, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	15	2	<5	30	3	<5	30	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	35	75	2	35	50	3	40	50	3
Agropyron riparium	10	T[c]	2	5	5	2	10	T	3
Agrostis gigantea	5	T	1	0	T	3	5	0	-
Bromus inermis	20	20	3	30	35	3	20	40	3
Festuca rubra	5	5	2	10	5	2	5	5	3
Medicago sativa	0	0	-	0	0	-	0	0	-
Phleum pratense	25	T	1	20	T	1	20	0	-
Poa pratensis	0	0	-	0	5	3	0	5	3
Trifolium hybridum	0	0	-	0	T	1	0	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 42

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE SWIFT RIVER SITE ON MAY 23, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	15	2	10	35	3	10	35	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	35	45	2	30	40	3	40	40	3
Agropyron riparium	15	T[c]	1	15	T	1	5	T	2
Agrostis gigantea	5	T	2	5	T	2	5	T	2
Bromus inermis	15	45	3	15	50	3	20	45	3
Festuca rubra	5	5	2	5	5	3	10	5	2
Medicago sativa	0	5	2	0	T	1	0	0	-
Phleum pratense	25	T	1	25	T	1	20	T	1
Poa pratensis	0	0	-	5	5	3	0	5	3
Trifolium hybridum	0	T	2	0	T	1	0	5	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 43

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE SWIFT RIVER SITE ON SEPTEMBER 27, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	5	2	25	3	10	2
INDIVIDUAL SPECIES						
Agropyron pauciflorum	35	2	40	3	50	2
Agropyron riparium	T[c]	2	T	1	0	-
Agrostis gigantea	T	1	T	1	T	1
Bromus inermis	20	2	15	2	5	2
Festuca rubra	25	2	5	3	5	2
Medicago sativa	T	1	T	1	0	-
Phleum pratense	20	2	40	3	40	3
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 44

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE SWIFT RIVER SITE ON MAY 15, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	5	1	30	3	15	2
INDIVIDUAL SPECIES						
Agropyron pauciflorum	25	1	15	2	15	2
Agropyron riparium	T[c]	1	0	-	5	2
Agrostis gigantea	T	1	T	1	T	1
Bromus inermis	5	1	5	2	5	2
Festuca rubra	30	2	30	3	20	3
Medicago sativa	0	-	0	-	0	-
Phleum pratense	35	1	50	3	55	2
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	5	1	0	-	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 45

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE SWIFT RIVER STIE ON MAY 23, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	15	2	5	35	3	5	25	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	15	50	2	20	50	3	25	65	3
Agropyron riparium	10	5	1	10	5	2	5	T[c]	1
Agrostis gigantea	5	T	1	5	T	3	5	T	3
Bromus inermis	5	20	3	10	15	3	10	15	3
Festuca rubra	40	20	2	20	10	2	25	5	3
Festuca saximontana	10	5	3	5	5	3	0	5	3
Medicago sativa	0	0	-	0	T	1	0	0	-
Phleum pratense	5	T	1	5	T	1	10	T	1
Poa compressa	5	0	-	10	5	3	10	T	2
Poa palustris	0	T	1	5	10	3	5	10	2
Poa pratensis	5	0	-	10	0	-	5	0	-
Trifolium hybridum	0	T	1	0	T	1	0	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 46

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE SWIFT RIVER SITE ON MAY 23, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	10	2	<5	30	3	<5	25	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	15	40	2	20	35	3	20	45	3
Agropyron riparium	15	T[c]	1	5	5	3	0	T	1
Agrostis gigantea	5	T	2	5	0	-	5	T	1
Bromus inermis	5	35	2	10	20	3	10	25	3
Festuca rubra	30	10	2	20	5	2	20	10	3
Festuca saximontana	10	T	3	5	T	3	5	T	1
Medicago sativa	0	5	1	0	T	1	0	5	1
Phleum pratense	10	5	1	10	5	1	10	5	2
Poa compressa	5	T	3	10	5	4	10	T	3
Poa palustris	5	5	2	10	25	3	10	10	2
Poa pratensis	0	0	-	5	T	2	10	0	-
Trifolium hybridum	0	T	1	0	T	1	0	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 47

