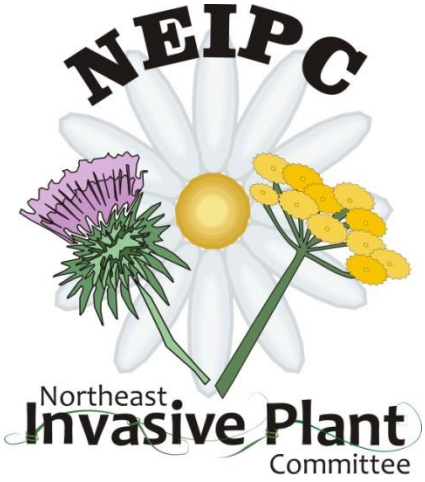
PEACE - LIARD

RE-VEGETATION MANUAL



APPROVED BY THE NEIPC MEMBERSHIP ON APRIL 28TH, 2010

INTRODUCTION:

The activities of the oil and gas, forestry and livestock industries in the Peace and Fort Nelson Forest District (DPC/DFN) have increased the amount of disturbance on the landscape. Seeding of plants species after disturbance is a common practice in the DPC/DFN. The North East Invasive Plant Committee (NEIPC) is a multi-stakeholder, multi-agency committee that strives to prevent further damage to the ecosystem of northeast BC from invasive plants and begin to rehabilitate ecosystems that have been degraded by invasive alien plants. Concerns voiced by many NEIPC members regarding the apparent use of seed used for re-vegetation that was ecologically inappropriate or that was contributing to the spread of invasive plants resulted in the formation of a sub-committee to look at re-vegetation in the Peace-Liard. This manual is the result of the work completed by this sub-committee and will be reviewed and approved by the NEIPC membership on an annual basis.

Operational recommendations based on research are available for land reclamation and seeding of disturbed areas. These seeding recommendations are currently housed in various locations. The purpose of this manual is to provide a quick reference for planning and implementing seeding projects. The process of seeding should be dealt with on a site-specific, prescriptive basis. The prescriptions should take advantage of the wide array of available information and expertise. Potential prescriptions could be revised with new information, changes in seed availability, and seed prices.

The layout and general information provided in this manual are based on the Draft Seeding Manual Prince Rupert Forest Region and the Clearwater Forest District Reclamation/Re-vegetation Guidelines. Specific information on seed mixes is from the work of local agrologists in the DPC/DFN.

The value of this manual is increased by the incorporation of a diversity of input. If you have a comment or suggestion regarding this manual, please contact any NEIPC or Re-vegetation Committee member.

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1. PLANNING A SEEDING PROJECT

1.1 Setting Goals and Objectives

Goals and objectives should be set early in the planning stages and revised as new information becomes available or conditions change. Goals can be general but objectives need to be clear, concise and measurable.

The first decision to make is whether or not to seed a disturbed site. Sites can be disturbed by events such as logging, road construction, road maintenance, fire, disease or insect attack or land clearing (Table 1). Disturbances can lead to several outcomes. There are potential problems such as soil erosion, weed spread and site degradation. There are also opportunities to seed. Seeding can not only minimize erosion and weed problems and but also enhance the site through nitrogen additions and improvement of soil structure. Seeding can also be used to displace or replace invasive plants or unwanted vegetation and enhance the site for integrated resource management.

Table 1Several types of disturbances, possible negative results, and effects of a seeding treatment

Site Disturbance	Result	Seeding Treatment	Effect
-logging -road construction -fire, disease and insect attack -land clearing	-erosion -weed infestation -soil compaction -soil displacement -visual impact	-species or mix -application rate -timing	-weed, brush & erosion control -nitrogen additions -improve soil structure, forage -wildlife cover & aesthetics -alter animal distribution -site reclamation

The benefits to seeding include aesthetics, preventing establishment of invasive plants, enhancing or rehabilitating sites, controlling erosion, improving forage or wildlife cover, and managing brush (Table 1). Specific objectives can be set such as preventing a thistle patch from spreading down a road, adding nitrogen to a nitrogen poor site, improving soil porosity, preventing siltation in a stream, providing some early spring forages for ungulates or reclaiming a wellsite. It is important to clearly outline what you hope to accomplish to determine whether or not to seed as well as species, rate, application method and time. Clearly stating your goals and objectives also allows you to evaluate the success of the seeding and build on your experience.

