Revegetation of Disturbances

in the Northeast Coal Block, Current Activities and State-of-the-Art, 1977

Province of British Columbia

Ministry of
Mines and
Petroleum Resources

PAPER 1978-6

INSPECTION AND ENGINEERING DIVISION

REVEGETATION OF DISTURBANCES IN THE NORTHEAST COAL BLOCK, CURRENT ACTIVITIES AND STATE - OF - THE - ART, 1977

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ACKNOWLEDGEMENTS

Information on revegetation in the Peace River (northeast) Coal Block has been gathered by companies, their consultants and the Ministry of Mines and Petroleum Resources. Most of the companies' data was available to us through reports submitted to government under the Coal Guidelines process. We would like to thank Denison Coal Ltd. for releasing data collected following their Stage I report. Each set of data are presented alphabetically according to the company responsible.

SUMMARY

Data gathered by companies, consultants and the Ministry of Mines and Petroleum Resources in the Peace River (Northeast) Coal Block is sufficient to present an initial set of findings.

There is a major difference between species survival both above and below the treeline. Legume species do not generally survive above the treeline.

A total of 34 species (or varieties) consisting of 21 grasses and 13 legumes has been seeded at various times.

Above treeline, grass species performance was excellent for meadow foxtail, good for creeping red fescue and timothy, and moderate for meadow fescue, Canada bluegrass, slender wheatgrass, and bromegrass. Redtop grows well the first season but has a poor ability to over-winter. Legume growth was very poor above treeline. The only two legume species which grew at all were alsike and red clover and these only grew in sheltered moist pockets.

Below treeline, growth of grass and legume species was generally good for the majority of species tested. Growth was excellent for creeping red fescue and redtop; good for Canada bluegrass, slender wheatgrass, and timothy; and moderate for meadow fescue, bromegrass, and meadow foxtail. Legume growth was excellent for alfalfa, alsike clover, red clover, sweet clover, and white clover. Birdsfoot trefoil and sainfoin grew poorly.

Grass species survival and performance is greatly enhanced by the addition of fertilizer. Above the treeline, fertilizer applications

are critical to the survival of all seeded species. Below the treeline, legume survival is very important to the survival of the unfertilized grass - legume mixture. Sites of low nutrient availability rely on legume growth for several years in order to inject enough available nitrogen into the system to allow grass survival.

The Ministry of Mines and Petroleum Resources have set out test plots to demonstrate the application of different seeding rates.

Three broad types of seeding techniques have been tried in the Peace River Coal Block including broadcast seeding, harrowing after broadcast seeding, and hydroseeding.

Broadcast seeding is the most common method of seeding, consisting of scattering seed on the surface of the ground.

Broadcast seeding without fertilizer applications has resulted in satisfactory growth at most sites below the treeline. Above treeline, this method of seed application has generally resulted in poor growth.

Harrowing all areas above treeline has been recommended by the Ministry of Mines and Petroleum Resources since 1976.

Hydroseeding was used in an experimental way in the alpine areas of Bullmoose/Chamberlain and initial results indicate favourable growth over the first summer. Good survival is anticipated next year.

Grass seed coated with micronutrients and legume seed coated with micronutrientes as well as rhizobia innoculant were tested during 1977.

INTRODUCTION

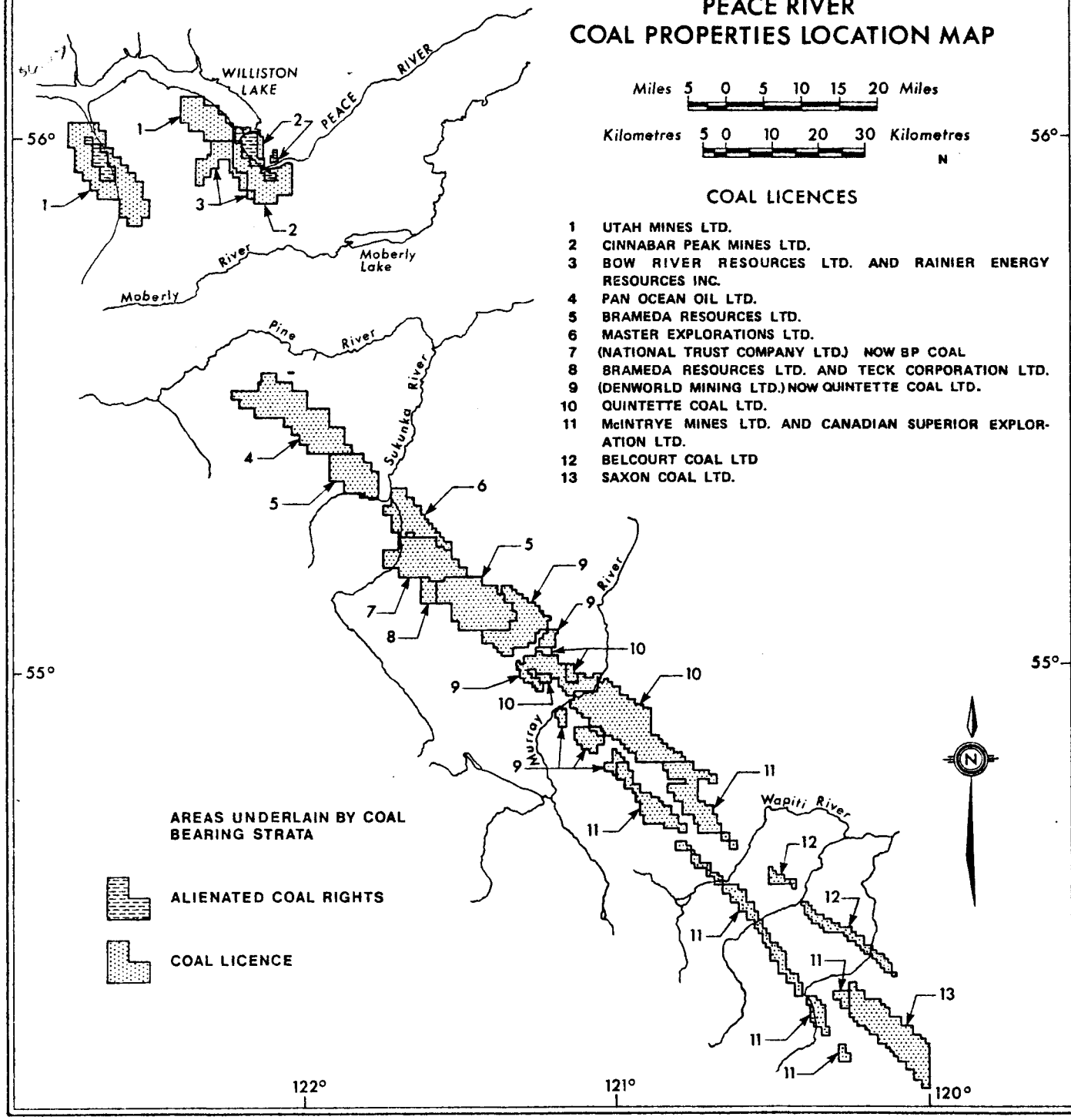
The Peace River (Northeast) Coal Block is located in the Rocky Mountain foothills, extending a distance of 150 miles from Williston Lake to the Alberta border (Figure 1). The area, comprising seven hundred and fifty coal licences, has received increasing exploration activity over the last few years, with a promise of further development in the future. In general, exploration work has taken place in high elevation alpine and subalpine regions where revegetation is difficult and disturbances are highly visible.

Under Sections 7 and 8 of the Coal Mines Regulation Act, it is the responsibility of the Ministry of Mines and Petroleum Resources to ensure that areas disturbed by coal exploration and mining are adequately reclaimed. Mining companies contemplating development are required to follow the Guidelines for Coal Development (Environment and Land Use Committee, March 1976) which outline the requirements of all agencies associated with mine development. Several companies in the northeast have initiated programs designed to solve long term reclamation and environmental protection problems related to the proposed open pit operations. To date, however, the majority of reclamation work has been associated with exploration activities.

The major objective of this report is to document all revegetation activities in the Peace River Coal Block to provide a baseline from which future reclamation programs, future research and reclamation guidelines can be designed.

FIGURE 1

PEACE RIVER COAL PROPERTIES LOCATION MAP



COAL LICENCES

1 UTAH MINES LTD.
2 CINNABAR PEAK MINES LTD.
3 BOW RIVER RESOURCES LTD. AND RAINIER ENERGY RESOURCES INC.
4 PAN OCEAN OIL LTD.
5 BRAMEDA RESOURCES LTD.
6 MASTER EXPLORATIONS LTD.
7 (NATIONAL TRUST COMPANY LTD.) NOW BP COAL
8 BRAMEDA RESOURCES LTD. AND TECK CORPORATION LTD.
9 (DENWORLD MINING LTD.) NOW QUINTETTE COAL LTD.
10 QUINTETTE COAL LTD.
11 McINTRYE MINES LTD. AND CANADIAN SUPERIOR EXPLORATION LTD.
12 BELCOURT COAL LTD
13 SAXON COAL LTD.

RECLAMATION ACTIVITIES IN THE PEACE RIVER COAL BLOCK

BRAMEDA RESOURCES LIMITED/INTERNATIONAL ENVIRONMENTAL CONSULTANTS LTD.

1976 Revegetation Program

During the 1976 field season, work done in the alpine areas of the Chamberlain and Bullmoose properties consisted of broadcast seeding and a large scale test of hydroseeding. Forested areas were broadcast seeded using the standard forestry mix (creeping red fescue, timothy and alsike clover).

Broadcast seeding in the alpine was undertaken using a mixture of creeping red fescue, alsike clover, annual rye, and crested wheatgrass at a rate of 56 kg/ha (50 lb/ac).

Hydroseeding was conducted on an operational scale in a variety of difficult alpine areas. The following seed and fertilizer rates were applied.

Species	Rate of Application
Vetch	13 kg/ha
Rambler alfalfa	"
Sweet clover	"
White clover	"
Annual rye	"
Canada bluegrass	"
Crested wheatgrass	22 kg/ha
Russian wild rye	"
Brome grass	"
Timothy	"
Creeping red fescue	45 kg/ha
Total	211 kg/ha

Fertilizer	Rate of Application
34-0-0	180 kg/ha
11-55-0	112 kg/ha
0-0-60	112 kg/ha
Total	404 kg/ha

Other minor elements were added to the mixture at the rate of 2.5 kg per hectare. The mulch used for the mixture was a wood fibre product sold as "Silva Fibre" by Weyerhaeuser of Canada Ltd.

In addition to the operational hydroseeding, a plot was laid out to test the growth of each species used in the hydroseed mix. The test plot was laid out on a drill site on Mount Chamberlain (Figure 2).

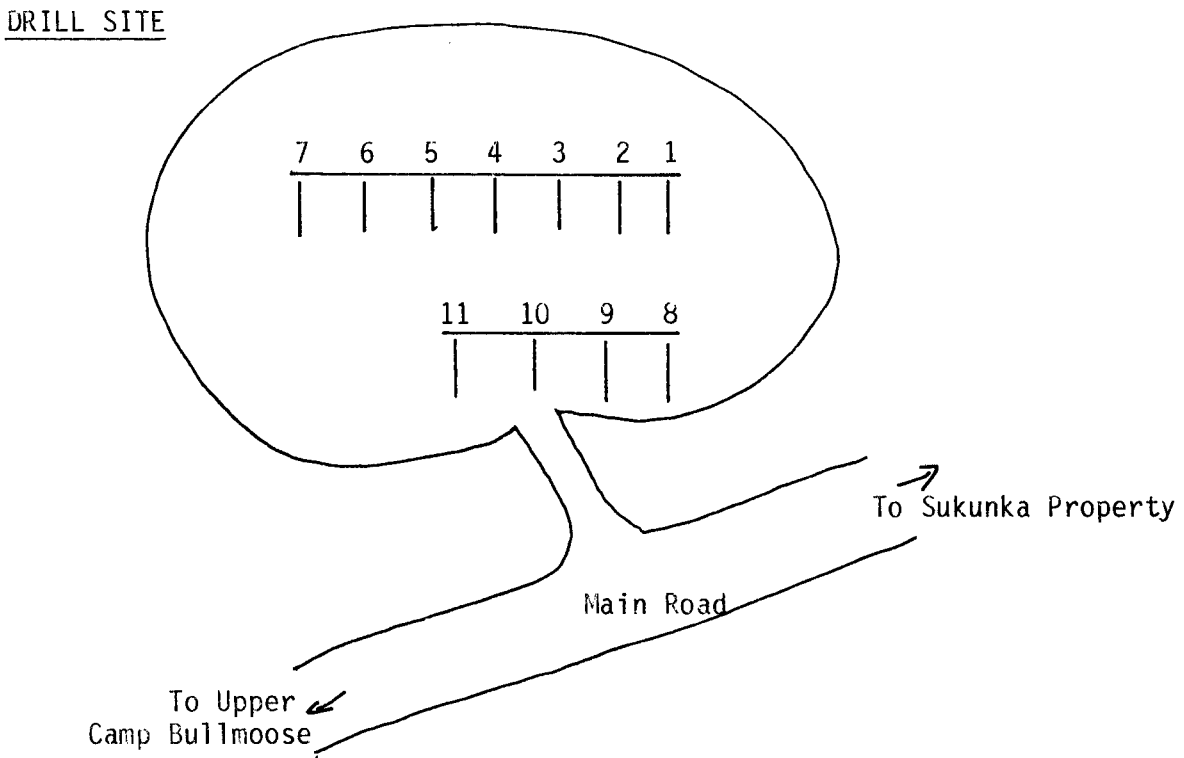
In August 1976, this drillsite was prepared for seeding by hand-raking some of the coarser material to produce a finer tilth in the seedbeds. Each species was planted by hand using a rake. Each set of rows was marked by a wooden stake bearing the name of the species being tested (Figure 2). Upon completion of planting, the surface of the test plot was sprayed by an aqueous slurry of cellulose-fibre mulch to provide additional protection to the seeds against freezing during the winter months.

Results

Both the areas that were seeded by hand broadcasting and hydro-seeding were not assessed in detail.

FIGURE 2

LOCATION AND LAYOUT OF SPECIES USED IN EXPERIMENTAL HYDROSEEDING, BRAMEDA RESOURCES LIMITED/IEC, 1976



1. Annual Rye
2. Brome Grass
3. Canada Blue
4. Creeping Red Fescue
5. Crested Wheat
6. Rambler Alfalfa
7. Russian Wild Rye
8. Sweet Clover
9. Timothy
10. Vetch
11. White Clover

Areas that had been hydroseeded generally grew well. By late August grass species were approximately 10 cm high although no legumes were visible. Unfortunately many of the areas that had been hydroseeded were redisturbed by exploration during 1977. Snowfall early in September prevented an assessment of individual species success.

The individual species trials had generally fared poorly by late August, 1977. All stakes marking rows of species had disappeared (probably eaten by marmots) and B.C. Ministry of Mines personnel had difficulty in relocating these plots.

Although initial results of the hydroseeding are encouraging, plant survival through the first and succeeding overwintering periods will determine the success of this method.

DENISON COAL LTD./B.C. RESEARCH

Introduction

Denison Coal Ltd. and B.C. Research have conducted studies which are designed to define and overcome reclamation problems associated with proposed open pit mining in alpine and subalpine areas. Studies have included:

1) an assessment of the physical and chemical characteristics of potential waste rock material using drill core samples. Assessments have included:
    a) freeze/thaw weathering tests
    b) chemical analysis of selected parameters affecting plant growth
    c) plant growth chamber experiments
    d) fish bioassays.

2) characteristics of surface soil materials for use as a top dressing for waste dumps.

3) preliminary collection and evaluation of native plant species for future use in reclamation programs.

4) a system of plots to test the growth and survival of a number of agronomic species near the proposed Sheriff pit area.

Preliminary results from these programs were presented in the "Stage I Environmental Study of the Quintette Coal Project". It is anticipated that a full discussion of all reclamation programs will be presented in their Stage II submissions. Only results of the field test plots are discussed in this report.

A series of test plots near the proposed Sheriff pit area were set up in the spring of 1976 and results were assessed in the fall of 1976 and again in the summer of 1977. The 1976 data was reported in the "Stage I Environmental Study of the Quintette Coal Project" and is reproduced below with minor editing. The 1977 plot assessments were tabulated by B.C. Research and have been provided to the Ministry of Mines by Denison Coal Ltd. The interpretation of the 1977 results is our own.

Methods

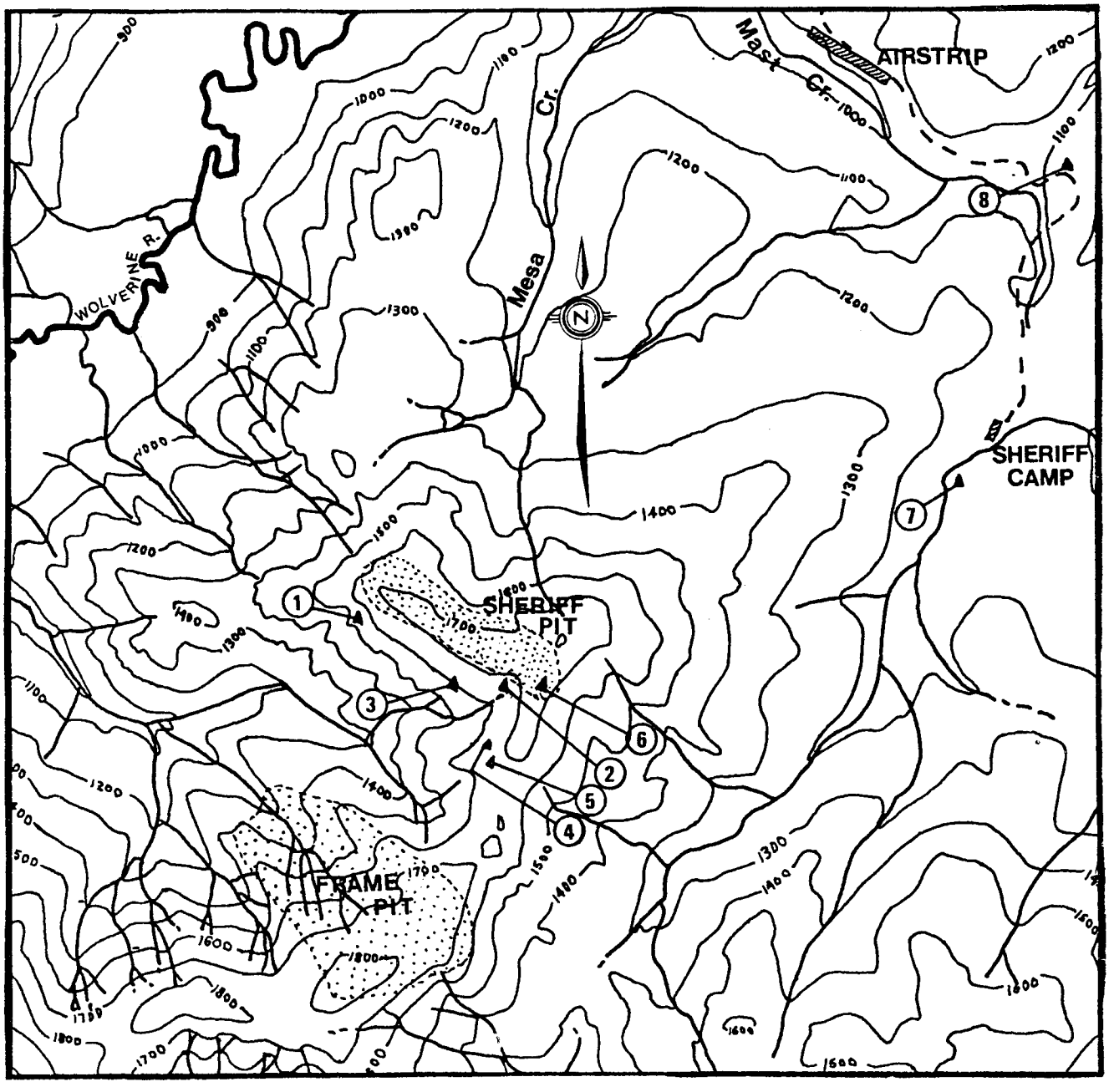
Between June 30 and July 4, 1976, revegetation plots to test agricultural species were planted on eight previously disturbed sites. Plots were located at six high elevation (1700 metres) trench sites which had been backfilled and contoured in the Sheriff pit area, and at two lower elevation (1100 metres) abandoned gas well sites near Mast Creek (Figure 3).