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE SWIFT RIVER SITE ON SEPTEMBER 27, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	5	2	30	3	15	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	10	2	10	3	25	3
Agropyron riparium	T[c]	1	T	1	5	3
Agrostis gigantea	T	1	5	2	T	1
Bromus inermis	20	2	5	2	T	2
Festuca rubra	25	2	10	2	10	2
Festuca saximontana	0	-	0	-	T	3
Medicago sativa	T	1	0	-	0	-
Phleum pratense	20	2	25	3	30	3
Poa compressa	0	-	T	3	T	3
Poa palustris	25	3	45	3	30	3
Poa pratensis	0	-	T	2	0	-
Trifolium hybridum	0	-	0	-	T	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 48

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE SWIFT RIVER SITE ON MAY 15, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	25	3	15	2
INDIVIDUAL SPECIES						
Agropyron pauciflorum	10	2	20	2	20	2
Agropyron riparium	5	1	5	2	T[c]	1
Agrostis gigantea	T	1	T	1	T	2
Bromus inermis	5	1	10	3	5	2
Festuca rubra	10	1	5	3	25	2
Festuca saximontana	0	-	0	-	0	-
Medicago sativa	T	1	0	-	0	-
Phleum pratense	40	1	40	3	25	2
Poa compressa	0	-	T	3	T	3
Poa palustris	25	3	20	3	20	3
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	10	1	0	-	5	1

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 49

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH A MULCH AMENDMENT AT THE WATSON LAKE SITE ON MAY 22, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	5	20	2	55	85	5	25	35	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	20	15	2	20	15	3	25	25	2
Agropyron riparium	0	5	1	0	T[c]	3	5	T	2
Agrostis gigantea	20	15	2	15	15	5	5	10	3
Bromus inermis	5	10	1	10	25	5	10	15	3
Festuca rubra	5	25	3	5	20	4	15	30	4
Medicago sativa	0	T	1	0	T	3	0	T	2
Phleum pratense	50	30	2	50	25	5	35	20	3
Poa pratensis	0	T	3	0	T	3	5	T	2
Trifolium hybridum	0	T	1	0	T	3	0	T	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 50

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED WITH NO MULCH AMENDMENT AT THE WATSON LAKE STIE ON MAY 22, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	10	2	40	85	5	30	45	3
INDIVIDUAL SPECIES									
Agropyron pauciflorum	20	15	2	20	15	3	20	15	3
Agropyron riparium	10	T[c]	3	10	T	3	0	T	1
Agrostis gigantea	5	10	3	5	15	5	15	15	4
Bromus inermis	10	10	2	10	25	5	15	20	3
Festuca rubra	15	30	3	10	20	4	20	25	4
Medicago sativa	0	T	1	0	T	3	0	T	3
Phleum pratense	25	35	2	30	25	5	25	25	3
Poa pratensis	15	T	1	15	T	1	5	0	-
Trifolium hybridum	0	T	1	0	T	2	0	T	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 51

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE WATSON LAKE SITE ON SEPTEMBER 27, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	10	2	80	4	40	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	10	2	15	3	10	2
Agropyron riparium	0	-	0	-	T[c]	1
Agrostis gigantea	10	3	5	4	10	4
Bromus inermis	5	1	T	2	T	2
Festuca rubra	5	3	5	4	5	3
Medicago sativa	0	-	0	-	0	-
Phleum pratense	70	2	75	4	75	3
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 52

COVER AND VIGOUR OF AGRONOMIC CULTIVARS SEEDED AT THE WATSON LAKE SITE ON MAY 15, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	25	2	5	1
INDIVIDUAL SPECIES						
Agropyron pauciflorum	25	1	30	2	25	2
Agropyron riparium	0	-	T[c]	2	0	-
Agrostis gigantea	5	1	T	2	5	1
Bromus inermis	10	1	10	2	20	1
Festuca rubra	5	2	5	3	10	2
Medicago sativa	0	-	0	-	0	-
Phleum pratense	55	1	55	2	40	1
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 53

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH A MULCH AMENDMENT AT THE WATSON LAKE SITE ON MAY 22, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	5	10	2	45	70	5	20	35	4
INDIVIDUAL SPECIES									
Agropyron pauciflorum	10	T[c]	1	10	T	3	15	5	3
Agropyron riparium	0	5	1	0	T	3	5	T	3
Agrostis gigantea	5	10	2	10	20	5	5	25	4
Bromus inermis	15	10	2	5	10	4	20	10	3
Festuca rubra	5	25	3	20	20	4	10	20	4
Medicago sativa	0	0	-	0	T	3	0	0	-
Phleum pratense	55	35	2	40	30	5	30	15	4
Poa compressa	0	0	-	5	0	-	5	0	-
Poa palustris	10	15	3	5	20	5	5	25	5
Poa pratensis	0	0	-	5	T	3	5	0	-
Trifolium hybridum	0	0	-	0	0	-	0	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 54

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED WITH NO MULCH AMENDMENT AT THE WATSON LAKE SITE ON MAY 22, 1978.