There are circumstances where seeding a disturbed site is not the best option. For example, a small clearing in a native forest that is away from roads and invasive plants may regenerate without the use of seeding. In this hypothetical example, seeding may introduce unwanted, domestic, plant species. By stating the desired outcomes of the project through your objectives, the decision to seed or not to seed after disturbance will become clear.

One method of goal setting is to state general goals then specify measurable objectives. Often additional or side benefits occur, which may not be critical in determining whether

or not to seed but they deserve mention as they may be important later on or to someone else.

Goal Setting Example:

Scenario - A mesic site is going to be cleared and there is a nearby infestation of yellow and orange hawkweed (*Hieracium spp).* It is expected that unless the disturbance is reseeded, the invasive plant will establish. It is also predicted that the site will benefit significantly from the addition of nitrogen because it will improve the ability of native species to compete with the hawkweeds. A prescription is to be developed to prevent invasive plant establishment and site enhancement seeding.

The goals might then be recorded as:

General Goals:

- Establish desirable grass and forb species in order to prevent the spread of invasive plants onto the disturbed area.
- Enhance the site by establishing nitrogen fixing legumes, reduce fine material losses through quick revegetation and high levels of vegetative coverage, and improve soil structure through rooting activity of seeded plants.

Specific Objectives:

- Establish seeded grasses and forbs at 90% cover by year 3 to decrease bare soil available to the establishment of invasive species.
- Establish nodulated legumes at 15 to 20% cover with total scores above 20 using the Field Guide to Nodulation & Nitrogen Fixation Assessment.

Additional Benefits

- Increased forage availability for ungulates.
- Improved aesthetics.

Goals and objectives can be derived from studies, experience, as well as speculation. The specific objectives are the stated and measurable parameters that you expect to achieve. However, more information is often required before objectives can be set. Referring to and consulting local experts will assist your objective setting and overall project.

1.2 Decision Tree for the Peace Forest District

The general recommendation for revegetation is to ensure disturbed areas are seeded as quickly as possible after the disturbance. This limits the ability of invasive species to infest the site and provides the desirable species with the best opportunity for establishment. It is acknowledged, however, that even certified seed may contain some weed species. Therefore, in pristine areas where there are no known invasive plant sites,

natural revegetation may be the best option. In order to assist with this determination, the following decision tree identifies situations when natural revegetation may be the preferred option. This is especially relevant in the Liard area of northeastern British Columbia.

Figure 1. Peace Liard Revegetation Decision Matrix

1.3 Referrals and Consultation

Information on seeding after disturbance is rapidly evolving. The bibliography in Appendix 6.9 lists some of the references available to assist in prescription formulation. There are numerous research and operational seeding programs underway that generate new information regularily. Generally, this information is extrapolated from these experiences to formulate a prescription. It is worthwhile to check with researchers and specialists to see what is current. Feedback on prescriptions will allow you to incorporate other peoples experience, reduce risk and increase your confidence.

Some key contacts include:

- BC Ministry of Forests, Lands and Natural Resource Operations office in Dawson Creek:
  - Range Agrologists
  - Forest Health Specialist
  - Engineering Specialist
  - Research Silviculturist
- BC Ministry of Agriculture offices in Dawson Creek and Fort St. John:
- BC Ministry of Forests, Lands and Natural Resource Operations in Prince George
  - Range Ecologist
  - Invasive Plant Specialist
  - Regional Silviculture Specialists
  - Regional Engineering Specialists
- Peace Region Forage Seed Association
  Contact information for local forage seed venders on association website: http:www.peaceforageseed.ca

1.4 Estimating Environmental Parameters

Seeding prescriptions should indicate the species, varieties, seeding rate, application method and time of seeding. Knowledge of the seedbed and biogeoclimatic conditions are needed to determine these factors.