Fifteen species were tested using both single and mixed species trials (Appendix A-1). A split plot design was proposed with two replicates at each site. However, the area that was required for the complete layout of both single and mixed species trials was too large and following site 1 (where the single species trial contained two replicates) the layout was reduced to one replicate for the single species trial. Two replicates for the mixed species trial were always done. Plots measured 1 metre by 2 metres for the single species trials and 2 metres by 2 metres for the species mixes. Plots were surrounded by a 0.5 metre border (Appendix A-2).

The seeding rates for single species trials were 45 kg/ha (40 lb/ac) for all grasses and sainfoin, and 28 kg/ha (25 lb/ac) for all legumes.

FIGURE 3

LOCATION OF TEST PLOTS (▲) ESTABLISHED NEAR THE PROPOSED SHERIFF AND FRAME PITS, DENISON COAL LTD./B.C. RESEARCH, 1977
(Scale 1:50,000)



Seed mixes were spread at the rate of 45 kg/ha (40 lb/acre). Plot boundaries were laid out using twine and the corners were marked with 15 cm galvanized nails. Consecutively numbered tags were placed at plot corners (Appendix A-2). Plots were raked, seeded, fertilized and then re-raked to cover the seed and fertilizer. Legumes were innoculated just prior to seeding. For all species and species mixes, the following three fertilizer rates were used:

Control - no fertilizer
Optimum fertilizer rate - 36:45:22 kg/ha (32:40:20 lb/ac) of $N:P_2O_5:K_2O$
Double fertilizer rate - 72:90:45 kg/ha (64:80:40 lb/ac) of $N:P_2O_5:K_2O$

Results (1976)

Test plots were assessed on August 20, 1976 - less than two months after seeding. These tests provide an initial assessment of the performance of a variety of species at different locations and under several fertilizer treatments (Appendix A-3 and A-4). For the purpose of this report the results are presented in a raw form and conclusions are based on initial overview rather than a detailed analysis of the data.

Of the grass species, creeping red fescue, bromegrass, meadow foxtail, meadow fescue, timothy and redtop showed promising growth while slender wheatgrass and Canada bluegrass did not perform well. All legume species germinated and grew to some extent but the low cover values throughout makes a relative assessment difficult for each of the different species. The legumes showed better results in the seed mix trials than the single species trials. Legumes usually require two seasons to become established.

Fertilizer treatments resulted in major improvements to plant growth throughout. Without a more complete analysis of the data it is not yet clear whether the "optimum" rate of fertilizer is adequate or whether an increased application of fertilizer elicits an additional plant growth response.

Differences in plant growth as a result of the site conditions (elevation, slope, aspect and physical or chemical soil parameters) are not yet clear.

In general, the sites chosen for species trials are extreme and if successful establishment of vegetation occurs, future reclamation will be promising. Sites 1 to 6 are very high subalpine forest or in alpine tundra and Sites 7 and 8 are on abandoned gas well sites at lower elevations (Figure 3). Even though these sites are at low elevations they were put on portions of the drill pads which had remained bare following seeding by the gas exploration company. Site 8 was very gravelly and compacted and will provide a good test for species suitability at difficult lower-elevation sites.

Results (1977)

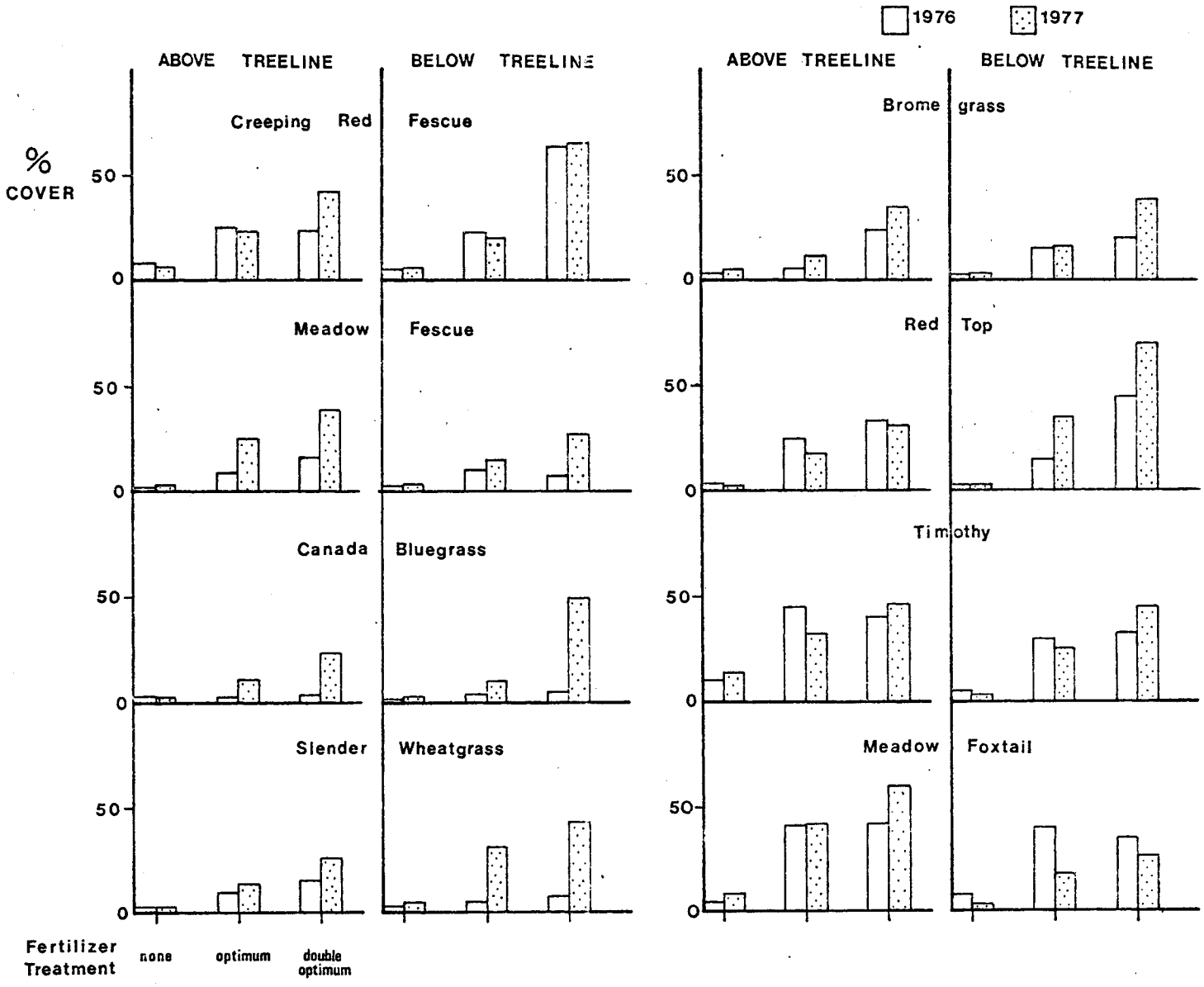
Data collected during the summer of 1977 are tabulated in Appendix A-5. They have not, as yet, been analyzed or discussed by B.C. Research. These data represent two growing seasons and one overwintering period.

Grass species - single species trials

All grass species responded to increased fertilizer levels whether above or below treeline (Figure 4).

FIGURE 4

AVERAGE GROWTH (% COVER) OF SINGLE GRASS SPECIES TRIALS ABOVE TREELINE (SITES 1, 1a, 2 TO 6) AND BELOW TREELINE (SITES 7 & 8), DENISON COAL/B.C. RESEARCH, 1976 and 1977.



Above the treeline all species grew to some extent. The maximum second year growth (% cover) occurred in plots receiving the largest application of fertilizer and was excellent for meadow foxtail (65%); good for creeping red fescue (42%) and timothy (46%); moderate for meadow fescue (38%), bromegrass (34%), slender wheatgrass (25%), and Canada bluegrass (23%); and poor for redtop (31%). Redtop was rated poor because it had burned off and the leaves were brown. Cover increased during the second year in all species except redtop and timothy.

Below the treeline, all grass species required a fertilizer application and responded to increased levels of nutrients. Second year growth with double optimum fertilizer treatment was excellent for redtop (70%) and creeping red fescue (64%); good for Canada bluegrass (49%), timothy (45%) and slender wheatgrass (43%); and moderate for bromegrass (38%), meadow fescue (27%), and meadow foxtail (27%). Cover increased during the second year in all species except meadow foxtail. The largest gain in growth was shown by Canada bluegrass which increased from 5% cover in 1976 to 49% cover in 1977.

Legume species - single species trials

The growth of legume species varied considerably depending upon whether the site was above or below the treeline (Figure 5).

Above the treeline all species grew poorly. In all cases, legume growth decreased during the second year.

Below the treeline, on the other hand, average legume growth (% cover) with double optimum fertilizer treatment during the second year was

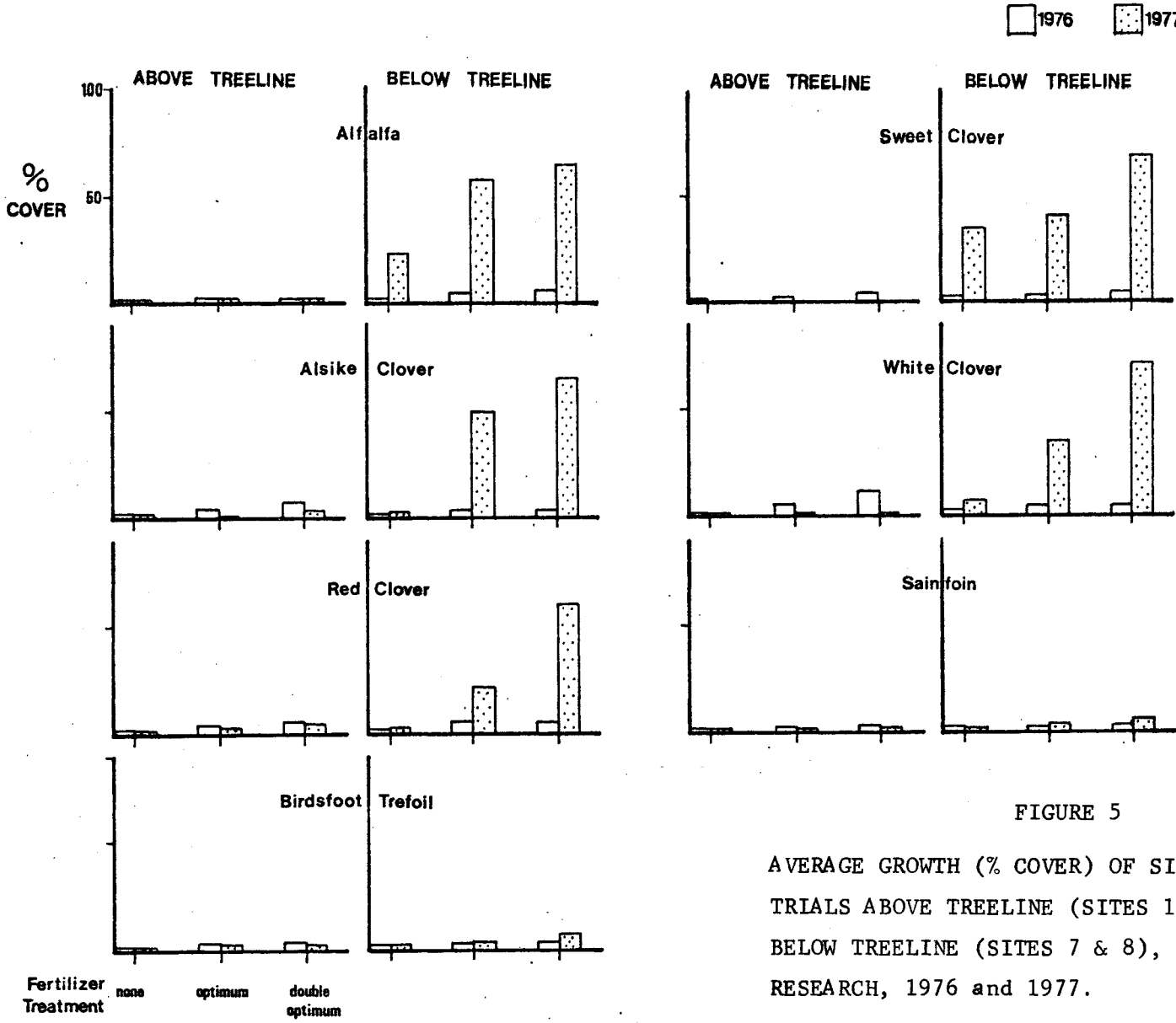


FIGURE 5

AVERAGE GROWTH (% COVER) OF SINGLE LEGUME SPECIES TRIALS ABOVE TREELINE (SITES 1, 1a, 2 TO 6) AND BELOW TREELINE (SITES 7 & 8), DENISON COAL/B.C. RESEARCH, 1976 and 1977.

excellent for white clover (70%), sweet clover (66%), alfalfa (64%), alsike clover (64%), and red clover (60%), but poor for birdsfoot trefoil (7%) and sainfoin (4%). In all cases, growth increased during the second year. Higher fertilizer applications increased legume growth in all instances, although it appears that legumes perform well at lower application rates.

Species mix trials

Growth of species mixes was moderate to good above the treeline and excellent below the treeline (Figure 6).

Above the treeline, growth was similar for all three species mixes. Growth was poor for unfertilized treatments, moderate for optimum fertilizer rates and moderate to good for double optimum rates. Second year growth increased over first year growth for all treatments. This increase was a result of growth of grass species as legumes overwintered poorly and accounted for a lower proportion of cover.

Below the treeline, second year growth was similar for all three mixes. Second year growth was good for unfertilized treatments and excellent for all fertilized plots and growth of the entire mix generally increased with higher fertilizer rates. This increase is due to greater growth of grass species, as legumes, whether fertilized or unfertilized, account for approximately 50% cover for all treatments. Second year growth increased over first year growth for all treatments. This increase is attributed to legume growth as the cover of grass species either remained unchanged or decreased from the first year.

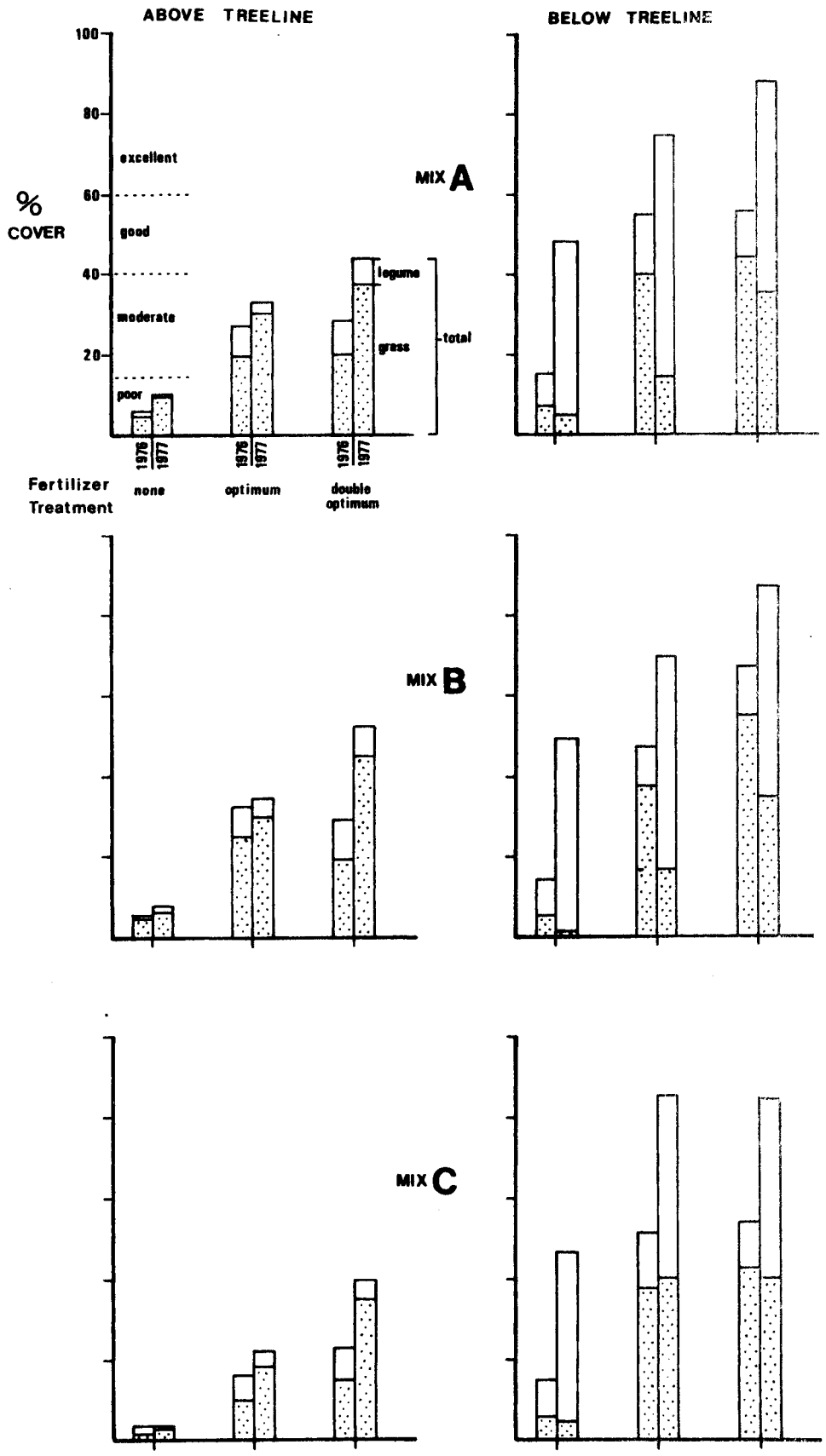


FIGURE 6
AVERAGE GROWTH (% COVER) OF SPECIES MIX TRIALS ABOVE TREELINE (SITES 2 TO 6) AND BELOW TREELINE (SITES 7 & 8), DENISON COAL/B.C. RESEARCH, 1976 AND 1977.

McINTYRE LTD. - DUKE MOUNTAIN

This property was visited by B.C. Ministry of Mines personnel for a short period in September, 1977. An access road that ran along a ridgetop between 1675 m (5500 ft.) and 1860 m (6100 ft.), which was constructed and seeded during 1973, was surveyed for revegetation success. Vegetation along this road was the krummholz type characterized by short stunted trees in depressions and tundra (mesic) on the more exposed areas.

In general, revegetation of the road was excellent with up to eighty per cent cover in some areas. It is not known what species mix was applied but the present vegetation cover of the road is primarily composed of native species and does not involve agronomic species to any extent. The only two species that could have been seeded were redtop (Agrostis alba) and alsike clover (Trifolium hybridum) and both were not a significant component of the existing vegetation.

The major growth has been a result of invasion of native grass species. Areas with a high cover of native species are generally adjacent to tundra and areas through krummholz are generally bare. Native grass species found invading the road surface (in decreasing order of dominance) were bluejoint (Calamagrostis canadensis), spike trisetum (Trisetum spicatum), fescue (Festuca brachyphylla), arctic bluegrass (Poa arctica), hairy wild-rye (Elymus innovatus), bentgrass (Agrostis scabra), and mountain timothy (Phleum alpinum).

Non-grass species occurred less commonly on the road surface but occasionally accounted for as much as 30% cover. Invading species (in decreasing order of dominance) included woodrush (Luzula parviflora), sedge (Carex sp.), longstem greencaps (Artemesia arctica), monkshood (Aconitum delphinifolium), and chickweed (Cerastium berringianum).

MINISTRY OF MINES AND PETROLEUM RESOURCES

Introduction

In the Peace River Coal Block it became increasingly clear that the standard forestry mix applied by hand without fertilizer was not yielding successful results above the timberline. Ministry of Mines and Petroleum Resources inspectors have been active in promoting the use of a variety of cultural techniques and different species more suited to alpine conditions.

During 1976, two test plots were laid out above treeline to test a number of species and varieties sent by Dr. Pringle at Beaverlodge.

During 1977, the system of test plots was expanded to answer several short-term questions which were often in doubt when reclamation advice was given to operators.

The objectives of the test plots were:

a) To test species germination, growth and survival under a variety of conditions.
b) To test fertilizer requirements.
c) To test the effect of different seeding rates.
d) To test the use of seed coated with micronutrients.
e) To test the difference between spring and fall seeding.