	UNFERTILIZED CONTROL			19-26-0 FERTILIZER			34-0-0 & 0-45-0 FERTILIZER		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	5	25	3	60	80	5	30	50	4
INDIVIDUAL SPECIES									
Agropyron pauciflorum	10	5	2	10	T[c]	3	15	T	3
Agropyron riparium	0	5	2	0	T	2	0	T	3
Agrostis gigantea	5	5	3	5	20	5	5	10	4
Bromus inermis	20	10	2	10	15	4	15	10	3
Festuca rubra	5	25	3	20	15	4	10	20	4
Medicago sativa	0	T	1	0	0	-	0	T	3
Phleum pratense	40	20	2	30	25	5	25	30	4
Poa compressa	5	0	-	5	0	-	5	0	-
Poa palustris	15	30	3	20	25	5	20	30	5
Poa pratensis	0	0	-	0	0	-	5	0	-
Trifolium hybridum	0	T	2	0	T	3	0	T	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

TABLE 55

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE WATSON LAKE SITE ON SEPTEMBER 27, 1978.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	10	1	80	4	40	3
INDIVIDUAL SPECIES						
Agropyron pauciflorum	5	1	10	2	5	1
Agropyron riparium	0	-	0	-	T[c]	1
Agrostis gigantea	5	2	T	4	5	4
Bromus inermis	5	1	T	2	T	2
Festuca rubra	5	2	5	3	5	3
Medicago sativa	0	-	0	-	0	-
Phleum pratense	70	1	60	4	70	3
Poa compressa	0	-	T	3	0	-
Poa palustris	10	3	25	4	15	4
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 56

COVER AND VIGOUR OF NORTHERN ECOTYPES SEEDED AT THE WATSON LAKE SITE ON MAY 15, 1979.

	UNFERTILIZED CONTROL		19-26-0 FERTILIZER		34-0-0 & 0-45-0 FERTILIZER	
	COVER[a] (%)	VIGOUR[b] (1-5)	COVER (%)	VIGOUR (1-5)	COVER (%)	VIGOUR (1-5)
ENTIRE TREATMENT	<5	1	20	3	5	2
INDIVIDUAL SPECIES						
Agropyron pauciflorum	25	1	15	3	20	2
Agropyron riparium	0	-	0	-	0	-
Agrostis gigantea	T[c]	1	T	3	T	3
Bromus inermis	T	1	T	1	T	1
Festuca rubra	T	2	5	3	T	2
Medicago sativa	0	-	0	-	0	-
Phleum pratense	70	1	30	2	45	2
Poa compressa	0	-	15	4	10	3
Poa palustris	5	2	35	3	25	3
Poa pratensis	0	-	0	-	0	-
Trifolium hybridum	0	-	0	-	0	-

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

APPENDIX D

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE ALASKA HIGHWAY REVEGETATION SECONDARY TEST SITES

LIST OF TABLES

TABLE 1

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE BEAVER CREEK SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	65	95	5	60	95	5	50	95	5	70	95	5
INDIVIDUAL SPECIES												
Agropyron riparium	10	T[c]	3	5	T	5	5	T	4	5	T	5
Agropyron sp. (*violaceum*)	5	5	4	5	5	4	5	10	4	0	5	4
Agrostis gigantea	5	5	5	5	10	5	5	5	5	5	5	5
Alopecurus pratensis	5	5	5	5	10	5	5	10	5	5	10	5
Festuca rubra	5	5	4	5	5	4	5	5	4	5	5	4
Medicago sativa	10	T	2	10	T	1	10	T	1	5	T	5
Phleum pratense	10	10	4	10	5	4	10	10	4	5	5	5
Poa palustris	20	10	5	25	15	5	30	20	5	35	20	5
Poa pratensis	0	T	4	5	5	3	0	5	4	5	5	4
Trifolium hybridum	30	60	5	25	45	5	25	35	5	30	45	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 2