1.4.1 Seed beds

Seeding is used to vegetate sites, if there is already good plant cover on the site, then seeding may not be necessary and will probably fail. Adequate seed beds meet two conditions: 1) it must have reduced or eliminated competition from other plants for an initial period while the seeded species establish and 2) they should provide enough loose surface soil or ash for uniform, shallow, seed coverage and good seed-to-soil contact. Seed bed preparation is the process that damages or destroys competing vegetation and exposes mineral soil or provides an ash layer. In a forest setting, for example, seed beds are usually prepared by industrial activities such as logging, road construction, land clearing, mechanical site preparation for tree planting or natural occurrences such as wild fires or landslides.

Before the expense of seeding is incurred it is important to assess the seed bed to see if it is adequate for seed to establish. What is acceptable for exposed mineral soil or depth of disturbance is in part determined by the objectives of the seeding. For example, if seeding is used to entice livestock into an area they normally would not graze because of unpalatable native species, then a low percentage of good seed bed might be acceptable. A limited establishment of highly palatable species with the unpalatable native species would be acceptable and accomplish the goal. On the other hand, if the purpose of the seeding is to replace invasive plants such as scentless chamomile (*Matricaria perforate)* with domestic species such as meadow bromegrass (*Bromus biebersteinii*) then a high percentage of good seed bed is necessary. Different plant species also have different seedbed requirements or tolerances. Appendix 6.1 gives some information on the attributes of various species currently used.

Section 2.6 of the Procedures for Environmental Monitoring in Range and Wildlife Habitat Management, (here after referred to as the Procedures for Habitat Monitoring), outlines some of the requirements and methods of measuring seedbeds. Some key points that should be recorded are summarized below:

1. Before applying treatments that disturb the soil, record the plants present, their cover and vigour, coarse woody debris and the thickness of the forest floor. If, as is often the case, you are trying to assess the site for seeding after the treatment has occurred, this information can be collected from adjacent, untreated areas to give you an estimate of what the site looked like before treatment.

2. After the treatment the percentage of exposed mineral soil should be recorded as well as the condition of the seed bed. A visual estimate can be made of exposed mineral soil in terms of percentage of total area and a descriptive assessment of firmness and depth of disturbance. Additional information on seed bed assessment is presented in Section 4.10.6, #34 of the Procedures for Habitat Monitoring.

1.4.2 Biogeoclimatic regimes

Determining the biogeoclimatic classification before formulating a prescription is necessary because this factor determines the plant species used, variety, application rate, method and timing of seeding. This is done by first locating the site on a Biogeoclimatic Zone Map, then field verifying with the Field Guide to Identification and Interpretation of Ecosystems. For seeding prescriptions it is necessary to note micro site conditions such as the proportion of the site that is poorly drained, well drained, etc. Refer to Appendix 6.1 for a summary of regional moisture and climatic conditions.

Biogeoclimatic maps: Available at a scale of 1:250, 000 these maps are available in .pdf format at http://www.for.gov.bc.ca/hre/becweb/resources/maps/map_download.html and they provide a relatively detailed portrayal of the geographic distribution of the biogeoclimatic units. Biogeoclimatic linework is also available in digital format from the Land and Resource Data Warehouse (LRDW) so that it can be accessed in a variety of

ways using geographic information system (GIS) capabilities. The biogeoclimatic map should be referred to before leaving the office, but should not be relied on totally, especially if the area is near biogeoclimatic unit boundaries, in complex mountainous terrain, or in areas only recently accessible by ground.

1.5 Planning for Evaluation

Seeding programs are built on past experiences and the extrapolation of past experiences into new areas. Measuring your successes and failures will provide clear information on which to base future decisions. Evaluation methods involving less data collection are usually preferred for operational seeding. Common evaluation methods are described in:

- Procedures for Habitat Monitoring Section K (http://ilmbwww.gov.bc.ca/risc/pubs/teecolo/habitat/),
- Field Guide to Nodulation & Nitrogen Fixation Assessment, Appendix 6.2.

When assessing seeding remember:

- A photographic record easily documents what is happening.
- Yearly assessment is not necessary. Seedings often do not reach their potential until year 2 or 3, so assessment in the first couple of years is important but after establishment it is often adequate, depending on goals, to assess the site every 3 to 5 years.
- Assessment should be in terms of percent of seeding area and percent cover where the plants established.
- Assess rhizobium infection of legumes including evidence of active nitrogen fixation.
- For erosion control, evaluate fine material loss, siltation, sloughing and failure.
- Have an information handling system planned such as a spreadsheet so that data can be easily organized, stored and presented in a form that allows for analysis and interpretation.