Methods

The 1976 test plots were put in on July 5th and 19th and were laid out in rows in hand-cleared alpine soils. Site 1 was located on

Bullmoose Mountain and site 2 was located on Mount Gorman near Saxon. The species and layout sequence are presented in Appendices B-1 and B-2. The growth of these plots was assessed in late 1976 but, with the exception of a visit in the spring of 1977, early fall snowfall prevented their assessment during 1977.

During 1977, trials to test the performance of agronomic species were set up on disturbances resulting from exploration activity. There were four experimental layouts spread out over six sites. A description of these six sites is summarized in Appendix B-3.

Plot boundaries were laid out with twine and the corners were marked with 15 cm galvanized nails and flagging tape. Representative soils were collected and sent to the Soils Testing Laboratory, Ministry of Agriculture, Kelowna. Legumes were innoculated prior to seeding. All plots were raked, seeded and fertilized, and lightly re-raked. Species used in these trials are listed in Appendix B-4.

Layout for general species trials

This layout (Layout I - Appendix B-5) was designed to test 27 agronomic species of grasses and legumes as well as two seed mixes. Four sets of this layout were established - three in the alpine and one at lower elevation. One alpine set was seeded in September and the others in early July. The spring seeded plots were assessed in late August or early September for growth and germination.

Layout for trials testing the use of coated seed

This layout (Layout II - Appendix B-6) is designed to test if grass

seed pre-coated with micronutrients and legume seed coated with micronutrients and nitrogen fixing bacteria perform any better than normal seed in the high subalpine to alpine.

Layout for trials testing seeding rates

This layout (Layout III - Appendix B-7) was replicated three times in September. All sites were high subalpine to alpine.

Layout for trials testing the use of fertilizers

This layout (Layout IV - Appendix B-8) was replicated three times in September. All sites where high subalpine to alpine.

Sketch maps of all sites are presented in Appendix B-9.

Results and Discussion

Germination and growth results from trials seeded during the spring of 1976 (Sites 76-1 and 76-2) and assessed in the fall of that year are presented in Appendix B-10. With the exception of two species at site 76-1, all germinated successfully by September. With the onset of cold weather during September 1976 many of these species had suffered rapid die-back. The performance of these species should have been assessed in late 1977, but when the sites were visited in early September 1977, they were covered in snow. However, during a visit to test plot 1 in July, poor overwintering of most species was indicated.

Plots seeded in the spring of 1977 (77-1, 77-2, and 77-3) were examined in late August and early September, 1977 (Appendix B-11).

The growth at sites 77-1 and 77-2 was excellent. Germination at site 77-3 was poor and the assessment of results was made difficult as a result of locating the plot on an area that had been seeded last fall (but not fertilized) with the standard forestry mix. Growth at all these sites generally increased with higher applications of fertilizer.

At the low elevation site (77-1) with double the recommended fertilizer treatment, meadow fescue, perennial ryegrass, bromegrass, orchard grass, meadow foxtail, ceres alfalfa and sweet clover performed well ($>$ 40 per cent cover). Moderate growth (15 to 39 per cent cover) was attained by creeping red fescue, Kentucky bluegrass, Canada bluegrass, crested wheatgrass, pubescent wheatgrass, slender wheatgrass, streambank wheatgrass, reed canary grass, Russian wild ryegrass, timothy, alsike clover, red clover, white clover, and sainfoin. Poor growth ($<$ 15 per cent cover) occurred for hard fescue, tracenta bentgrass, redtop, drylander alfalfa, birdsfoot trefoil, and cicer milkvetch.

In the alpine, growth varied considerable between sites 77-2 and 77-3. Site 77-2 was laid out on what appeared to be an excellent growth medium which was later confirmed by chemical analysis (Appendix B-12). The silt loam texture, high organic matter content (18 per cent) and relatively high nutritional status of site 77-2 indicates a much better growth medium than site 77-3 with its gravelly texture, low organic matter and lower nutritional status.

At site 77-2, with double the recommended fertilizer treatment, all species grew well with covers of at least 10 per cent (Appendix B-11). Perennial ryegrass and meadow foxtail showed exceptionally good growth. Growth conditions at this site were very favourable and not representative of the majority of disturbances in the alpine.

Growth at site 77-3 was generally poor (Appendix B-11). This area appeared to represent an average to harsh site and is a good test of species performance under rigorous conditions. Species which appeared to be growing best were tracenta bentgrass and meadow foxtail.

UTAH MINES LTD. - CARBON CREEK

Utah Mines Ltd. conducted baseline and monitoring programs on their Carbon Creek property from 1971 to 1976. These programs have been fully documented in their Stage I submission. Programs to assess the extent of revegetation were conducted in 1973 and 1975 by B.C. Research, and in 1976 by Dolmage Campbell and Associates. A summary of these reports is presented below.

Exploration was conducted on the Carbon Creek property during the field seasons of 1971 to 1976, with the exception of 1974. Disturbed areas were broadcast seeded with a mixture composed of creeping red fescue (40 per cent), alsike clover (40 per cent), and timothy (20 per cent)

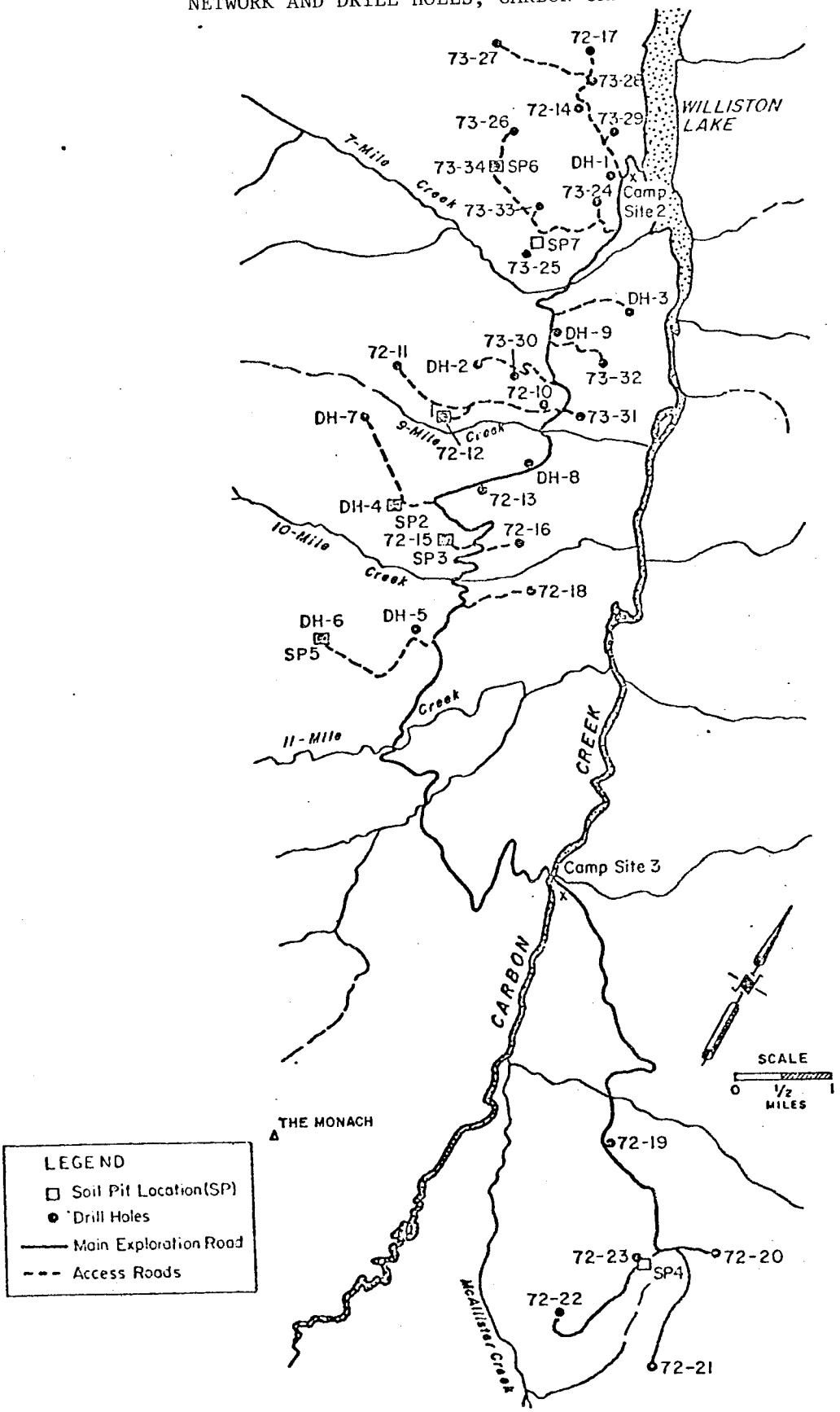
Evaluation of the Revegetation Program

The areas disturbed prior to 1975 (Figure 7) were surveyed for revegetation during the period between August 5 and 9, 1975. All roads and drill pads were visited with the exception of DH 72-22.

At each drill hole site the following parameters were recorded: per cent cover of all species (native and seeded), drill pad diameter, slope, aspect, elevation and soil texture. In several instances, where the pad had been redisturbed in 1975, only the undisturbed portion of the pad was assessed.

The roads were surveyed by recording the seeding results and natural revegetation along each section of the road network. The results are in a descriptive and semi-quantitative form because of the greater variability of conditions along roads. When assessing natural

FIGURE 7
LOCATION OF PRE-1975 EXPLORATION ROAD
NETWORK AND DRILL HOLES, CARBON CREEK



colonization, species which were obviously growing on transported organic matter were not recorded.

Drill pads were re-assessed in 1976.

Results and Discussion

Drill Hole Sites

The 1975 evaluation of seeding success and natural revegetation on drill pad areas is presented in Appendices C-1 and C-2. In general, revegetation was excellent and the three seeded species (timothy, creeping red fescue, and alsike clover) all performed well. There were, however, several drill pads which did not revegetate. A few of these drill pades in the McAllister Creek area may not have been seeded. Drill pads above 4000 feet elevation all had reduced growth. Several of the drill pads without good plant survival had coarse textured materials and it appeared that alsike clover was the first species to be affected when dry conditions were encountered.

Twenty-two native species were found colonizing the drill pad areas. Native species cover averaged only 1.35 per cent in the Dense Forest Habitat type (Appendix C-1). Cottonwood (Populus trichocarpa), trembling aspen (Populus tremuloides), and willows (Salix spp.) were the first major colonizers.

On the drill pads in the Open Forest Habitat type, native species covered an average of 5.25 per cent (Appendix C-2). This average is high because of rapid natural revegetation on the drill pads in the Pine-Spruce plant community areas. Here a number of shrub and forb species occurred covering a total of 15 per cent of the drill pad area.

Results of the 1976 assessment are shown in Appendix C-3. Forty-two native plant species were recorded in 1976, which is considerably more than the twenty-two species reported in 1975. More native species were present on all drill sites except two (Appendix C-4). The diversity of native species suggested that natural succession is being initiated on most sites and that a return to native vegetation cover could be expected.

Exploration Roads

The seeding program conducted by Utah personnel resulted in excellent revegetation along much of the road network. Poor results can be attributed to areas that were not seeded rather than unfavourable conditions. An evaluation of the seeding results is presented in Appendix C-5.

An accurate quantitative assessment of natural revegetation occurring on exploration roads could not be made as native colonizers accounted for only limited cover. Thus, while a large proportion of the species colonizing the exploration roads has been recorded, an accurate estimate of the total cover of these species was not possible. The percentage cover (Appendix C-6) shown for many species is probably an overestimate.

A total of 58 species were found colonizing the roads and included 6 trees, 12 shrubs, 36 forbs and chamaephytes, 3 sedges and 1 woodrush (Appendix C-6). This total represented a large increase over the total of 24 species recorded in 1973.

The major factor determining the rate and type of species colonizing the roads appeared to be seed source availability. Most of the exploration roads have been constructed through Dense Forest habitat

with a limited understory component and low species diversity. In portions of the McAllister Creek area, however, the surrounding vegetation was Open Forest and contained patches of subalpine meadow. These meadows were floristically diverse and provided an abundant available seed source. Consequently, many species invaded the roads in this area. Over much of the remaining area, the most widespread native colonizers were characterized by a light wind-blown seed dispersal mechanism, eg., Populus sp., Salix sp. and Epilobium sp., and many species were found to occur in isolated clumps corresponding to seepage areas where both moisture and plant nutrients were available.

CURRENT STATE-OF-THE-ART

Data gathered in the Peace River Coal Block is sufficient to present an initial set of findings, however, there are several constraints that should be kept in mind when interpreting the reliability of the data. The assessment of revegetation on seeded exploration areas provides particular problems. For example, germination, growth and survival of seeded species on an area is a result which we can measure and interpret. However, if there has been no growth on a portion of a disturbed area we are uncertain whether this was caused by the site conditions or by the fact that the area was not seeded, fertilized, or both. Therefore, negative conditions cannot be interpreted with certainty from a survey of the seeding program.

It is fortunate, therefore, that there have been several sets of revegetation test plots where the seed and fertilizer applications have been carefully controlled.

The long-term survival of agronomic species is also in doubt and the characterization of the success of species is often based on one overwintering period.

SPECIES PERFORMANCE

There is a major difference between species survival above and below the treeline. Above the treeline, growth is totally dependent on fertilizer applications. There is also a greater chance that species above the treeline will be winter-killed. The most noticeable difference between areas above and below treeline is that legume species

do not generally survive above the treeline. Legume failures dictate that fertilizer must be applied on those areas for grass species survival.

In the Peace River Coal Block, a total of 34 species (or varieties) consisting of 21 grasses and 13 legumes have been seeded at various times (Table 1). At the present time it is not possible to assess the performance of more than half of these species with any degree of certainty as data on overwintering success is unavailable (Table 2).

Above treeline, grass species performance was excellent for meadow foxtail, good for creeping red feseue and timothy, and moderate for meadow fescue, Canada bluegrass, slender wheatgrass, and bromegrass. Redtop grows well the first season but has a poor ability to overwinter. Legume growth was very poor above treeline. The only two legume species which grew at all were alsike and red clover and these only grew in sheltered moist pockets.

Below treeline, growth of grass and legume species was generally good for the majority of species tested. Growth was excellent for creeping red fescue and redtop; good for Canada bluegrass, slender wheatgrass and timothy; and moderate for meadow foxtail, bromegrass and meadow fescue. Legume growth was excellent for alfalfa, alsike clover, red clover, sweet clover and white clover. Birdsfoot trefoil and sainfoin grew poorly.

FERTILIZER APPLICATIONS

Grass apecies aurvival and performance is greatly enhanced by the addition of fertilizer. Above the treeline, test plot data and results

TABLE 1

SEEDING DATES AND LOCATIONS OF ALL AGRONOMIC SPECIES USED IN THE PEACE RIVER COAL BLOCK

Company:*	Denison Coal Ltd.			Brameda Resources Ltd.		Ministry of Mines & Petroleum Resources		Utah Mines Ltd.	Coalition
Location:	Quintette	Saxon	Quintette	Bullmoose	Chamberlain	Bullmoose Saxon	Bullmoose Spieker Sheriff	Carbon Creek	Sukunka-Bullmoose
Type of seeding:	General	General	Test plots	General	Test plots	Test plots	Test plots	General	General
Consultant:			B.C. Research		I.E.C.				
Creeping red fescue	1976	1977	1976	1976	1976	1976	1977	1973,75,76	1976
Meadow fescue			1976			1976	1977		
Hard fescue						1976	1977		
Chewing fescue						1976			
Kentucky bluegrass	1976					1976	1977		
Canada bluegrass			1976		1976		1977		
Perennial ryegrass							1977		
Annual ryegrass				1976	1976				
Tracenta - bentgrass							1977		
Colonial bentgrass						1976			
Crested wheatgrass	1976			1976	1976	1976	1977		
Pubescent wheatgrass						1976	1977		
Intermediate wheatgrass	1976					1976			
Slender wheatgrass			1976			1976	1977		
Streambank wheatgrass						1976	1977		
Bromegrass	1976		1976		1976	1976	1977		
Chinook orchardgrass							1977		
Redtop			1976				1977		
Reed canarygrass						1976	1977		
Russian wild ryegrass					1976	1976	1977		
Climax timothy	1976		1976		1976	1976	1977	1973,75,76	1976
Meadow foxtail			1976			1976	1977		
Alfalfa - beaver						1976			
Alfalfa - rambler	1976				1976				
Alfalfa - ceres							1977		
Alfalfa - drylander							1977		
Alfalfa			1976						
Alsike clover			1976			1976	1977	1973,75,76	1976
Red clover			1976			1976	1977		
Birdsfoot trefoil			1976			1976	1977		
Sweet clover			1976		1976		1977		
White clover			1976		1976	1976	1977		
Cicer milkvetch					1976		1977		
Crown vetch	1976								
Sainfoin			1976			1976	1977		

* Companies not listed used the standard forestry mix consisting of creeping red fescue, timothy, and alsike clover.

TABLE 2

PRELIMINARY EVALUATION OF SPECIES PERFORMANCE IN THE PEACE RIVER COAL BLOCK, 1977

Zone:	Above treeline						Below treeline					
Evaluation:	Excel-lent	Good	Mod.	Poor	Dead	Un-Known	Excel-lent	Good	Mod.	Poor	Dead	Un-Known
Creeping red fescue		*					*					
Meadow fescue			*						*			
Hard fescue						*						*
Chewing fescue						*						*
Kentucky bluegrass						*						*
Canada bluegrass			*					*				
Perennial ryegrass						*						*
Annual ryegrass						*						*
Tracenta bentgrass						*						*
Colonial bentgrass						*						*
Crested wheatgrass						*						*
Pubescent wheatgrass						*						*
Intermediate wheatgrass						*						*
Slender wheatgrass			*					*				
Streambank wheatgrass						*						*
Bromegrass			*						*			
Orchardgrass						*						*
Redtop				*			*					
Reed canarygrass						*						*
Russian wild rye-grass						*						*
Timothy		*						*				
Meadow foxtail	*								*			
Alfalfa - beaver						*						*
Alfalfa - rambler						*						*
Alfalfa - ceres						*						*
Alfalfa - drylander						*						*
Alfalfa				*			*					
Alsike clover				*			*					
Red clover				*			*					
Birdsfoot trefoil				*						*		
Sweet clover					*		*					
White clover				*			*					
Cicer milkvetch						*						*
Crown vetch						*						*
Sainfoin				*						*		

of operational revegetation indicate that fertilizer applications are critical to the survival of all seeded species. Below the treeline, growth of single grass species without an accompanying application of fertilizer was poor on the sites tested by B.C. Research. Legumes, on the other hand, performed well whether fertilized or not.

Legume survival is very important to the survival of the unfertilized grass - legume mixture. On sites below treeline that contain sufficient nutrients, grass as well as legume growth are adequate. Sites of low nutrient availability rely on legume growth for several years in order to inject enough available nitrogen into the system to allow grass survival. Above the treeline, sites are generally low in nitrogen and phosphorus and legume growth cannot occur here because of the harsh climatic conditions. Therefore, in order to have successful growth of grasses above the treeline, fertilizer additions are necessary.

SEEDING RATES

In the past, the Ministry of Mines and Petroleum Resources has recommended a minium application rate of 50 lb/acre (56 kg/ha) for use in alpine areas. A rate of 25 lb/acre (28 kg/ha) has been recommended for forested areas. These rates are approximations and, depending upon a number of factors, should be increased or decreased accordingly.

Seeding rates depend on:

1) Size of seed
2) Per cent germination of seed
3) Per cent survival of seed
4) Amount of seed available for survival (seed buried too deep)
5) Uniformity of seed distribution

The size of seed, per cent germination and per cent survial are usually taken into account in prescribing the seed mix. The operator, however, has control over the placement of seed. In the alpine, a rate of 50 lb/acre allows for a "normal" quantity of seed that is harrowed too deep, remains on the soil surface or misses the target area altogether. If the seeding crew is sloppy in their placement of seed and an uneven seeding occurs, then this rate may be insufficient.

The forested rate of 25 lb/acre does not allow for any harrowing and therefore seed should not be lost by burying too deep. However, there is little margin for the uneven spread of seed and, if seeding is not done with due care and attention then this rate should be increased to 40 lb/acre.

The Ministry of Mines and Petroleum Resources have set out test plots to demonstrate the application of different seeding rates. The results of these trials should confirm these recommendations.