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE DESTRUCTION BAY SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	70	15	3	75	30	3	75	30	3	80	50	4
INDIVIDUAL SPECIES												
Agropyron riparium	10	5	3	5	5	3	20	10	2	15	10	3
Agropyron sp. (*violaceum*)	15	60	3	25	60	3	20	60	3	20	55	4
Agrostis gigantea	5	5	2	5	T[c]	2	5	T	1	5	T	3
Deschampsia caespitosa	0	0	-	0	0	-	0	0	-	0	0	-
Festuca rubra	15	10	3	5	10	3	5	10	3	5	15	4
Medicago sativa	20	T	2	25	T	2	15	T	2	20	T	2
Poa alpigena	0	T	3	0	0	-	0	0	-	0	0	-
Poa glauca	5	15	4	5	20	4	5	15	4	5	15	4
Poa palustris	20	5	2	15	5	2	20	5	2	25	5	3
Trifolium hybridum	10	T	2	15	T	1	10	T	2	5	T	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 3

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE HAINES JUNCTION SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	30	25	3	20	30	3	15	25	3	30	40	3
INDIVIDUAL SPECIES												
Agropyron cristatum	30	20	2	40	15	2	40	20	3	25	10	2
Agropyron pauciflorum	5	10	3	5	15	3	5	10	3	5	10	3
Agropyron riparium	20	10	3	10	5	2	5	5	2	10	5	2
Agropyron sp. (*violaceum*)	30	25	3	30	25	3	25	30	3	25	25	3
Deschampsia caespitosa	0	0	-	0	0	-	0	0	-	0	0	-
Festuca rubra	15	30	3	15	35	3	20	35	3	20	30	3
Medicago sativa	0	0	-	0	0	-	0	0	-	0	0	-
Poa glauca	0	5	4	0	5	3	0	T[c]	3	5	10	3
Trifolium hybridum	0	0	-	0	T	1	5	T	1	10	10	2

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 4

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE MARSH LAKE SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	<5	2	<5	<5	2	<5	<5	2	<5	55	4
INDIVIDUAL SPECIES												
Agropyron cristatum	40	5	1	30	10	1	40	10	1	30	5	2
Agropyron pauciflorum	10	30	2	5	25	2	10	35	2	5	5	3
Agropyron riparium	5	15	2	5	20	2	5	10	2	20	10	3
Agropyron sp. (*violaceum*)	20	35	2	25	30	2	30	40	2	20	5	3
Deschampsia caespitosa	0	0	-	0	0	-	0	0	-	0	T[c]	2
Festuca ovina	5	0	-	5	0	-	0	0	-	5	T	3
Festuca rubra	20	10	3	30	15	3	15	5	3	10	15	4
Medicago sativa	0	5	1	0	T	1	0	T	2	0	5	2
Poa compressa	0	T	3	0	T	4	0	0	-	5	20	5
Poa glauca	0	T	3	0	0	-	0	0	-	0	25	4
Poa pratensis	0	0	-	0	0	-	0	0	-	0	10	3
Trifolium hybridum	0	T	2	0	0	-	0	0	-	5	T	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 5

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE JOHNSON'S CROSSING SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	10	65	5	10	80	5	5	75	5	25	90	5
INDIVIDUAL SPECIES												
Agropyron pauciflorum	30	5	4	25	5	4	30	5	4	20	5	4
Agropyron riparium	30	5	4	20	5	3	25	5	3	20	T[c]	2
Agropyron sp. (*violaceum*)	10	5	4	10	5	4	15	5	4	15	5	4
Agrostis gigantea	5	10	5	5	10	5	5	10	5	5	5	5
Festuca rubra	10	30	5	20	25	5	15	20	5	10	15	5
Medicago sativa	0	T	3	0	T	3	0	T	3	0	T	3
Poa alpigena	0	T	3	0	T	3	0	T	3	0	T	4
Poa compressa	5	T	5	5	T	5	5	T	5	5	T	5
Poa glauca	5	T	4	0	T	3	0	T	3	5	T	2
Poa palustris	5	25	5	10	20	5	5	25	5	10	15	5
Poa pratensis	0	T	3	5	5	4	0	5	4	5	5	4
Trifolium hybridum	0	20	5	0	25	5	0	25	5	5	50	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 6