2. SEED BEDS AND TIMING

2.1 Seed Bed Preparation

Much of the success or failure of a seeding project can depend on seed bed preparation. A good seed bed is characterized by:

- Loose granular soil on the surface and a firm, but not compacted subsoil. Never seed on a hard crusted surface, unless mulch is used to cover the seed.
- Moisture present in the subsoil and preferably in the surface. If precipitation is expected in a few days, seedlings have been successful when the surface soil is dry, if there is moisture in the subsoil.
- Exposed mineral soil for seed germination. Mixing of the organic (duff) and mineral soil also make a satisfactory seed bed for planting.

- A rough surface for broadcast seeding. The first moisture will assist in washing and covering the seed with soil material.
- Sufficient nutrients available for establishment. Deep disturbance, which exposes the subsoil usually requires fertilization for good establishment of seedlings.

2.2 Specific Seed Bed Preparation for Different Types of Denuded Areas

1. Haul Roads (Cutslopes, Fillslopes, Borrow, Waste and Sidecast Materials)
    - Leave cutslopes rough, don't blade with a smooth surface.
    - Vary the treatment of cutslopes:
        1. Cutslopes in unconsolidated soil material with slope ratios flatter than 1 1/4 to 1 can be grass-legume seeded without mulching.
        2. Cutslopes in consolidated soil material with slope ratios of 3/4 to 1 1/4 to 1 should be mulched when grass seeded.
        3. Cutslopes in unconsolidated soil with slope ratios of less than 3/4 to 1 and cutslopes in consolidated bedrock should not be grass-legume seeded or mulched.
    - Fertilize if nutrients are insufficient for seeding establishment, this is especially true for cutslopes and excavated borrow areas.
    - Seed as soon as possible after disturbance.
2. Permanently & Temporarily Abandoned Roads, Skid Roads & Landings
    - Rip or scarify compacted road surfaces and landings and/or overburden recontour and respread topsoil respectively if possible.
    - Seed at the time of disturbance.
3. Skid Trails, Fireguards and Logging Disturbed Areas
    - Usually will not need any site preparation if they are seeded as soon as possible after disturbance and, if within the realm of site degradation, overburden respread should be prescribed.

2.3 Time After Site Disturbance

Seeding should be done as soon as possible after the disturbance. The longer disturbances are left unseeded the more chance there is for soil erosion, site degradation, and the occupation of the site by unwanted vegetation. One practice that is sometimes used is the attachment of seeding equipment onto site disturbing equipment. For example, a seeder can be attached to implements used for ripping. This practice seeds at the most suitable time, immediately after the disturbance, and saves on the cost of applying the seed. If seeding cannot be done during the disturbance process it should be done as soon as possible afterwards.

2.4 Soil and Temperature Requirements

Seed requires adequate soil moisture and temperature to germinate. After germination young seedlings can be killed by drought, frosts or excessive moisture or ponding.

Timing of seeding must allow for germination and adequate growth before adverse conditions such as killing frost or drought occur.

2.5 Seeding Seasons

The preferred time to seed is during, or immediately after, a site disturbance. If the timing of the disturbance cannot be planned, or seeding has to be delayed, then consider the attributes of the following three seeding periods or seasons.

1. **Spring** (March to early June)
   Seeding can begin as snow leaves the site (April-May), thus providing adequate moisture. Later in the spring (June), there is a possibility that high temperature and drought may limit success of the seeding. There is some initial indications that legumes do better when seeded in this season than in the winter or dormant season (Brooke, B.M. and Holl, F.B., 1988), but field observations of winter seeding of legumes in this region have not verified this research.

2. **Late Summer** (August)
   When seeding at this time the goal is to have the seed applied, germinated and up about five or more centimeters before killing frosts occur. There is usually adequate moisture and suitable temperatures. There is some risk in seeding early in the season (July), as the seed may germinate then die in subsequent droughts. If seeded during drought, then the seed will lay dormant until adequate moisture is available for germination. If the dormant period is excessive and the seed is in direct sunlight, then there will be a loss of germination and a loss of rhizobium on inoculated legumes. Later in the fall, such as in September, there is a risk that frosts may limit success of the seeding. Spring and Dormant season seeding are lower risk in the Peace Liard and are therefore preferred.