CULTURAL TECHNIQUES

Three broad types of seeding techniques have been tried in the Peace River Coal Block. These are broadcast seeding, harrowing after broadcast seeding, and hydroseeding.

Broadcast seeding

This technique is the most common method of seeding consisting of scattering seed on the surface of the ground. Broadcast seeding has been accomplished by hand scattering of seed, hand held cyclone seeders or cyclone seeders mounted on equipment with a 12 volt power

take-off. Aerial seeding using helicopter or fixed-wing aircraft have not been tried in this area.

Broadcast seeding without fertilizer applications has resulted in satisfactory growth at most sites below the treeline. Above treeline, this method of seed application has generally resulted in poor growth. The general failure of broadcast seeding above treeline may be attributed to lack of fertilizer rather than seeding technique. Results of plot trials above treeline indicate that fertilizer applications must accompany seeding for successful growth and germination, and that, given adequate fertilizer, most of the grass species used in seeding programs will grow well.

Broadcasting of seed, nevertheless, was probably a major contributing factor to revegetation failures in the alpine. Possible reasons why broadcasting seed on the soil surface could be an important factor include:

1) Heavy winds in alpine areas result in seed not reaching the disturbed surfaces or blowing off disturbed surfaces.

2) Compacted surfaces which do not provide cracks for seed.

3) Seed germination on ths soil surface is easily affected by rapid change in temperature (frosts) and moisture.

4) Larger sized seed are at a distinct disadvantage for possible settlement in soil cracks.

Harrowing after broadcast seeding

Harrowing all areas above treeline has been recommended by the Ministry of Mines and Petroleum Resources since 1976. A variety of

methods have been used for burying seed. The best method appears to be a spring harrow towed behind a small cat followed by seed and fertilizer applications and then re-harrowing. Another method that has been used was to tidy up with a cat, seed and scarify by dragging trees over the seed-bed. A third method involves seeding followed by running the cat, with the blade raised, back and forth over the seed-bed. The cat tracks provide the necessary micro-relief.

It is too early to see if methods involving harrowing have been successful, however, preliminary observations indicate that seed catch will be largely improved over former broadcasting techniques.

Hydroseeding

Hydroseeding is a method used for revegetation where a mixture of seed, fertilizer, and mulch is combined in an aqueous slurry and sprayed onto the soil surface.

Hydroseeding was used in an experimental way in the alpine areas of Bullmoose/Chamberlain and initial results indicate favourable growth over the first summer. Good survival is anticipated next year.

The major drawback with hydroseeding is its high cost compared to conventional methods of seeding and fertilizing. Greater costs are incurred because of mulch (including transportation) and long water haulage.

Hydroseeding is a useful technique where areas cannot be seeded by conventional equipment and its use is best restricted to these cases.

COATED SEED

Grass seed coated with micronutrients and legume seed coated with micronutrients as well as rhizobia innoculant were tested during 1977. It is hoped that coated seed will increase survival in alpine sites.

GUIDELINES FOR REVEGETATION IN THE PEACE RIVER COAL BLOCK

In the Peace River Coal Block there are two distinct situations that require different treatments for revegetation - areas above treeline and areas that are forested.

AREAS ABOVE TREELINE

- Areas above treeline occur at elevations where tree growth is absent and/or where trees become stunted or deformed (krummholz). These areas are often referred to as alpine or high sub-alpine and generally occur above the 4500 ft. (1370 m) contour. They are characterized by short cold growing seasons and high wind velocities. Revegetation is very difficult.
- Salvage of surface soils, recontouring and site preparation must be carried out.
- The following mix is to be used in areas above treeline. Substitutions and omissions may be made only on permission of the reclamation inspector.

	% by weight
Boreal creeping red fescue	25
Meadow foxtail	25
Climax timothy	20
Canada bluegrass	5
Carleton bromegrass	10
Alsike clover	15

Applied at a rate of 50 lb/acre (55 kg/ha), (1 acre = $\frac{1}{4}$ mi. of road; 1 hectare = 1 km of road).

- All seeding should take place during the early spring or fall. Spring seeding gives plants a complete growing season to become established, while fall seeding allows seed to over-winter before germinating the following spring. Species seeded in the alpine between July 20 and August 31 may begin to germinate but will have a high mortality rate with the onset of early fall frosts. Seeding during this period should be avoided as it is usually a waste of time and money.

- Seeding during or immediately after rain will increase revegetation success because seed germination is assisted by the moist soil conditions.

- A fertilizer application must accompany seeding. If not, germination and growth will be poor and the area will require subsequent seeding and fertilization. A "complete" fertilizer formulation such as 20-20-10 should be applied. In the three digit fertilizer description, the first number refers to the number of pounds of nitrogen contained in 100 lbs of fertilizer. Similarly, the second and third numbers refer to the number of pounds of phosphorus and potassium, respectively, contained in 100 lbs of fertilizer. Alpine regions in the Peace River area require approximately 60 lbs nitrogen, 80 lbs phosphorus and 35 lbs potassium per acre.

  Thus:

400 lb/acre of 20-20-10 gives	80 lb/acre N
	80 lb/acre P
	40 lb/acre K
500 lb/acre of 13-16-10 gives	65 lb/acre N
	80 lb/acre P
	50 lb/acre K

If a single complete fertilizer is not available, two or more can be used to supply the required rate of each nutrient.

	400 lb/acre of 16-20-0 gives	64 lb/acre N
		80 lb/acre P
plus	60 lb/acre of 0-0-60 gives	36 lb/acre K

The major drawback to using two fertilizers is that they must be applied separately because they are difficult to mix.

FORESTED REGIONS

Generally disturbances in forested areas pose few revegetation problems. Provided that the site is recontoured and stabilized, revegetation is relatively straightforward.

- The following seed mix is to be used:

	% by weight
Boreal creeping red fescue	40
Climax timothy	20
Redtop	15
Alsike clover	25

- Seed is to be applied at a rate of 40 lb/acre (44 kg/ha), (1 acre = $\frac{1}{4}$ mi. of road, 1 hectare = 1 km of road). Seeding can be done at any time during the year, although the best times are early spring and fall.
- Applications of fertilizer are normally not required in the forested region. However, rocky or gravelly areas, where topsoil salvage has not been possible, must receive a fertilizer application identical to that recommended in areas above treeline.

FUTURE RESEARCH NEEDS

Reclamation research in the Peace River Coal Block is still in its infancy. However, if proposed developments are to proceed, there are a number of immediate as well as long term problems which must be solved.

Problems of immediate concern include:

1) The relationship between the time of seeding and species survival. Legume survival could be enhanced by improved timing of seeding.

2)* An assessment of fertilizer requirements for initial growth and long term maintenance, including the use of slow-release fertilizer.

3)* An assessment of species survival over several winters and to assess the alternatives in species composition.

4)* An assessment of optimum seed application rates.

5) A direct comparison of the applicability and use of different seeding methods including broadcasting, harrowing, hydro-seeding, and aerial seeding.

6)* An assessment of the use of coated seed.

Long-term research should include:

1) Assessment of the need for evaluation and propagation of

* Indicates preliminary study is underway.

native species for revegetation of large scale mine wastes.

2)* An inventory of the physical and chemical characteristics of overburden on proposed open pit mining areas.

3) A study of methods of promoting legume survival in alpine areas.

4) Assessment of reclamation of alpine areas for use by ungulates.

5) Assessment of feasibility of fertilization of existing alpine vegetation to increase productivity for ungulate range.

* Indicates preliminary study is underway.

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APPENDIX A

DENISON COAL LTD./B.C. RESEARCH TEST PLOTS

Appendix

APPENDIX A-1

AGRICULTURAL SPECIES TESTED IN FIELD TRIALS, QUINTETTE, 1976

SINGLE SPECIES TRIALS

GRASSES

Common Name	Latin Name
Creeping red fescue	Festuca rubra
Brome grass	Bromus inermis
Meadow foxtail	Alopecurus pratensis
Meadow fescue	Festuca elatior
Timothy	Phleum pratense
Slender wheatgrass	Agropyron trachycaulum
Canada bluegrass	Poa compressa
Red top	Agrostis alba

LEGUMES

Common Name	Latin Name
Sweet clover	Melilotus sp.
Birdsfoot trefoil	Lotus corniculatus
Alsike clover	Trifolium hybridum
Red clover	Trifolium pratense
Alfalfa	Medicago sativa
Sainfoin	Onobrychis viciaefolia
White clover	Triforum repens

MIXED SPECIES TRIALS

SEED MIX A

Species	% in seed mix
Creeping red fescue	15
Timothy	15
Brome grass	15
Meadow foxtail	10
Slender wheatgrass	10
Red clover	15
Sainfoin	10
Sweet clover	10

SEED MIX B

Species	% in seed mix
Creeping red fescue	10
Timothy	20
Brome grass	20
Canada bluegrass	15
Alsike clover	10
Birdsfoot trefoil	10
Alfalfa	15

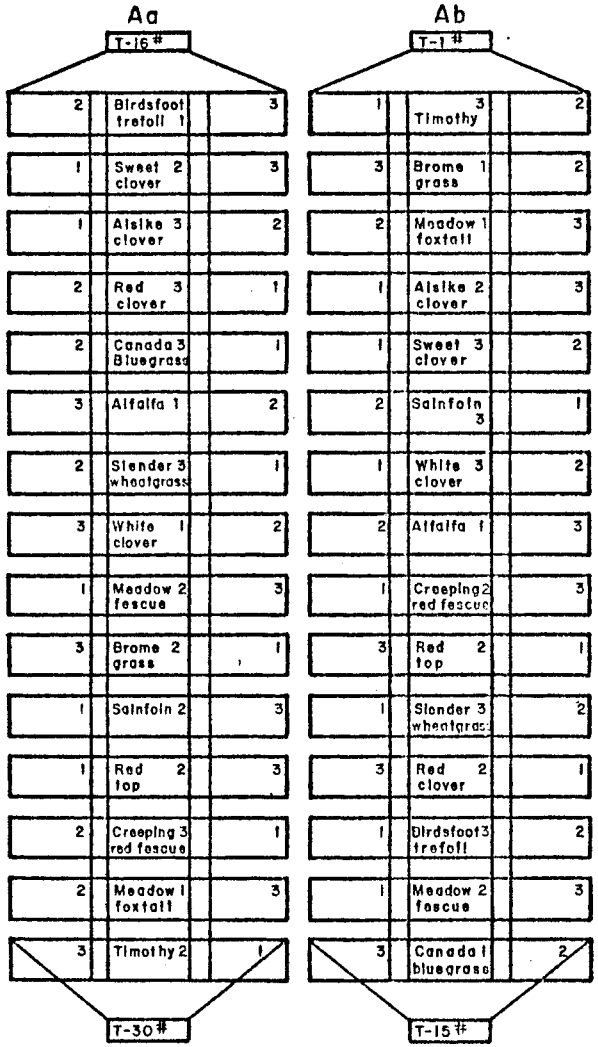
SEED MIX C

Species	% in seed mix
Creeping red fescue	5
Brome grass	10
Red top	10
Meadow fescue	10
Slender wheatgrass	15
Canada bluegrass	10
Sainfoin	15
White clover	15
Birdsfoot trefoil	10

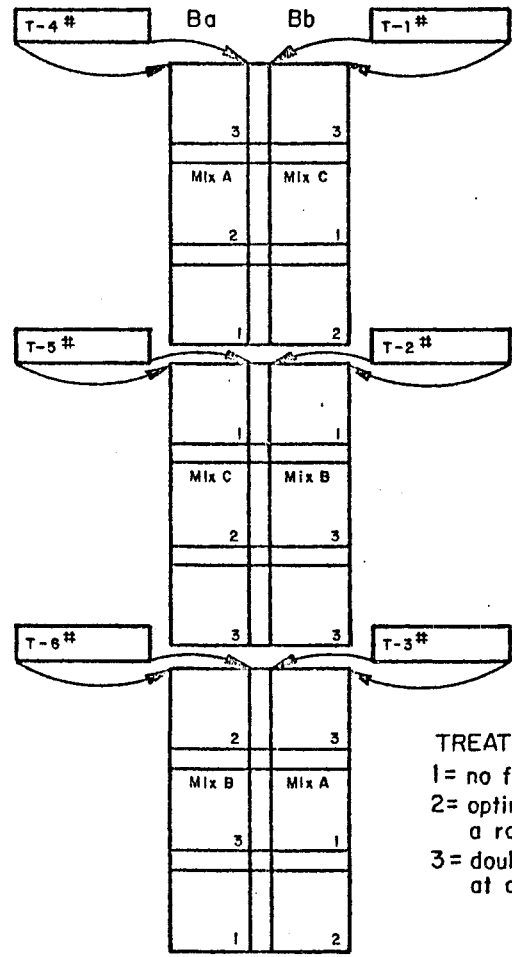
APPENDIX A-2

LAYOUT OF AGRICULTURAL SPECIES FIELD TRIALS, QUINTETTE, 1976

LAYOUT A



LAYOUT B



TREATMENTS:

1 = no fertilizer

2 = optimum fertilizer at a rate of 32:40:20 lb/ac

3 = double optimum fertilizer at a rate of 64:80:40 lb/ac

Layout Aa – at site 1 only, layout Ab at sites 1-8, layout B at sites 2-8.

APPENDIX A-3

RESULTS OF SINGLE SPECIES FIELD TRIALS (PERCENT COVER/TEST PLOT), QUINTETTE, AUGUST 20, 1976

Site	1			1			2			3			4			5			6			7			8		
Elevation (metres)	1600			1600			1690			1675			1595			1690			1720			1160			1065		
Slope (degrees)	21			21			24			15			21			9			17			0			0.5		
Aspect (degrees)	345			345			200			200			300			270			160			-			312		
Date seeded (day-mo-yr)	29-6-76			29-6-76			30-6-76			30-6-76			1-7-76			5-7-76			5-7-76			2-7-76			3-7-76		
Layout	Ab			Aa			Ab			Ab			Ab			Ab			Ab			Ab			Ab		
Fertilizer treatment*	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Creeping red fescue	25	50	10	15	60	60	2	5	15	2	20	25	5	20	30	5	10	10	2	10	10	2	5	75	8	40	50
Bromegrass	2	5	60	2	5	10	5	10	50	1	2	5	1	5	3	5	3	25	2	4	8	2	10	20	3	20	20
Meadow foxtail	2	60	50	3	50	60	10	60	40	5	30	50	2	25	60	3	50	20	5	15	15	10	50	40	5	30	30
Meadow fescue	1	10	15	5	30	50	1	5	10	1	5	10	1	3	5	1	3	10	1	10	15	2	10	5	2	10	10
Timothy	25	40	25	15	40	60	3	30	50	5	40	25	1	40	30	20	60	50	4	60	40	5	20	15	5	40	50
Slender wheatgrass	3	10	20	3	30	40	1	1	2	3	10	10	1	5	10	2	5	5	2	5	10	2	5	5	1	5	8
Canada bluegrass	1	1	10	1	5	5	1	1	1	10	2	1	1	1	1	1	2	1	1	1	1	2	2	5	<1	4	5
Red top	2	50	20	5	20	80	2	5	10	1	20	40	2	15	10	8	40	40	2	15	30	2	10	70	5	20	20
Sweet clover	<1	<1	1	1	2	5	1	5	10	<1	1	2	1	2	2	1	1	2	1	1	2	2	2	2	1	1	2
Birdsfoot trefoil	2	1	3	3	5	5	<1	2	<1	1	2	2	1	1	1	3	3	5	1	3	5	2	2	2	1	3	3
Alsike clover	1	2	2	5	10	20	2	8	10	1	5	5	1	3	3	2	3	5	1	5	3	2	5	5	1	2	2
Red clover	2	10	5	2	2	10	1	2	10	1	2	2	1	5	2	3	5	5	1	1	5	2	10	5	1	1	2
Alfalfa	1	2	1	1	2	2	<1	3	2	<1	1	<1	1	1	2	1	1	2	1	3	2	2	5	2	1	2	5
Sainfoin	1	3	3	1	5	10	1	2	5	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1
White clover	2	5	8	2	10	25	2	10	10	1	2	15	1	3	10	5	5	10	2	5	5	3	5	5	1	3	2

* 1 = no fertilizer

2 = optimum fertilizer rate of 32:40:20 lb/acre of $N:P_2O_5:K_2O$

3 = double optimum rate of 64:80:40 lb/acre of $N:P_2O_5:K_2O$

APPENDIX A-4

RESULTS OF SEED MIX TRIALS (PERCENT COVER/TEST PLOT), QUINTETTE, AUGUST 20, 1976

Site		2						3						4						5						6						7						8					
Elevation (m)		1690						1675						1595						1690						1720						1160						1065					
Slope (degrees)		20						18						14						14						13						0						0.5					
Aspect (degrees)		200						200						300						270						160						-						312					
Date seeded (day/month/year)		30-6-76						5-7-76						1-7-76						5-7-76						5-7-76						2-7-76						3-7-76					
Layout†		Ba			Bb			Ba			Bb			Ba			Bb			Ba			Bb			Ba			Bb			Ba			Bb			Ba			Bb		
Fertilizer treatment*		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Mix A	grasses	2	40	40	10	20	40	2	5	5	5	10	10	5	15	20	3	20	30	5	25	15	8	15	30	1	5	1	2	30	20	10	50	60	10	40	50	3	50	40	5	25	25
	legumes	3	20	20	4	20	20	<1	<1	1	1	1	1	2	10	2	2	10	10	3	5	2	2	3	5	1	1	1	1	10	5	20	20	20	10	20	20	2	5	5	2	5	5
Mix B	grasses	10	30	30	3	30	40	3	10	10	3	8	5	3	20	30	4	40	20	5	25	15	5	25	40	2	45	15	2	15	30	5	50	70	10	50	70	3	20	30	5	30	50
	legumes	2	10	30	2	10	20	<1	2	1	1	1	1	2	10	20	1	20	10	1	5	5	1	5	5	2	5	5	1	5	2	10	20	20	20	10	20	2	5	5	2	5	5
Mix C	grasses	2	25	30	2	20	25	1	5	8	2	1	10	1	5	15	1	5	20	1	15	15	3	20	10	1	5	15	1	1	5	10	50	60	10	40	60	3	30	25	1	30	25
	legumes	2	25	30	3	10	25	1	1	1	2	1	<1	2	5	10	2	5	5	2	5	5	2	5	2	2	5	5	1	1	2	20	20	20	15	30	20	1	2	2	1	5	5

* 1 - no fertilizer
2 - optimum fertilizer rate of 32:40:20 lb/acre of $N:P_2O_5:K_2O$
3 - double optimum rate of 64:80:40 lb/acre of $N:P_2O_5:K_2O$

† see Figure 29

APPENDIX A-5

QUINTETTE AGRICULTURAL SPECIES ASSESSMENT 1977

The following criteria were used to assess the growth of agricultural species:

1) ability to produce ground cover (%)

2) survival
   - by survival class
     1. - mortality
     2. - mortality expected
     3. - surviving but not well
     4. - surviving well

3) ability to reproduce
   - as percent of plants producing seed heads

The erosion of the sites was assessed using the following scale:

1) - low
2) - moderate
3) - severe

APPENDIX A-5 (Continued)