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE SWIFT RIVER SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	<5	30	3	<5	40	3	<5	35	3	15	55	4
INDIVIDUAL SPECIES												
Agropyron riparium	15	T[c]	2	5	5	1	15	T	1	10	T	1
Agropyron sp. (*violaceum*)	25	15	3	20	20	3	25	20	3	25	10	4
Agrostis gigantea	5	T	2	5	T	1	5	T	2	0	5	3
Bromus inermis	5	30	3	10	25	3	5	25	3	5	10	3
Festuca ovina	5	5	2	0	5	3	5	T	3	0	15	4
Festuca rubra	20	25	3	20	20	3	25	25	3	15	25	4
Medicago sativa	0	T	1	0	T	1	0	T	1	0	5	3
Phleum pratense	20	10	2	20	10	2	15	10	2	10	10	3
Poa compressa	5	10	4	5	10	3	0	10	3	5	5	4
Poa palustris	0	5	2	10	5	2	5	5	2	5	5	3
Poa pratensis	0	0	-	5	0	-	0	0	-	0	T	2
Trifolium hybridum	0	T	2	0	T	1	0	5	3	25	10	3

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

TABLE 7

COVER AND VIGOUR OF THE ENTRIES SEEDED AT THE WATSON LAKE SECONDARY SITE

	CONTROL			POTASSIUM SULFATE FERTILIZER			MICRONUTRIENT FERTILIZER			HAY MULCH		
	COVER[a] (%)		VIGOUR[b] (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)	COVER (%)		VIGOUR (1-5)
	1978	1979	1979	1978	1979	1979	1978	1979	1979	1978	1979	1979
ENTIRE TREATMENT	30	55	4	55	85	5	30	60	4	45	85	5
INDIVIDUAL SPECIES												
Agropyron riparium	5	T[c]	1	5	T	2	5	T	2	10	0	-
Agropyron sp. (*violaceum*)	25	5	3	20	5	4	25	5	4	20	5	4
Agrostis gigantea	0	10	5	10	10	5	5	5	5	5	5	5
Bromus inermis	5	10	3	10	10	4	10	10	3	5	15	3
Festuca rubra	15	20	4	10	15	4	15	25	4	10	15	4
Medicago sativa	0	T	1	0	T	1	0	T	1	0	T	1
Phleum pratense	25	25	4	15	30	5	25	20	4	15	15	5
Poa compressa	5	T	3	5	T	5	5	0	-	5	0	-
Poa palustris	15	20	5	10	30	5	5	20	5	5	20	5
Poa pratensis	5	0	-	10	0	-	5	0	-	0	0	-
Trifolium hybridum	0	10	5	5	T	4	0	15	4	25	25	5

a All cover values have been rounded to the nearest 5%.

b Vigour ratings are subjective assessments of gross morphology and phenology. 1 = minimum; 5 = maximum development.

c Trace amount of cover.

APPENDIX E

BOTANICAL AND COMMON NAMES USED IN THIS REPORT

BOTANICAL AND COMMON NAMES USED IN THIS REPORT

BOTANICAL NAME	COMMON NAME
Agropyron cristatum (L.) Gaertn.	Crested wheatgrass
Agropyron pauciflorum (Schwein.) Hitchc.	Slender wheatgrass
Agropyron riparium Scribn. & Smith	Streambank wheatgrass
Agropyron subsecundum (Link) Hitchc.	Bearded wheatgrass
Agropyron violaceum (Hornem.) Lange	Purple wheatgrass
Agrostis gigantea Roth	Red top
Alopecurus pratensis L.	Meadow foxtail
Arctagrostis latifolia (R. Br.) Griseb.	Arcticgrass
Bromus inermis Leyss.	Smooth brome
Bromus Pumpellianus Scribn.	Northern brome
Calamagrostis canadensis (Michx.) Beauv.	Bluejoint
Deschampsia caespitosa (L.) Beauv.	Hairgrass
Festuca ovina L.	Sheep fescue
Festuca rubra L.	Red fescue
Festuca saximontana Rydb.	Native fescue
Hierochloe odorata (L.) Wahlenb.	Sweetgrass
Hordeum jubatum L.	Foxtail barley
Medicago falcata L.	Yellow lucerne
Medicago sativa L.	Alfalfa
Phleum pratense L.	Timothy
Poa alpigena (E. Fries) Lindm.	Bluegrass
Poa compressa L.	Canada bluegrass
Poa glauca M. Vahl	Glaucous bluegrass
Poa palustris L.	Fowl bluegrass
Poa pratensis L.	Kentucky bluegrass
Puccinellia Parl.	Alkaligrass
Trifolium hybridum L.	Alsike clover

* Botanical nomenclature follows E. Hulten, Flora of Alaska and Neighbouring Territories, Stanford University Press, Stanford, California, 1968.