QUINTETTE AGRICULTURAL SPECIES ASSESSMENT, 1977

SPECIES MIX TRIALS

MIX	SITE	NO FERTILIZER							OPTIMUM FERTILIZER							DOUBLE FERTILIZER						
		Grasses			Legumes			Erosion Class	Grasses			Legumes			Erosion Class	Grasses			Legumes			Erosion Class
		% GROUND COVER	Survival Class	% Seed Heads	% GROUND Cover	Survival Class	% Seed Heads		% GROUND Cover	Survival Class	% Seed Heads	% GROUND Cover	Survival Class	% Seed Heads		% GROUND Cover	Survival Class	% Seed Heads	% GROUND Cover	Survival Class	% Seed Heads	
A	2	+	2	0	+	2	0	2	17	3	50	3	2	0	2	25	4	80	+	2	0	3
	2	4	2	0	+	2	0	3	7	4	95	1	2	0	3	60	4	60	2	3	0	3
	3	2	2	0	0	1	0	3	10	3	40	0	1	0	3	25	4	50	0	1	0	3
	3	3	2	0	0	1	0	2	15	3	30	1	2	0	2	15	4	45	0	1	0	2
	4	5	2	0	5	2	0	1	25	3	5	20	4	0	1	15	4	10	25	4	0	1
	4	12	3	0	2	2	0	1	55	3	10	5	2	0	1	50	4	25	20	4	0	1
	5	10	3	5	0	1	0	1	60	3	30	0	1	0	2	70	4	70	1	2	0	2
	5	4	2	0	1	2	0	3	25	3	40	0	1	0	2	40	4	60	0	1	0	1
	6	10	3	25	0	1	0	2	20	4	50	0	1	0	3	10	3	50	0	1	0	1
	6	40	3	25	0	1	0	2	70	4	80	0	1	0	2	65	4	90	10	3	0	2
	7	5	4	100	60	4	100	1	5	4	100	90	4	100	1	10	4	100	85	4	100	1
	7	1	2	10	65	4	100	1	5	3	30	85	4	100	1	25	4	100	75	4	100	1
	8	10	4	80	40	4	90	1	20	3	20	40	4	90	1	50	4	70	25	4	70	1
	8	2	2	0	10	4	80	1	25	3	10	25	4	60	1	60	4	60	20	4	70	1
B	2	5	2	0	+	2	0	2	25	3	75	+	2	0	1	60	4	90	5	4	0	1
	2	1	2	0	+	2	0	3	25	3	10	+	2	0	3	40	4	40	+	2	0	3
	3	3	2	0	0	1	0	2	15	3	30	0	1	0	2	25	4	60	0	1	0	2
	3	2	2	0	0	1	0	2	10	3	25	0	1	0	2	30	4	50	0	1	0	2
	4	10	2	0	2	2	0	1	15	3	10	15	3	0	1	30	4	70	30	4	5	1
	4	10	2	0	1	2	0	1	25	3	10	25	3	0	1	30	3	10	30	4	0	1
	5	3	2	0	1	2	0	3	30	3	25	1	2	0	2	60	4	60	0	1	0	2
	5	5	3	0	0	1	0	3	40	3	30	0	1	0	2	60	4	60	0	1	0	2
	6	20	3	30	0	1	0	1	80	4	75	0	1	0	2	65	4	90	2	2	0	1
	6	8	3	30	0	1	0	3	35	4	45	0	1	0	2	50	4	70	0	1	0	2
	7	0	1	0	100	4	100	1	5	4	100	80	4	100	1	5	4	100	95	4	100	1
	7	2	4	50	70	4	80	1	7	4	100	85	4	100	1	15	4	100	80	4	100	1
	8	5	3	5	15	4	0	1	30	3	5	25	4	25	1	50	3	40	25	4	50	1
	8	1	2	0	4	3	0	1	25	3	10	25	3	0	1	70	4	70	10	4	50	1
C	2	0	1	0	0	1	0	1	17	3	60	+	1	0	1	40	4	55	+	2	0	1
	2	3	2	0	+	2	0	2	17	3	40	1	2	0	3	30	4	90	+	2	0	2
	3	0	1	0	0	1	0	2	7	3	15	0	1	0	1	20	4	50	0	1	0	2
	3	1	2	0	0	1	0	2	15	3	25	0	1	0	2	20	4	50	0	1	0	2
	4	3	2	0	2	2	0	1	15	3	0	10	3	0	1	20	3	40	20	3	0	1
	4	3	2	0	1	2	0	1	25	4	30	25	4	0	1	40	4	70	20	4	0	1
	5	3	2	0	0	1	0	2	30	4	40	0	1	0	2	30	4	50	1	2	0	2
	5	0	1	0	0	1	0	3	20	3	20	0	1	0	2	50	3	20	0	1	0	3
	6	15	3	20	0	1	0	1	30	3	40	0	1	0	2	70	4	80	0	1	0	1
	6	1	2	0	0	1	0	1	8	3	10	0	1	0	3	30	4	90	0	1	0	1
	7	5	4	80	80	4	100	1	25	4	100	70	4	100	1	35	4	100	65	4	100	1
	7	3	4	100	80	4	100	1	20	4	100	70	4	100	1	20	4	100	75	4	100	1
	8	3	3	0	2	2	0	1	60	4	80	20	4	50	1	50	4	70	25	4	50	1
	8	5	3	50	10	3	10	1	60	4	80	20	3	50	1	60	4	80	5	4	50	1

APPENDIX A-5 (Continued)

AGRICULTURE SPECIES ASSESSMENT, QUINTETTE JULY 1977. 1

SINGLE SPECIES TRIALS

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Canada Bluegrass	1a	+	2	0	1	5	2	10	1	9	3	50	1
	1b	2	3	0	2	7	3	25	2	35	4	80	1
	2	0	1	0	3	4	3	90	2	5	3	100	2
	3	1	2	0	2	10	3	50	3	22	4	50	1
	4	1	2	0	1	20	3	10	1	35	4	50	1
	5	4	2	0	3	10	3	0	2	25	4	50	2
	6	4	3	0	1	20	4	90	1	30	4	90	1
	7	+	2	0	1	1	2	50	1	33	4	50	1
	8	3	2	0	1	20	3	90	1	65	3	90	1
Meadow Fescue	1a	1	2	0	1	5	3	60	1	10	3	50	1
	1b	3	2	0	2	27	4	75	2	64	4	90	1
	2	+	2	0	1	15	4	100	1	27	4	100	1
	3	0	1	0	2	50	4	75	1	25	4	80	3
	4	3	2	0	1	40	4	75	1	60	4	85	1
	5	5	2	0	2	15	4	50	3	25	4	50	3
	6	5	3	5	1	20	4	80	1	57	4	95	2
	7	+	2	0	1	2	2	50	1	5	3	90	1
	8	5	3	5	1	25	4	70	1	48	4	80	1

APPENDIX A-5 (Continued)

Agricultural Species, continued

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Slender Wheatgrass	1a	1	2	0	1	18	3	20	1	15	3	30	1
	1b	1	2	0	1	15	3	20	2	15	3	25	2
	2	0	1	0	3	1	3	50	3	12	3	100	2
	3	2	2	0	3	10	3	20	3	20	4	80	2
	4	3	2	0	1	20	3	5	1	30	4	5	1
	5	1	2	0	2	12	4	25	3	27	4	30	2
	6	5	3	10	1	12	4	50	3	60	4	95	2
	7	2	2	0	1	12	4	90	1	10	4	95	1
	8	5	3	0	1	50	4	90	1	75	4	95	1
Red Top	1a	+	2	0	1	5	2	0	1	40	2	0	2
	1b	+	1	0	1	28	2	10	2	25	2	10	2
	2	0	1	0	3	4	3	3	2	7	3	10	3
	3	1	2	0	2	15	3	20	1	35	3	50	2
	4	2	2	0	1	7	2	0	1	14	3	0	1
	5	1	2	0	1	20	2	0	2	70	3	40	1
	6	2	3	0	3	45	3	10	2	27	3	10	1
	7	0	1	0	1	21	2	20	1	70	3	60	1
	8	4	2	2	1	50	2	50	1	70	3	40	1

APPENDIX A-5 (Continued)

Agricultural Species, continued

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Creeping Red Fescue	1a	5	2	0	1	20	2	5	1	55	3	50	1
	1b	8	2	0	1	15	3	10	2	20	3	50	2
	2	+	2	0	3	10	3	50	2	23	4	45	2
	3	1	2	0	3	38	3	60	1	64	4	50	2
	4	5	2	0	1	20	3	2	1	35	3	5	1
	5	5	2	0	1	24	4	50	2	45	4	50	1
	6	15	3	5	1	37	4	75	1	50	4	80	2
	7	2	2	0	1	19	3	30	1	60	4	100	1
	8	10	2	1	1	29	3	20	1	69	4	60	1
Meadow foxtail	1a	3	2	0	2	30	3	50	3	50	4	20	3
	1b	1	2	0	1	25	3	30	2	60	4	85	2
	2	8	3	90	2	69	4	60	1	58	4	100	1
	3	4	3	0	3	35	3	10	1	58	4	70	2
	4	1	2	0	1	60	3	40	1	80	4	75	1
	5	3	2	0	1	30	3	10	2	60	4	50	1
	6	38	3	70	1	43	4	95	1	55	4	90	1
	7	2	2	0	1	18	2	5	1	35	3	50	1
	8	3	2	0	1	19	2	0	1	18	2	1	1

APPENDIX A-5 (Continued)

Agricultural Species, continued

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Brome Grass	1a	3	2	0	1	5	3	5	1	20	4	60	1
	1b	3	2	0	1	10	3	40	1	63	4	90	1
	2	5	2	50	1	9	3	20	1	23	4	85	1
	3	3	2	0	3	4	3	0	3	22	4	60	1
	4	1	2	0	1	30	3	2	1	60	4	5	1
	5	3	2	0	1	5	2	0	2	24	3	5	1
	6	10	3	0	1	20	3	50	2	25	3	25	1
	7	3	2	0	1	17	3	5	1	56	4	50	1
	8	2	2	0	1	15	2	2	1	20	3	5	1
Timothy	1a	6	2	0	1	50	4	50	1	45	4	60	2
	1b	2	2	0	1	3	3	10	2	11	3	10	2
	2	2	2	0	2	20	3	10	2	27	4	10	1
	3	2	2	0	1	25	3	10	3	30	4	30	3
	4	5	2	0	1	30	3	10	1	60	4	50	1
	5	20	2	5	2	10	3	20	1	75	4	40	1
	6	57	3	30	1	85	4	90	1	73	4	80	1
	7	1	2	1	1	33	3	20	1	65	4	50	1
	8	5	2	0	1	20	2	1	1	25	3	3	1

APPENDIX A-5 (Continued)

Agricultural Species, continued

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Birdsfoot Trefoil	1a	+	2	0	1	1	2	0	1	+	2	0	1
	1b	+	2	0	1	1	2	0	2	+	2	0	1
	2	+	2	0	3	+	2	0	1	+	2	0	1
	3	0	1	0	3	0	1	0	2	0	1	0	1
	4	1	2	0	1	2	2	0	1	4	2	0	1
	5	1	2	0	2	2	2	0	1	4	3	0	1
	6	+	2	0	1	+	2	0	2	+	2	0	1
	7	1	2	0	1	2	3	0	1	10	4	60	1
	8	+	2	0	1	3	3	5	1	3	3	5	1
Red Clover	1a	+	2	0	2	1	2	0	2	+	2	0	2
	1b	1	2	0	1	1	2	0	1	+	2	0	2
	2	+	2	0	3	+	2	0	2	+	2	0	3
	3	0	1	0	3	0	1	0	1	0	1	0	2
	4	2	2	0	1	15	3	0	1	25	3	0	1
	5	0	1	0	3	2	2	0	1	+	2	0	1
	6	+	2	0	2	+	2	0	1	+	2	0	1
	7	1	2	0	1	16	4	50	1	60	4	95	1
	8	4	3	0	1	28	4	60	1	60	4	90	1

APPENDIX A-5 (Continued)

Agricultural species, continued

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Alfalfa	1a	0	1	0	1	0	1	0	2	0	1	0	1
	1b	1	1	0	1	10	1	0	1	6	1	0	1
	2	0	1	0	3	1	3	0	3	0	1	0	2
	3	0	1	0	1	0	1	0	2	0	1	0	2
	4	1	2	0	1	2	2	0	1	3	2	0	1
	5	0	1	0	1	0	1	0	1	0	1	0	1
	6	0	1	0	1	0	1	0	1	0	1	0	2
	7	21	4	60	1	40	4	60	1	45	4	90	1
	8	25	3	0	1	75	4	60	1	83	4	80	1
White Clover	1a	0	1	0	2	0	1	0	1	+	2	+	1
	1b	0	1	0	1	+	2	0	1	+	2	0	1
	2	0	1	0	3	+	2	0	2	+	2	0	3
	3	0	1	0	2	0	1	0	2	0	1	0	2
	4	1	2	0	1	3	2	0	1	5	3	0	1
	5	0	1	0	1	0	1	0	1	0	1	0	1
	6	+	2	0	1	2	2	0	2	1	2	0	1
	7	5	3	50	1	22	4	95	1	93	4	100	1
	8	10	3	5	1	48	4	80	1	48	4	80	1

APPENDIX A-5 (Continued)

Agricultural species, continued

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Sanfoin	1a	0	1	0	1	0	1	0	1	+	2	0	2
	1b	0	1	0	2	0	1	0	2	0	1	0	3
	2	0	1	0	3	+	2	0	2	+	2	0	2
	3	0	1	0	3	0	1	0	2	0	1	0	2
	4	2	2	0	1	2	3	0	1	5	3	0	1
	5	0	1	0	1	0	1	0	1	0	1	0	1
	6	0	1	0	1	0	1	0	1	0	1	0	1
	7	0	1	0	1	2	3	60	1	3	3	60	1
	8	2	2	0	1	3	3	50	1	6	4	70	1
Sweet Clover	1a	0	1	0	1	+	2	0	1	+	2	0	1
	1b	0	1	0	1	0	1	0	1	0	1	0	1
	2	0	1	0	1	0	1	0	1	0	1	0	1
	3	+	2	0	1	+	2	0	2	+	2	0	1
	4	0	1	0	1	0	1	0	1	0	1	0	1
	5	0	1	0	1	0	1	0	1	0	1	0	1
	6	0	1	0	1	+	2	0	1	+	2	0	1
	7	8	4	80	1	3	4	50	1	64	4	100	1
	8	60	4	100	1	75	4	100	1	68	4	100	1

APPENDIX A-5 (Continued)

Agricultural Species, concluded

SPECIES	SITE	NO FERTILIZER				OPTIMUM FERTILIZER				DOUBLE FERTILIZER			
		% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS	% GROUND COVER	SURVIVAL CLASS	% SEED HEADS	EROSION CLASS
Alsike Clover	1a	2	2	0	1	+	2	0	2	+	2	0	2
	1b	0	1	0	1	0	1	0	2	0	1	0	2
	2	+	2	0	2	0	1	0	2	0	1	0	2
	3	0	1	0	1	1	2	0	3	2	2	0	3
	4	2	2	0	1	4	3	0	1	16	4	0	1
	5	0	1	0	2	1	2	0	1	1	2	0	1
	6	+	2	0	1	+	2	0	1	1	2	0	1
	7	3	2	0	1	72	4	95	1	92	4	95	1
	8	3	2	0	1	25	4	70	1	35	4	70	1

APPENDIX B

MINISTRY OF MINES AND PETROLEUM RESOURCES TEST PLOTS

Appendix

APPENDIX B-1

PLOT LAYOUT TO TEST SELECTED SPECIES IN THE PEACE RIVER COAL BLOCK, MINISTRY OF MINES AND PETROLEUM RESOURCES, TEST PLOT 76-1, 1976

Location: Bullmoose Mountain
Elevation: 1800 m
Vegetation zone: Alpine
Vegetation type: Dry Tundra

Slope: 2°
Aspect: South
Date seeded: July 5, 1976
Parent material: Colluvium
Soil texture: Sandy loam

Species are listed from south to north.

Row number	Common Name	Scientific Name
1	Crested wheatgrass - Fairway	Agropyron cristatum
2	Streambank wheatgrass - Sodar	" riparium
3	Pubescent wheatgrass - Greenleaf	" trichophorum
4	Intermediate wheatgrass - Chief	" intermedium
5	Slender wheatgrass - Revenue	" trachycaulum
6	Bromegrass - Carlton	Bromus inermis
7	Bromegrass - Magna	" inermis
8	Meadow fescue - Miner	Festuca pratensis
9	Hard fescue - Bijant	" ovina
10	Creeping red fescue - Boreal	" rubra
11	Chewings fescue - Oasis	" rubra var fallax
12	Kentucky bluegrass - Park	Poa pratensis
13	Meadow foxtail - Oregon common	Alopecurus pratensis
14	Reed canary grass - Castor	Phalaris arundinacea
15	Colonial bentgrass - Exeter	Agrostis tenuis
16	Timothy - Climax	Phleum pratense
17	Russian wild rye - Sawki	Elymus junceus
18	Sainfoin - Melrose	Onobrychis vicifolia
19	Birdsfoot trefoil - Leo	Lotus corniculatus
20	Alfalfa - Beaver	Trifolium sativa
21	Alsike clover - Dawn	" hybridum
22	Red clover - Altaswede	" pratense
23	White clover - Nora	" repens

APPENDIX B-2

PLOT LAYOUT TO TEST SELECTED SPECIES IN THE PEACE RIVER COAL BLOCK, MINISTRY OF MINES AND PETROLEUM RESOURCES, TEST PLOT 76-2, 1976

Location: Mount Gorman
Elevation: 2100 m
Vegetation zone: Alpine
Vegetation type: Mesic Tundra

Slope: 10°
Aspect: East
Date seeded: July 19, 1976
Parent material: Colluvium
Soil texture: sandy loam

Row number		Scientific Name
1	Alfalfa -Beaver	Trifolium sativa
2	Alsike clover - Dawn	" hybridum
3	Sainfoin - Melrose	Onobrychis vicifolia
4	Red clover - Altaswede	Trifolium pratense
5	White clover - Nora	" repens
6	Birdsfoot trefoil - Leo	Lotus corniculatus
7	Chewings fescue - Oasis	Festuca rubra var fallax
8	Crested wheatgrass - Fairway	Agropyron cristatum
9	Hard fescue - Bijant	Festuca ovina
10	Meadow fescue - Miner	" pratensis
11	Slender wheatgrass - Revenue	Agropyron trachycaulum
12	Creeping red fescue - Boreal	Festuca rubra
13	Pubescent wheatgrass - Greenleaf	Agropyron trichophorum
14	Timothy - Climax	Phleum pratense
15	Streambank wheatgrass - Sodar	Agropyron riparium
16	Bromegrass - Carlton	Bromus inermis
17	Intermediate wheatgrass - Chief	Agropyron intermedium
18	Bromegrass - Magna	Bromus inermis
19	Kentucky bluegrass - Park	Poa pratensis
20	Meadow foxtail - Oregon common	Alopecurus pratensis
21	Reed canary grass - Castor	Phalaris arundinacea
22	Colonial bentgrass - Exeter	Agrostis tenuis
23	Russian wild rye - Sawki	Elymus junceus

APPENDIX B-3

DESCRIPTION OF SITES USED FOR TEST PLOTS, PEACE RIVER COAL BLOCK,

MINISTRY OF MINES AND PETROLEUM RESOURCES, 1977.

Site no.	77-1	77-2	77-3	77-4				77-5			77-6		
Location	Gas well site N.W. of jcn. of Wolverine and Bullmoose Roads	Old road west slope Bullmoose Mts.	Drill site EB1 S.E. slope, Mt. Spieker	N. W. Buttress of Bullmoose Mtn.				W. Slope south-east end of proposed Sheriff Pit			N.W. Buttress of Bullmoose		
Elevation(m)	1125	1780	1870	1720				1745			1700		
Vegetation zone	Engelman spruce - subalpine fir	Alpine	Alpine	Alpine				High Subalpine to Alpine			High Subalpine to Alpine		
Vegetation type	Lodgepole pine with spruce understory	mesic tundra	mesic tundra	Dry tundra above, mesic tundra below				mesic tundra			mesic tundra		
Type of Layout	I	I	I	I	II	III	IV	II	III	IV	II	III	IV
Slope (degrees)	2	8	3	0-4	17-23	0-5	0-5	13	13	13	7	0-5	0-5
Aspect (degrees)	30	280	30	290	290	250	250	260	260	260	20	20	20
Date seeded (d/m/yr)	5/7/77	7/7/77	9/7/77	13/9/77	13/9/77	19/9/77	19/9/77	17/9/77	17/9/77	17/9/77	19/9/77		
Parent material	Till	Colluvium	Colluvium	Colluvium-Shale				Shale	Shale	Shale	Shale		
Soil Texture	very gravelly clay	silt loam	gravelly silt loam	gravelly sandy loam				gravelly silt loam			silty clay loam		

APPENDIX B-4

LIST OF AGRONOMIC SPECIES TESTED IN PLOT TRIALS, PEACE RIVER COAL BLOCK, 1977

Common Name	Scientific Name
Boreal creeping red fescue	Festuca rubra L.
Meadow fescue	Festuca elatior L.
Hard fescue	Festuca ovina var. duriuscula (L.) Koch
Nugget Kentucky bluegrass	Poa pratensis L.
Canada bluegrass - "rubens" variety	Poa compressa L.
Manhattan perennial ryegrass	Lolium perenne L.
Tracenta bentgrass	Agrostis sp.
Nordan crested wheatgrass	Agropyron cristatum (L.) Gaertn.
Pubescent wheatgrass	Agropyron trichophorum (Link) Richt.
Slender wheatgrass	Agropyron trachycaulum (Link) Malte
Streambank wheatgrass	Agropyron riparium Scribn & Smith
Bromegrass	Bromus inermis Leyss
Chinook orchardgrass	Dactylis glomerata L.
Redtop	Agrostis alba L.
Reed canarygrass	Phalaris arundinacea L.
Russian wild ryegrass	Elymus junceus Fisch
Climax timothy	Phleum pratense L.
Meadow foxtail	Alopecurus pratensis
Ceres alfalfa	Medicago sativa L.
Drylander alfalfa	Medicago sativa L.
Alsike clover	Trifolium hybridum L.
Single cut red clover	Trifolium pratense L.
Broad leaf birdsfoot trefoil	Lotus corniculatus L.
Sweet clover	Melilotus sp.
White clover	Trifolium repens L.
Cicer milkvetch	Astragalus cicer L.
Melrose sainfoin	Onobrychis viciaefolia Scop.

APPENDIX B-5

LAYOUT I -

FOR GENERAL SPECIES TRIALS, PEACE RIVER COAL BLOCK, MINISTRY OF MINES & PETROLEUM RESOURCES, 1977.

Plot layout at:

Site 77-1 July 5, 1977

Site 77-2 July 7, 1977

Site 77-3 July 9, 1977

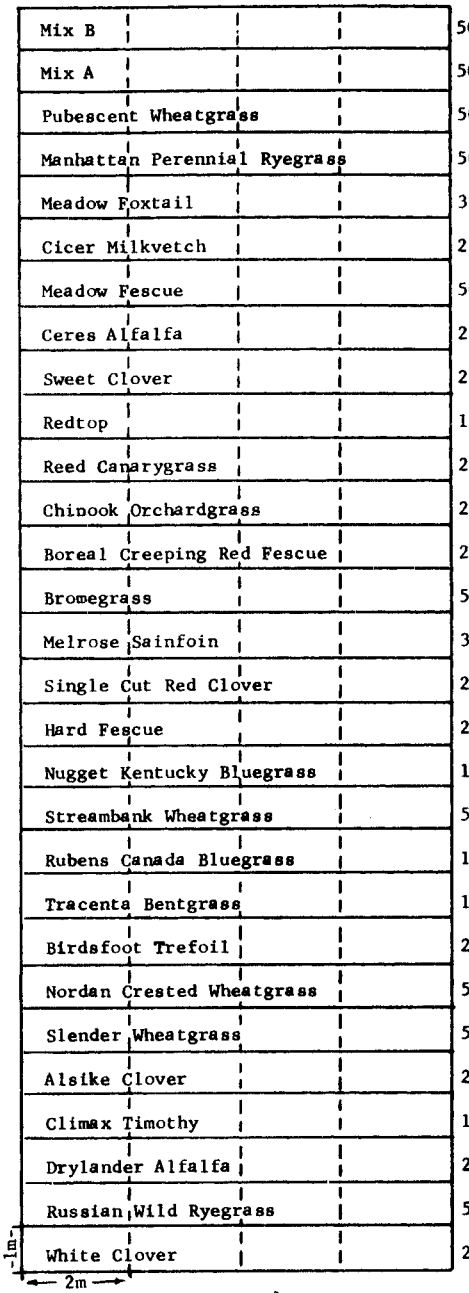
Site 77-4 September 13, 1977

Mix A %

Boreal creeping red fescue	40
Climax timothy	20
Alsike clover	40

Mix B %

Boreal creeping red fescue	20
Redtop	20
Meadow foxtail	20
Bromegrass	10
Timothy	10
Alsike clover	20



	Seed rate lbs/acre	kg/ha
Mix B	50	56
Mix A	50	56
Pubescent Wheatgrass	50	56
Manhattan Perennial Ryegrass	50	56
Meadow Foxtail	35	39
Cicer Milkvetch	25	28
Meadow Fescue	50	56
Ceres Alfalfa	25	28
Sweet Clover	25	28
Redtop	10	11
Reed Canarygrass	20	22
Chinook Orchardgrass	20	22
Boreal Creeping Red Fescue	20	22
Bromegrass	50	56
Melrose Sainfoin	35	39
Single Cut Red Clover	25	28
Hard Fescue	20	22
Nugget Kentucky Bluegrass	10	11
Streambank Wheatgrass	50	56
Rubens Canada Bluegrass	10	11
Tracenta Bentgrass	10	11
Birdsfoot Trefoil	25	28
Nordan Crested Wheatgrass	50	56
Slender Wheatgrass	50	56
Alsike Clover	25	28
Climax Timothy	10	11
Drylander Alfalfa	25	28
Russian Wild Ryegrass	50	56
White Clover	25	28

Fertilizer rate	double recommended level	recommended level	½ recommended level	Control
N (lb/ac)	64	32	16	0
(kg/ha)	(72)	(36)	(18)	0
P (lb/ac)	80	40	20	0
(kg/ha)	(90)	(45)	(22)	0
K (lb/ac)	40	20	10	0
(kg/ha)	(45)	(22)	(11)	0

APPENDIX B-6

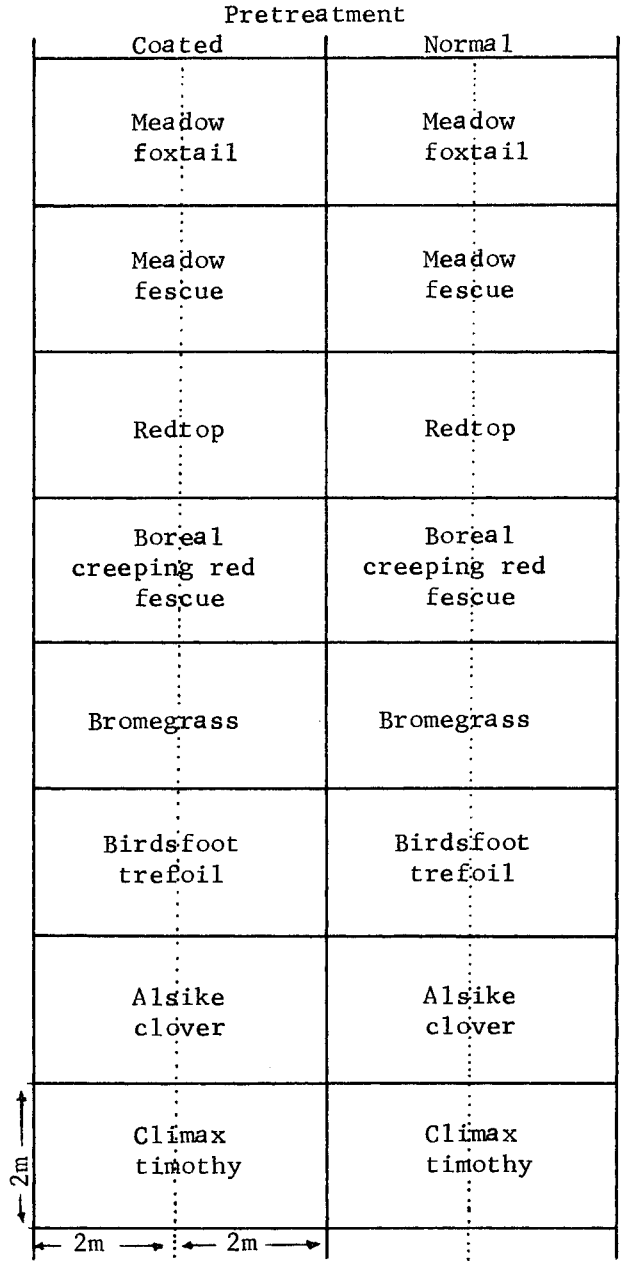
LAYOUT II - TRIALS TESTING THE USE OF COATED SEED,
PEACE RIVER COAL BLOCK,
MINISTRY OF MINES & PETROLEUM RESOURCES, 1977

Plot layout at:

Site 77-4 September 13, 1977
Site 77-5 September 17, 1977
Site 77-6 September 19, 1977

All plots seeded at a rate of:

50lb/ac (56 kg/ha)



Fertilizer rate

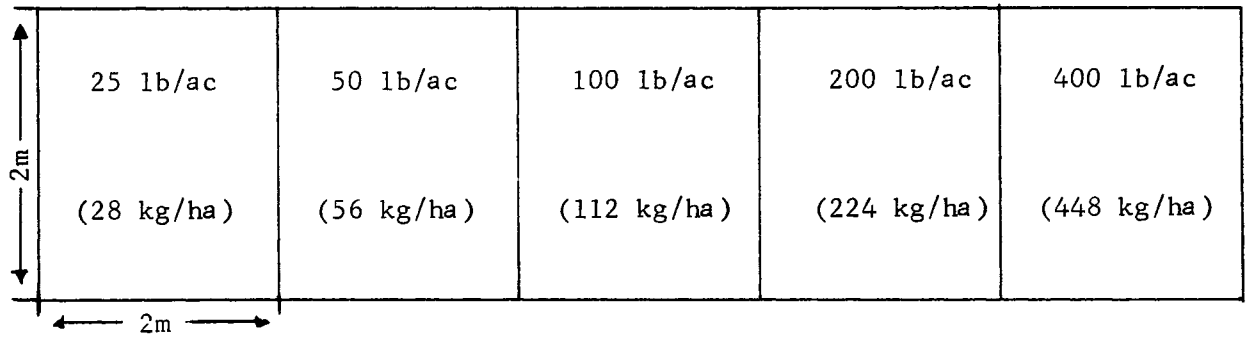
N (lb/ac)	0	32	32	0
(kg/ha)		(36)	(36)	
P (lb/ac)	0	40	40	0
(kg/ha)		(45)	(45)	
K (lb/ac)	0	20	20	0
(kg/ha)		(22)	(22)	

APPENDIX B-7

LAYOUT III - TRIALS TESTING SEEDING RATES,

PEACE RIVER COAL BLOCK,

MINISTRY OF MINES & PETROLEUM RESOURCES, 1977



All plots seeded with Mix B	(%)
Boreal creeping red fescue	20
Redtop	20
Meadow foxtail	20
Bromegrass	10
Timothy	10
Alsike clover	20

Fertilizer rate

N	32 lb/ac	(36 kg/ha)
P	40 lb/ac	(45 kg/ha)
K	20 lb/ac	(22 kg/ha)

Plot layout at:

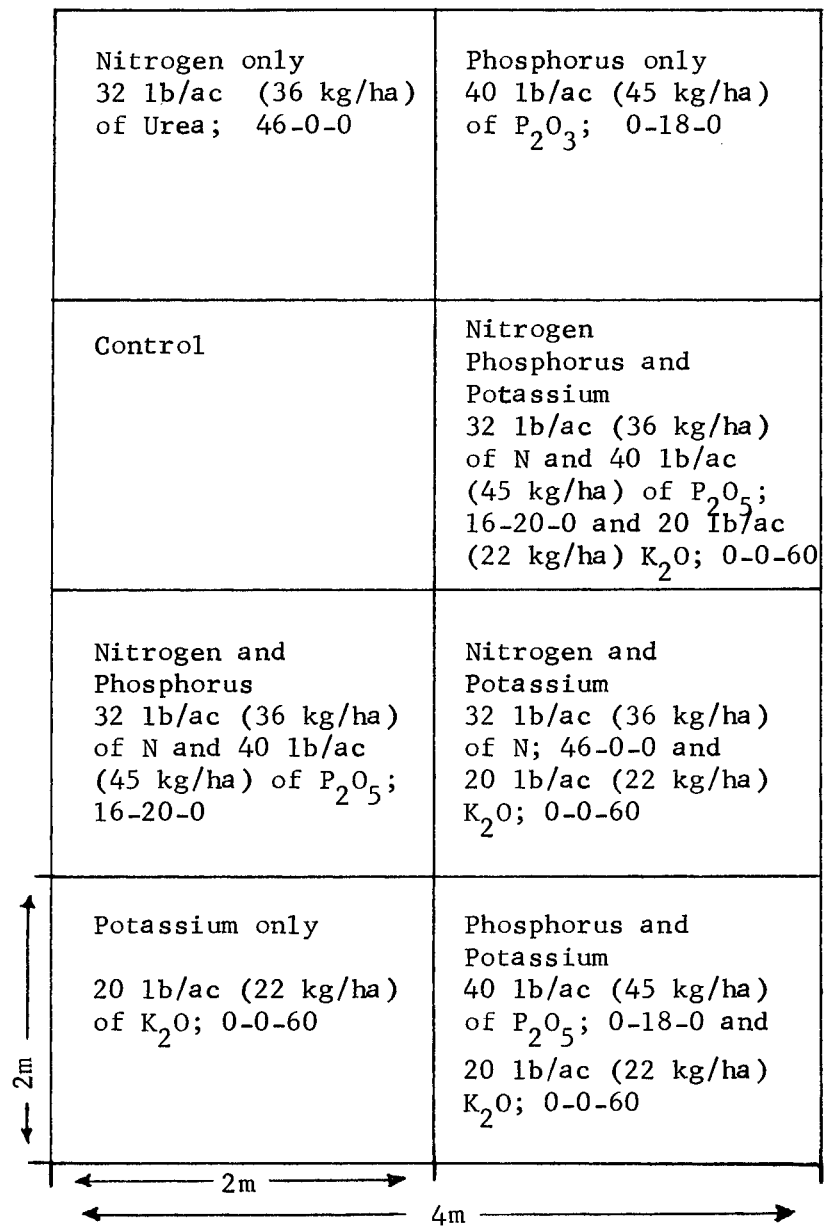
Site 77-4	September 19, 1977
Site 77-5	September 17, 1977
Site 77-6	September 19, 1977

APPENDIX B-8

LAYOUT IV - TRIALS TESTING THE USE OF FERTILIZERS,

PEACE RIVER COAL BLOCK,

MINISTRY OF MINES AND PETROLEUM RESOURCES, 1977



All plots seeded with Mix B

	%
Boreal creeping red fescue	20
Redtop	20
Meadow foxtail	20
Bromegrass	10
Timothy	10
Alsike clover	20

Seeding rate:

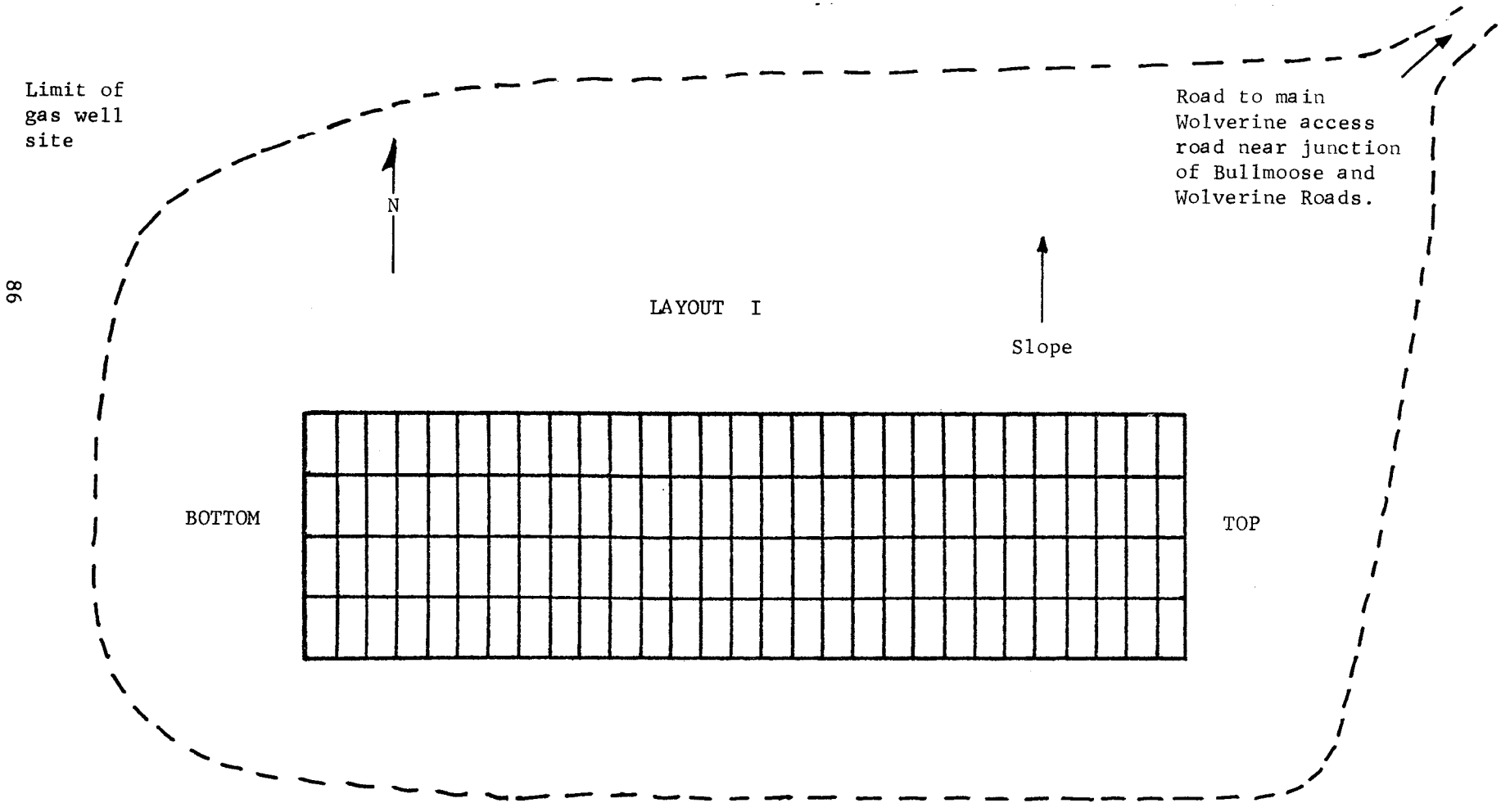
50 lb/ac (56kg/ha)

Plot layout at:

Site 77-4	September 19, 1977
Site 77-5	September 17, 1977
Site 77-6	September 19, 1977

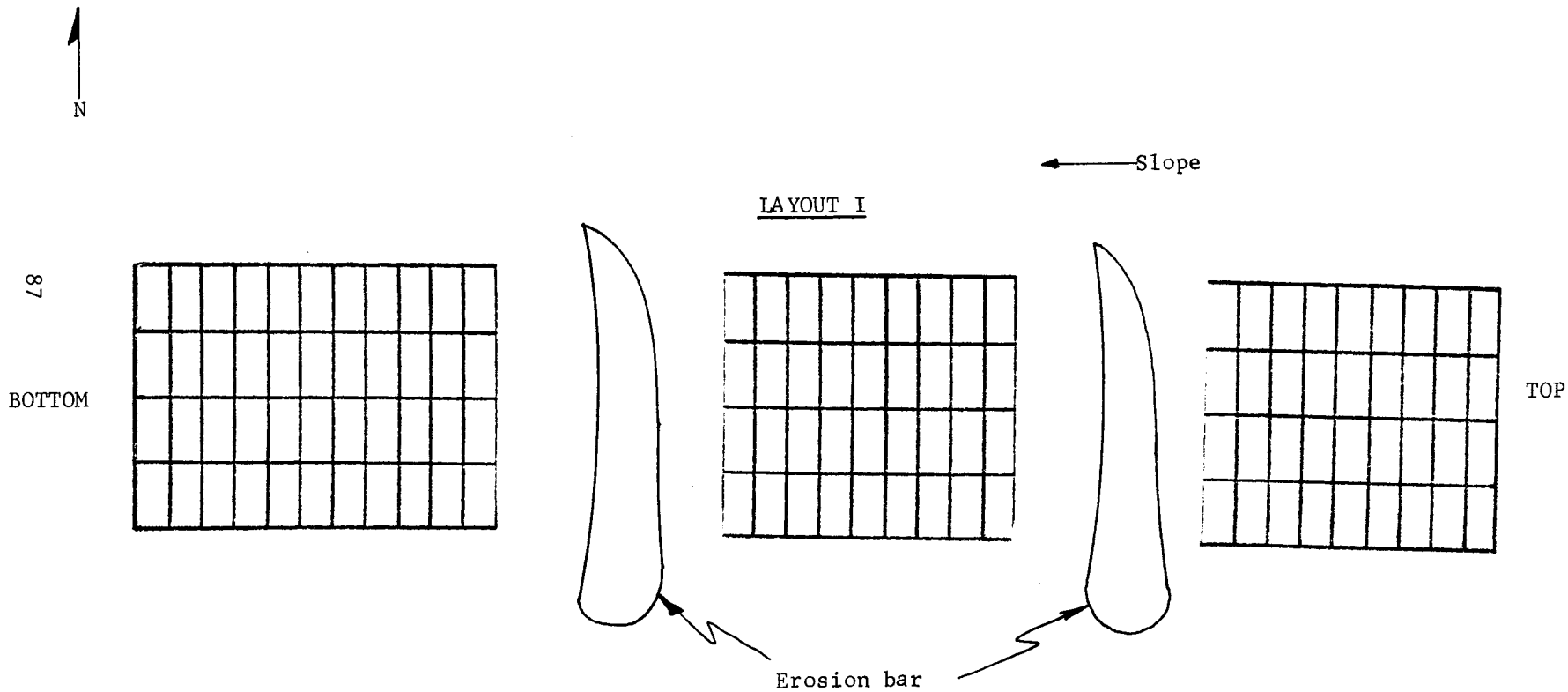
APPENDIX B-9a

SKETCH MAP OF MINISTRY OF MINES AND PETROLEUM RESOURCES TEST PLOTS AT SITE 77-1,
BULLMOOSE CREEK VALLEY,
1977



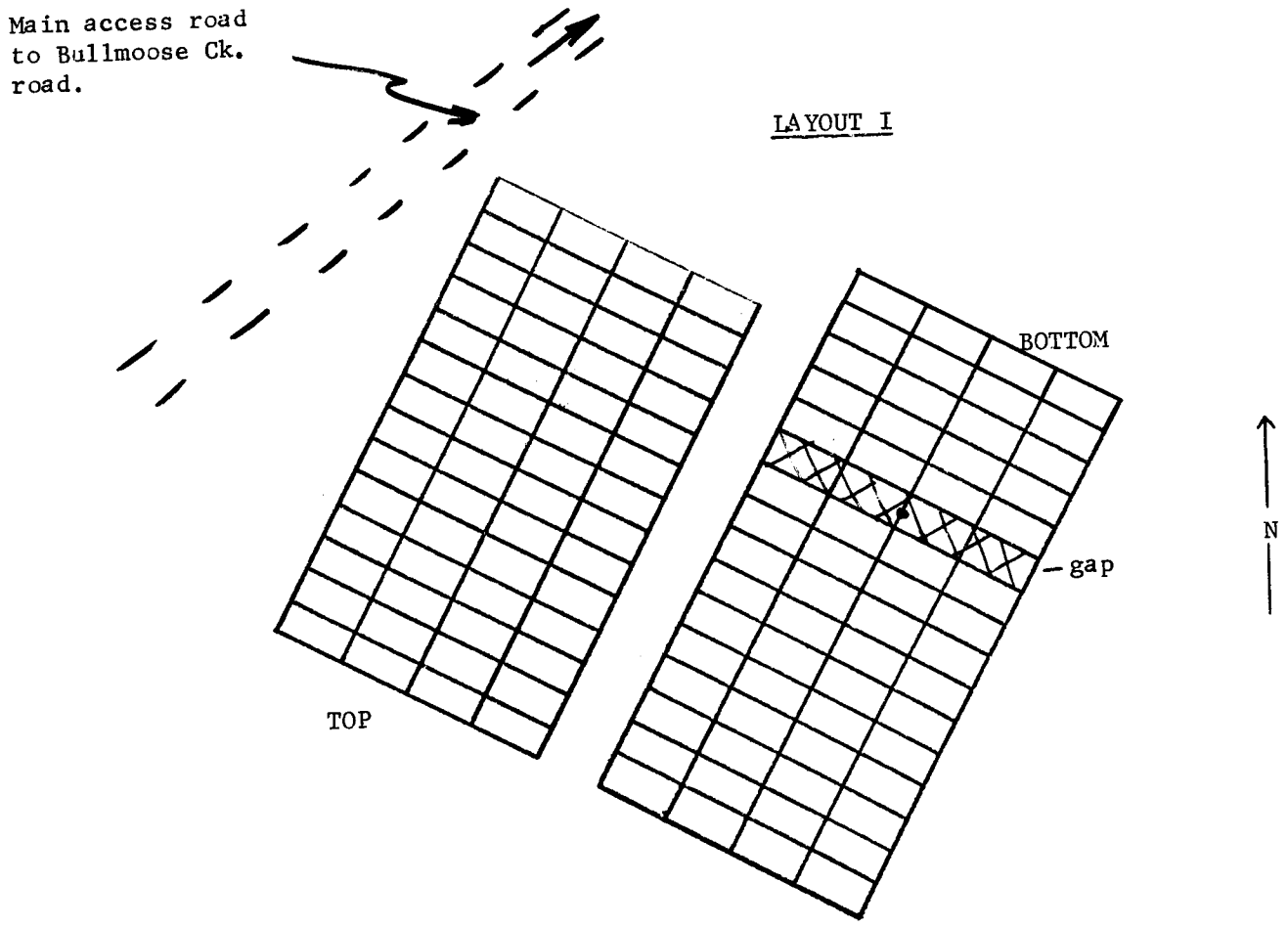
APPENDIX B-9b

SKETCH MAP OF MINISTRY OF MINES AND PETROLEUM RESOURCES
TEST PLOTS AT SITE 77-2, BULLMOOSE MOUNTAIN, 1977



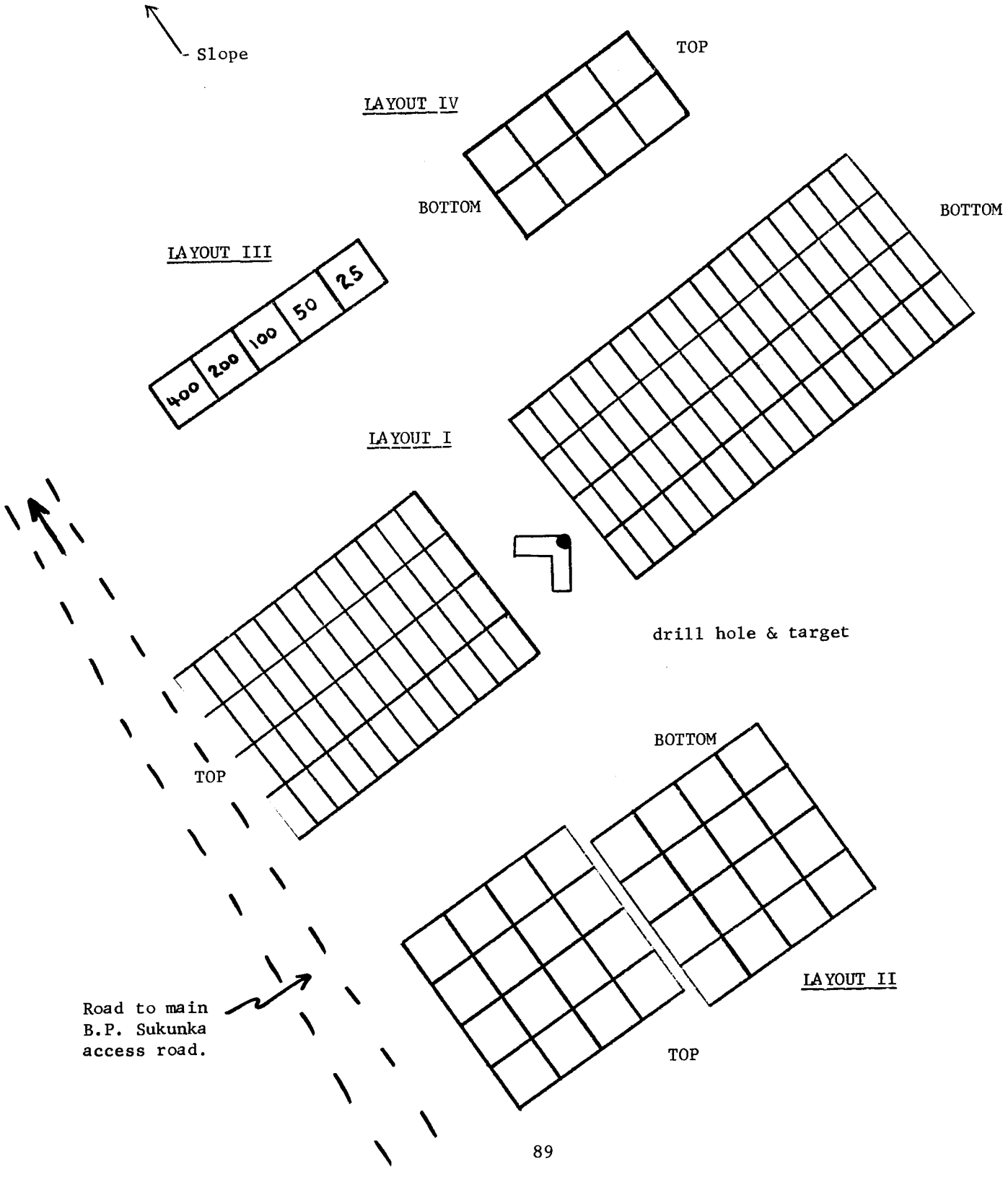
APPENDIX B-9c

SKETCH MAP OF MINISTRY OF MINES AND PETROLEUM RESOURCES
TEST PLOTS AT SITE 77-3, MOUNT SPIEKER, 1977



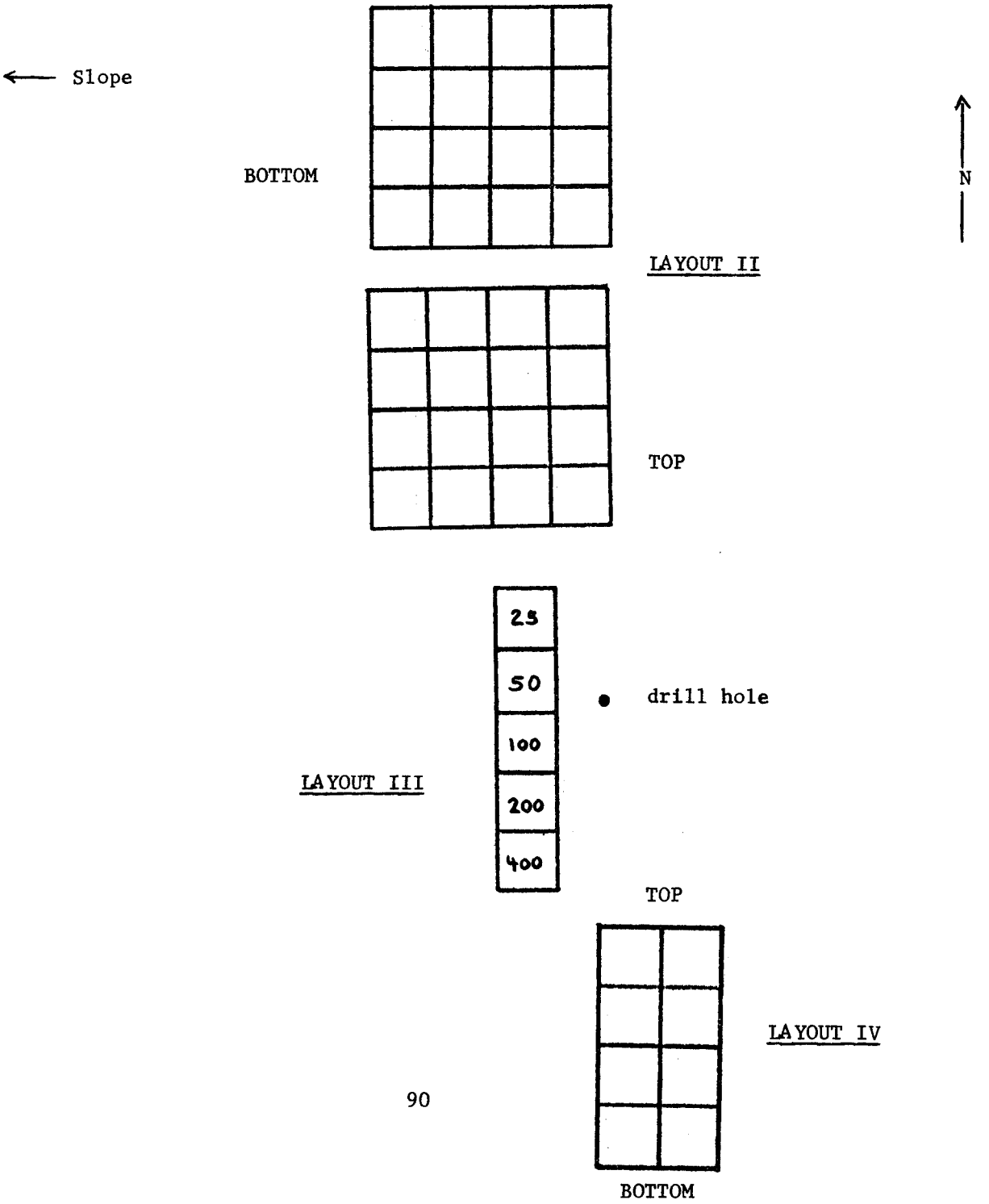
APPENDIX B-9d

SKETCH MAP OF MINISTRY OF MINES AND PETROLEUM RESOURCES TEST PLOTS AT SITE 77-4, BULLMOOSE MOUNTAIN, 1977



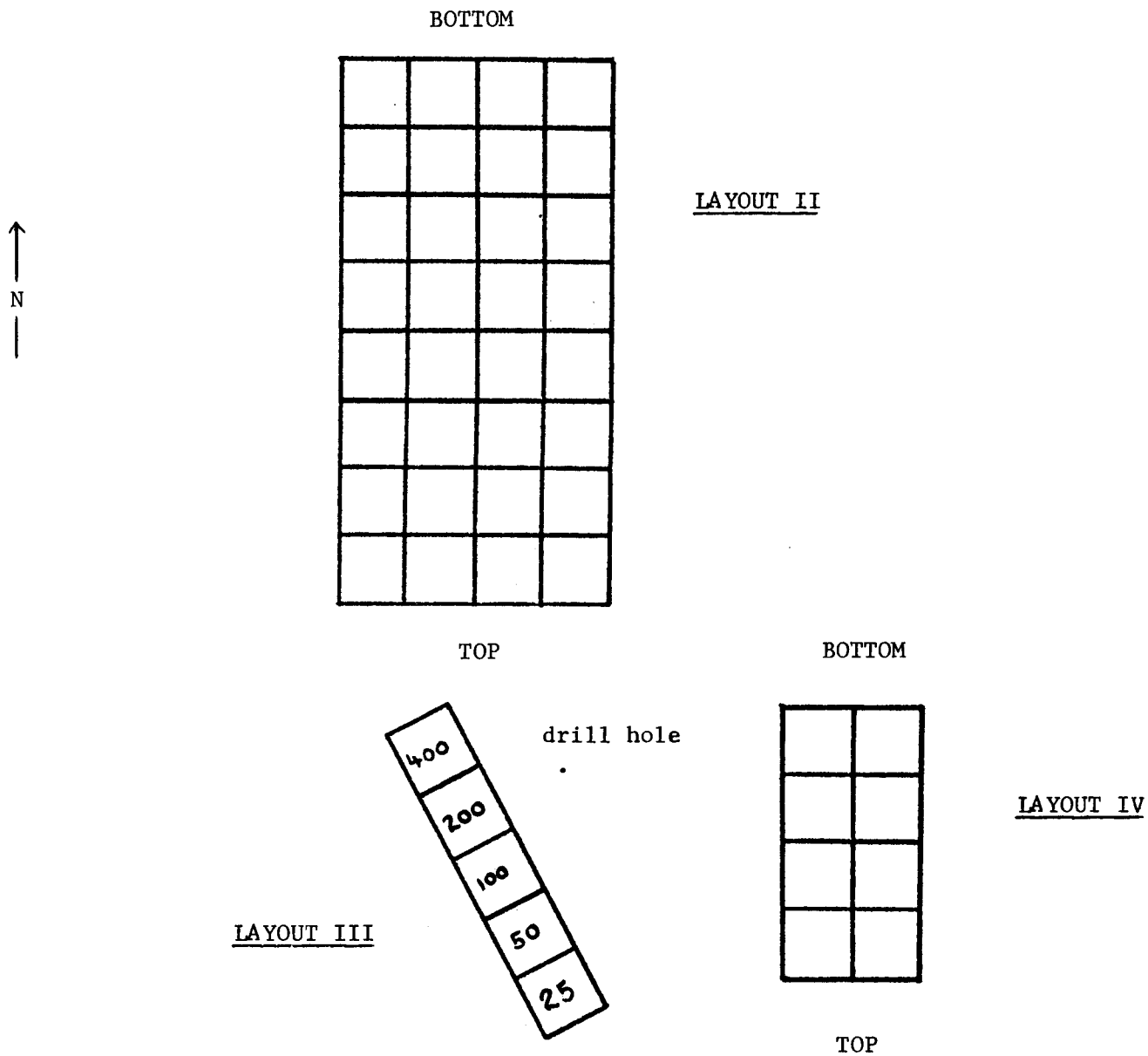
APPENDIX B-9e

SKETCH MAP OF MINISTRY OF MINES AND PETROLEUM RESOURCES TEST PLOT AT SITE 77-5, PROPOSED SHERRIF PIT AREA, 1977



APPENDIX B-9f

SKETCH MAP OF
MINISTRY OF MINES AND PETROLEUM RESOURCES TEST PLOTS AT SITE 77-6,
BULLMOOSE MOUNTAIN AREA, 1977



APPENDIX B-10

PRELIMINARY GROWTH ASSESSMENT OF TEST PLOTS SEEDED IN 1976, MINISTRY OF MINES AND PETROLEUM RESOURCES; PEACE RIVER COAL BLOCK

Site	76-1		76-2
Elevation (m)	1800		2100
Date seeded (day-mo-yr)	5-7-76		19-7-76
Date assessed (day-mo-yr)	22-7-76	5-9-76	15-9-76
Crested wheatgrass - Fairway	+	-	-
Streambank wheatgrass - Sadar	0	-	*
Pubescent wheatgrass - Greenleaf	+	+	+
Intermediate wheatgrass - Chief	+	-	+
Slender wheatgrass - Revenue	+	+	+
Bromegrass - Carlton	0	0	-
Bromegrass - Magna	0	0	-
Meadow fescue - Miner	0	-	-
Hard fescue - Bijant	0	-	-
Creeping red fescue - Boreal	+	+	+
Chewings fescue - Oasis	+	+	+
Kentucky bluegrass - Park	0	-	-
Meadow foxtail - Oregon common	+	+	+
Reed canarygrass - Castor	+	+	+
Colonial bentgrass - Exeter	+	+	*
Timothy - Climax	+	+	*
Russian wild ryegrass - Sawki	+	-	*
Sainfoin - Melrose	+	+	-
Birdsfoot trefoil - Leo	+	+	*
Alfalfa - Beaver	+	-	*
Alsike clover - Dawn	+	-	*
Red clover - Altaswede	+	-	-
White clover - Nora	+	-	*

Criteria used for germination and growth assessments.

0 No germination
- Growing poorly
+ Growing satisfactorily
* Growing well

APPENDIX B-11

GROWTH (% COVER) OF SPRING SEEDED TEST PLOTS, MINISTRY OF MINES AND PETROLEUM RESOURCES; PEACE RIVER COAL BLOCK, 1977

Site	77-1				77-2				77-3*			
Layout	I				I				I			
Elevation	1125				1780				1870			
Date seeded (day/mo/yr)	5-7-77				7-7-77				9-7-77			
Date assessed (day/mo/yr)	30-8-77				29-8-77				15-9-77			
Fertilizer treatment	0	½	1	2	0	½	1	2	0	½	1	2
Creeping red fescue	3	10	20	20	3	10	10	20	+	1	3	3
Meadow fescue	10	10	30	50	10	10	10	30	+	2	1	1
Hard fescue	3	10	10	10	3	10	10	20	+	1	1	2
Kentucky bluegrass	3	10	20	10	3	10	10	10	0	1	1	1
Canada bluegrass	3	20	20	10	3	10	10	10	0	1	2	2
Perennial ryegrass	3	20	40	60	10	30	30	60	1	3	5	4
Tracenta bentgrass	3	10	0	3	3	10	20	30	1	2	2	10
Crested wheatgrass	10	20	20	20	10	20	20	30	3	3	2	5
Pubescent wheatgrass	3	10	20	30	10	10	10	20	1	1	1	1
Slender wheatgrass	10	10	20	10	10	10	20	30	1	1	2	6
Streambank wheatgrass	10	20	20	30	10	20	30	30	1	1	2	3
Bromegrass	10	30	40	30	10	10	20	30	+	1	2	1
Orchardgrass	10	20	20	40	10	20	40	40	1	2	3	4
Redtop	0	3	10	10	10	10	30	40	0	1	2	6
Reed canarygrass	3	10	10	20	0	3	20	10	1	2	2	4
Russian wild ryegrass	10	10	20	30	10	10	10	10	1	3	2	2
Timothy	10	10	10	20	10	10	20	30	1	2	3	5
Meadow foxtail	3	10	20	40	10	20	20	50	+	2	6	10
Alfalfa - ceres	20	40	40	40	20	20	20	40	+	+	0	1
Alfalfa - drylander	10	10	10	10	10	20	20	20	0	0	0	0
Alsike clover	10	10	10	20	10	20	20	30	0	0	0	+
Red clover	10	20	20	30	10	20	40	40	+	1	1	2
Birdsfoot trefoil	10	10	10	10	10	10	10	10	1	1	1	+
Sweet clover	20	30	40	60	20	20	20	30	0	0	0	0
White clover	10	10	10	30	10	30	40	40	1	1	1	1
Cicer milkvetch	3	3	3	3	3	3	3	10	0	0	0	0
Sainfoin	10	10	20	20	10	10	10	10	0	0	0	0
Mix A	10	20	30	30	10	20	30	50	2	4	8	8
Mix B	10	10	20	10	10	20	20	30	0	3	7	7

* This site was inadvertently over-seeded with the forestry mix, therefore, it was difficult to distinguish species.

APPENDIX B-12

CHEMICAL ANALYSIS OF SELECTED SOIL PROPERTIES, TEST PLOT SITES, PEACE RIVER COAL BLOCK, MININSTRY OF MINES & PETROLEUM RESOURCES, 1977

SITE	TEXTURE	ORGANIC MATTER	pH	SALTS	NITRATES	P	K	Ca	Mg
		(%)	(H_2O)	mmhos/ cm	lb/ acre	lb/ acre	lb/ acre	lb/ acre	lb/ acre
77-1	very gravelly clay	1.9	8.0	0.34	3	11	127	5735	382
77-2	silt loam	18.0	6.6	0.28	12	11	105	6889	1000+
77-3	gravelly silt loam	4.7	4.5	0.16	1	37	74	798	132
77-4	gravelly sandy loam	2.3	5.0	0.10	1	110	282	919	147
77-5	gravelly silt loam	2.6	6.5	0.20	1	26	154	3266	332

APPENDIX C

UTAH MINES LTD. - CARBON CREEK,
ASSESSMENT OF REVEGETATION ON EXPLORATION AREAS.

Appendix

APPENDIX C-1

EVALUATION OF REVEGETATION ON DRILL PADS WITHIN THE DENSE FOREST HABITAT TYPE, CARBON CREEK, 1975

Habitat Type	DENSE FOREST																									Mean	Standard Deviation	Frequency (%)
Plant Community	Pine	Spruce - Pine																										
Drill Hole Number	6	1	2	3	5	8	9	10	11	14	16	17	18	21	23	24	25	26	27	28	29	30	31	32	33	34			
Drill Pad Diameter(metres)	30	35	35	40	30	35	20	30	30	35	25	30	25	30	25	30	30	25	22	35	34	15	35	45	30	25			
Percentage of Pad	100	70	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	30	100	100	100	100	100	30	30			
Slope (Degrees)	10	10	8	9	7	12	5	10	5	13	15	13	3	5	0	8	5	13	0	10	15	12	0	0	8	9	7.7	4.9	
Aspect (Degrees)	260	15	325	60	80	50	330	105	140	120	100	30	340	240	0	20	180	40	0	30	30	5	0	0	50	100	98.1	109.7	
Elevation (Feet)	3,120	2,400	3,530	2,700	3,420	3,520	2,800	3,260	4,480	3,790	3,320	2,700	3,090	4,450	4,400	2,720	3,240	3,560	3,600	2,650	2,500	3,230	3,020	2,710	3,200	3,640	3,320	587.5	
Soil Texture	Fine Gravelly Shale	Clay Loam	Clay Loam	Clay Loam	Gravelly Silt Loam	Silt Loam	Clay Loam	Clay Loam	Gravelly Clay Loam	Gravelly Sandy Loam	Silt Loam	Clay Loam	Silt Loam	Very Gravelly Sand Loam	3" to Bedrock	Silt Loam	Gravelly Silt Loam	Gravelly Silt Loam	Clay Loam	Clay Loam	Rocky Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam	Clay Loam			
Date of Disturbance	71	71	71	71	71	71	71	72	72	72	72	72	72	72	72	72	72	72	73	72	73	73	73	73	73	73			
Date Seeded	72	72	72	72	72	72	72	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73			
SEEDED SPECIES																													
Timothy	5	20	5	5	5	5	5	5	2	5	17	20	15	3	0	15	30	24	5	40	15	25	20	10	40	15	13.2	11.3	96
Creeping red fescue	45	25	25	60	25	60	5	10	8	20	18	35	15	1	0	25	20	24	60	15	20	30	25	40	19	25	24.3	16.9	96
Alsike clover		25	45	25	20	25	80	75	15	30	5	30	20	1	0	10	30	2	5	15	5	20	25	30	1	40	21.4	20.7	92
Barley				+		+																					0.03	0.13	7
TOTAL	50	70	75	90	50	90	90	90	25	55	40	85	50	5	0	50	80	50	70	70	40	75	70	80	60	80	58.9	27.0	96
NATURAL REVEGETATION - TREES																													
Abies lasiocarpa																											0.01	0.09	3
Populus trichocarpa	1			1		3	2									5					+			2	+		0.37	0.77	25
P. tremuloides				+																							0.20	0.96	7
SHRUBS																													
Alnus sinuata						1																					0.03	0.19	3
Rubus idaeus var. peraquenus				+			+	+																+			0.07	0.18	14
Salix spp.				4			2	+				+				+							+	2	+		0.38	0.90	29
Viburnum edule				+																		+					0.03	0.13	7
FORBS																													
Arnica cordifolia	1																	+									0.05	0.21	7
Epilobium angustifolium	+			+		1																+					0.09	0.24	14
Equisetum pretense				+																							0.01	0.09	3
Galium triflorum						1						+															0.05	0.21	7
Lupinus argenteus									+						+											+	0.05	0.16	11
Mertensia paniculata																+									1		0.05	0.21	7
TOTAL NATURAL REVEGETATION	2	0	0	7	0	6	4	1	+	0	0	1	0	0	+	5	0	1	0	0	+	1	+	4	2	+	1.35	2.01	62

APPENDIX C-2

EVALUATION OF REVEGETATION ON DRILL PADS WITHIN THE OPEN FOREST HABITAT TYPE, CARBON CREEK, 1975

HABITAT TYPE	OPEN FOREST							Mean	Standard Deviation	Frequency (%)
Plant Community	Spruce Fir					Pine-Spruce				
Drill Hole Number	4	7	12	13	15	19	20			
Drill Pad Diameter (m)	40	30	35	25		25	20	29.1	7.4	
Percentage of Pad	70	55	100	100		100	100			
Slope (degrees)	2	10	13	3		12	25	10.8	8.3	
Aspect (degrees)	45	25	120	15		270	340	135.8	137.9	
Elevation (feet)	3930	4180	3790	3670		3120	4350	3840	432.1	
Soil Texture	Gravelly silt loam	Gravelly silt loam	Gravelly silt loam				silt loam			
Date of Disturbance	71	71	72	72		72	72			
Date Seeded	72	72	73	73		73	73			
SEEDED SPECIES					Drill pad has been totally redisturbed					
Timothy	18	20	5	20		60	40	27.2	19.6	100
Creeping red fescue	5	20	20	15		15	19	15.7	5.7	100
Alsike clover	2	1	30	5		5	1	7.3	11.3	100
TOTAL	25	40	55	40		80	60	50.0	19.2	100
SHRUBS										
Alnus sinuata						+		0.08	0.20	17
Ribes lacustre						+		0.08	0.20	17
Rubus idaeus var. peramoenus						2		0.33	0.81	17
Rubus pedatus						2		0.33	0.81	17
Sambucus pubens							1	0.16	0.40	17
FORBS										
Aconitum columbianum							1	0.16	0.40	17
Anaphalis margaritacea						+		0.08	0.20	17
Arnica cordifolia	+	+					5	1.00	1.97	50
Epilobium glandulosum							+	0.08	0.20	17
Equisetum pratense						5		0.83	2.04	17
Galium triflorum						2		0.33	0.81	17
Lupinus argenteus							3	0.50	1.22	17
Luzula wahlenbergii							1	0.16	0.40	17
Mertensia paniculata						2	2	0.66	1.03	33
Osmorhiza depauperata							1	0.16	0.40	17
Valeriana sitchensis							1	0.25	0.41	33
TOTAL NATURAL REVEGETATION	+	1	0	0		15	15	5.25	7.56	67

APPENDIX C-3

RELATIVE SUCCESS OF PLANT SPECIES OBSERVED AT DRILL HOLE SITES, 1976

Disturbance Date:	1971								1972					1973								1975																
Drill Hole No.:	1	2	3	4	5	7	8	9	10	11	12	13	16	24	26	27	30	31	32	33	34	38	42	43	45	47	49	50	51	53	56	61	64	66	68	69
Total Cover	5	5	6	4	4	5	6	6	6	2	5	5	4	4	4	6	5	6	6	3	6	2	2	5	5	2	2	2	2	2	2	1	3	4	2	3
Seeded Species																																				
Timothy	2	3	2	2	2	5	5	3	6	2	2	5	3	2	3	2	2	4	2	3	5	1	2	2	3	1	1	1	1	2	2	1	1	3	1	1
Creeping red fescue	5	5	5	4	4	3	6	3	6	2	3	5	3	4	4	6	5	6	5	3	6	2	2	5	5	2	2	2	2	2	2	1	3	3	2	2
Clover	5	5	4	2	2	2	5	6	6	2	3	3	2	2	1	5	4	4	4	1	2	1	2	3	5	2	1	2	1	1	1	1	1	1	1	2
Barley			1																																	
Native Species																																				
Populus balsamifera			2											1																						
Populus tremuloides	1		1						1									1	1								+		+				1			
Pinus contorta			+		+		1																													
Picea glauca x Englemanii					+																															
Abies lasiocarpa					+																															
Alnus sinuata			1		+		1	1													1			1					1						1	
Salix sp.	1	1	3				2	1	1					1			1	1	1	1					1									1		
Ribes lacustre			1				1						1								1															
Rubus idaeus			1				2		1					1										1										+		
Sorbus scopulina				+																																
Spiraea lucida	1																		1					1	1											
Rubus pubescens				1			1	1											1							1				1		1				
Rubus pedadus				1														1										+	1				+		1
Vaccinium membranaceum		+		1	1	1				1																			1							
Rhododendron albiflorum		1		1	1																															
Rosa acicularis	1																			1				1	1											
Viburnum edule																	4						1													
Equisetum pratense	1	1	2				2	1											1							1				2	1				
Carex sp.			2						1																											
Anaphalis margaritacea			+																																	

APPENDIX C-3 (Continued)

Disturbance Date:																																							
Drill Hole No.:	1	2	3	4	5	7	8	9	10	11	12	13	16	24	26	27	30	31	32	33	34	38	42	43	45	47	49	50	51	53	56	61	64	66	68	69
Native Species (cont'd.)																																				
Cornus canadensis		1	1	1	1			1	1					1			1				1			1		1		1	1				1	1	
Vicia sp.			+				1																													
Mertensia paniculata	1		+			1	2		1					1	1				+	1				1	1				1	1	1				
Hieracium albiflorum			+																																	
Epilobium angustifolium		+	+	1			1		1	1							1				1		1	1						1						+
Geranium bicknellii																									1											
Petasites palmatus	1			1			1		1					1	1		1		+	1	1			1	1	1			1	1		1		1	
Taraxacum officinale	1																		1	1															
Pyrola secunda									1																											
Arnica cordifolia				1		1	2	1	1	1					1	1	1				1					1				1				1	
Galium triflorum							1		1				1																							
Lupinus argenteus										1																										
Senecio triangularis																															1				
Valeriana sitchensis																															1				
Thalictrum occidentale																															1				
Mitella nuda																															1				
Ranunculus eschscholtzii																															1				
Luzula wahlenbergii		1		1		2																													
Lathyrus ochroleucus													1																						
Osmorhiza depauperata							1																												
Ledum groenlandicum		1																																	
Dryopteris austriaca																+																			1

APPENDIX C-4

COMPARISON OF 1975 AND 1976 DATA
SHOWING NUMBERS OF NATIVE SPECIES INVADING DRILL HOLE SITES

Disturbance Date:	1971								1972					1973							
Drill Hole No.:	1	2	3	4	5	7	8	9	10	11	12	13	16	24	26	27	30	31	32	33	34
NUMBER OF NATIVE SPECIES																					
Trees																					
1975	0	0	2	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	1	1	0
1976	1	0	4	0	3	0	2	0	1	0	0	0	0	1	0	0	0	1	1	0	0
Shrubs																					
1975	0	0	3	0	0	0	1	2	2	0	0	0	0	1	0	0	1	1	2	1	0
1976	3	4	4	5	3	1	5	3	2	1	0	0	1	3	0	0	2	2	3	2	2
Herbs & Dwarf Shrubs																					
1975	0	0	2	1	0	1	2	0	0	1	0	0	0	1	1	0	1	0	0	1	1
1976	3	4	8	5	1	3	8	3	9	3	0	0	2	3	3	2	4	0	4	3	4
Total Species																					
1975	0	0	7	1	0	1	4	3	2	1	0	0	0	3	1	0	2	1	3	3	1
1976	7	8	16	10	4	4	15	6	12	4	0	0	3	7	3	2	6	3	8	5	6

APPENDIX C-5

ASSESSMENT OF SEEDING PROGRAM ALONG EXPLORATION ROADS, CARBON CREEK, 1975

LOCATION	DESCRIPTION
73 - 27 to 73 - 28	Either not well seeded in 1973 or redisturbed in 1975; only sporadically revegetated from 1973; good germination from 1975 seeding.
72 - 17 Spur	Only sparsely revegetated.
73 - 28 to DH-1	Well seeded in 1975, no germination at present.
73 - 26 to 73 - 34	Good revegetation redisturbed on travelled portion (75% cover); Timothy 35%, Fescue 35%, Clover 5%.
73 - 34 to Main Road	Good revegetation but one-half of the road has been redisturbed (80% cover on undisturbed area); Timothy 40%, Fescue 35%, Legume 5%.
73 - 33 Spur	Good revegetation but largely redisturbed.
73 - 24 Spur	Moderate revegetation.
Main Road, Campsite 2 to 7-Mile Cr	Excellent revegetation on untravelled portion
DH-3 Spur	About 30% of road is redisturbed; excellent revegetation on the rest of the road; one area sampled was as follows: (95% cover) Timothy 30%, Fescue 40%, Clover 25%.
73 - 32 Spur	Excellent revegetation on majority of road; one area sampled was as follows: (95% cover) Timothy 30
DH-2 Spur	Largely redisturbed.
72 - 11 to 72 - 10	Road redisturbed; seeded only in patches, mostly near main road.
72 - 12 Spur	Road not seeded, probably disturbed in 1975.
73 - 31 Spur	Good revegetation; only one area sampled; (30% cover) Timothy 5%, Fescue 20%, Clover 5%.
Main Road, 7-Mile Creek to 9-mile Cr.	Good revegetation, patches of seeded and unseeded areas.
DH-7 Spur	Almost entirely redisturbed, one or two patches remaining on roadside and good revegetation on undisturbed portion below DH-4

Continued...

LOCATION	DESCRIPTION
Main Road, 9-Mile Creek to 10-Mile Cr.	Excellent revegetation over most of the untravelled portion of the road; one area was as follows: (90% cover) Timothy 60%, Fescue 20%, Clover 10%.
72 - 18 Spur	Good revegetation (60% cover); Timothy 10%, Fescue 25%, Clover 5%.
DH-6 Spur	Good revegetation (60% cover); Timothy 35
Main Road, 10-Mile Creek to 11-Mile Cr. South Fork	Good revegetation over most of the untravelled portion of the road; one area sampled was as follows: (50% cover) Timothy 30%, Fescue 15%, Clover 5%.
Main Road, 11-Mile Creek South Fork to Carbon Creek	Good revegetation until switchback area near Carbon Creek; slump area near here. High clay content and groundwater seepage area - mass downslope movement at one point directly into Carbon Creek channel.
Main Road, Carbon Creek to 72-19	Seeded only for one mile, not seeded until near DH 72-19.
Main Road 72-19 to Road Fork	Appears not to have been seeded.
72-20 Spur	Appears not to have been seeded.
72 - 21 Spur	Seeding is patchy.
72 - 23 Spur	Appears not to have been seeded.

APPENDIX C-6

ASSESSMENT OF NATURAL REVEGETATION (% COVER) ALONG EXPLORATION ROADS, CARBON CREEK, 1975

LOCATION	73-27 to 73-28	72-17 Spur	73-28 to DH-1	73-26 to 73-34	73-34 to Main Road	73-33 Spur	73-24 Spur	Main Road Campsite 2 to 7-Mile	DH-3 Spur	73-32 Spur	DH-2 Spur	72-11 to 72-10	72-12 Spur	73-31 Spur	Main Road 7-Mile Cr. to 9-Mile Creek	DH-7 Spur	Main Road 9-Mile Cr. to 10-Mile Creek	72-18 Spur	DH-6 Spur	Main Road 10-Mile Cr. to 11-Mile South Fork	Main Road 11-Mile Cr. S. Fork to Carbon Cr.	Main Road Carbon Cr. to 72-19	Main Road 72-19 to Road Fork	72-20 Spur	72-21 Spur	72-23 Spur	Frequency
CONIFEROUS TREES																											
Picea engelmanii																	+										1
Pinus contorta																	+										1
DECIDUOUS TREES																											
Alnus sinuata		5																				+					2
Alnus tenuifolia		+							+						1		+										4
Populus tremuloides								+													+						2
Populus trichocarpa		3	5					3		+	2				3		1		+	3		1					10
SHRUBS																											
Acer glabrum				+							+																2
Rhododendron albiflorum																										+	1
Ribes lacustre				+				1							+						+						4
Ribes triste																									+		1
Rosa woodsii								+									+				+	1					4
Rubus idaeus var peramoenus		1		1				2							2		2		+	3	+	2					9
Rubus parviflora																		1				+					2
Rubus pedatus					+															1	+			+			4
Salix sp.								+									+										2
Sambucus pubens																						+					1
Spiraea lucida								+											3			+					3
Viburnum edule																			+	2	+	1					4
FORBS AND CHAMAEPHYTES																											
Aconitum columbianum																						+	+	3			3
Actaea rubra																						+					1
Agoseris glauca								1																1			2
Anaphalis margaritacea																				1		+					2
Arnica cordifolia				1				+									+		+			2	5	5	5	+	9
Aster conspicuous								+									+				+	1					4
Astragalus alpinus																						+			+		2
Chenopodium capitatum								+																			1
Cornus canadensis			+																								1
Epilobium angustifolium			+		+			+							+		1			2	+	+		+	+	10
E. glandulosum / E. latifolium		+																				+		1			3
Equisetum arvense / E. pratense		+						1	+						+		3				+	2	2	2			9
Fragaria virginiana								+							+												
Galium triflorum		+						+							2		+										2
Geranium bicknellii		+			2			1		+					+							1					5
Geum macrophyllum																					+	1			+		8
Heracleum lanatum																								1			1
Heuchera cylindrica																								1			1
Lathyrus ochroleucus		+		+				1							+		+	1						1			1
Lupinus argenteus																											6
Mertensia paniculata		+						+									2					+	1	2	2		4
Mitella nuda																					+	+	+	1			7
Osmorhiza depauperata																								1			1
Petasites frigidis var palmatus		+					+																	1			1
Potentilla sp.																											2
Polemonium humile								+														+	+	1			3
Senecio sp.																											1
Smilacina stellata																								1	+		2
Solidago canadensis								+														+					1
Streptopus amplexifolius																											1
Tiarella unifoliata																							+	1			2
Urtica lyallii															+							+	1	1			3
Valeriana sitchensis																											1
Veratrum eschscholtzii																							1	2			3
																							+		+		2
SEDGES AND RUSHES																											
Carex aenea / C. brevior / C. festivella		+	+					+			2											3			+		6
Luzula wahlenbergii																						3	4	3	3		4

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