3. **Winter or Dormant Season** (late October to March)
   This usually involves seeding on top of the snow. When seeding at this time the goal is to have the seed germinate in the spring as the snow melts. There are often less demands on time during this season, making seeding a good winter field exercise. There are some preliminary indications that legumes may not do as well when seeded during this season, (Brooke, B.M. and Holl, F.B., 1988), but field observations of winter seeding of legumes in this region have not verified this research. Grasses do very well when seeded during the winter.

3. APPLICATION METHODS AND SEEDING RATES.

3.1 Application Methods

The method used to spread the seed on the disturbed ground will depend on the conditions of the site, the goal of the seeding and the time and money available to do the seeding. Seed has to be sown or spread on the disturbed site. There are numerous ways

to accomplish this, from hand scattering seed to using hydro seeders and cyclone seeders slung from helicopters (Table 2).

1. **Hand seeding**
   When there are small areas of disturbance to be seeded it can be convenient to simply hand sow seed. One method of doing this is to place seed in a small bucket and, taking handfuls of seed, attempt to evenly spread the seed with side to side motions. It can be quite difficult to accurately apply a specified rate of seed using this method but for small sites the convenience often outweighs this problem. If you are traveling into an area where there have been a lot of small spots of disturbance take a bag of seed and hand sow the sites. For example if a contractor has been sent up to clean culverts taking a bag of seed along and hand seeding during the inspection will stabilize disturbances, minimize erosion and weed problems and improve the aesthetics.

2. **Personal cyclone seeder**
   This type of seeder is often referred to as a belly grinder as the seeder is held by a strap against the belly and a handle turns a cyclone spreader. This type of seeder comes with instructions and charts and can be calibrated accurately. The calibration of the seeder should be checked each time the seed mix is changed, the person doing the seeding is changed, and periodically while seeding. The advantage of this application method is the ability to seed any terrain that can be walked on with a fair degree of accuracy. The method is limited in the amount of area that can be covered. This method is a good choice for seeding small areas of road maintenance, landings, etc., usually less than 2 ha., when terrain is very rough.

3. **Seed boxes and spreaders attached to disturbance equipment**
   Rippers, rotor tiller mulching equipment, brush blades and other implements used to site prep, rehabilitate, or disturb sites can have seeders attached that allow for seeding at the same time the disturbance occurs. This method is excellent in that it applies the seed at the most appropriate time, immediately after the disturbance, and reduces the application costs. Usually the equipment operator has a solenoid switch that allow him/her to operate the seeder from the normal operating position. The preferred method would be to broadcast the seed as dribbling or drilling seed will leave a substantial area unseeded.

4. **Motor driven cyclone seeders**
   This type of seeder usually consists of a medium sized hopper capable of carrying approx. 25 to 50 kg. of seed and a small motor, usually electric running off a 12 volt battery, that drives a cyclone. The seeders are mounted on the back of pick-up trucks or on trailers that can be pulled by trucks or ATVs. The seeders come with instructions and charts for calibration. These seeders are a good choice for seeding medium sized sites, up to 5 hectares, and groups of small sites that are

accessible by vehicles. This type of seeder is also used to seed fence right of ways and other linear disturbances.

5. Air blast seeders

This type of seeder consists of a seed hopper capable of holding 100 + kg. of seed and a blower that directs seed through a gun like device that is pivoted and allows for the direction of seed over distances of 5 to 8 meters. The seeders are often mounted on trailers and are sometimes mounted for fitting in a back of a pick-up. The seeders come with instructions and charts for calibration. This type of seeder is excellent for seeding road sides, skid trails and landings when the terrain is relatively flat. Seed blown on dry with this type of seeder will not stay on steep road cuts. In general dry seeding is limited to slopes 2:1 or less.

6. Hydro seeders

Hydro seeders come in many shapes and forms. This type of seeder consists of a tank where a slurry, which may contain a soil binder, fertilizer, mulch and seed is kept in suspension by some form of agitation. The tanks can range from 100 to 3000 gallons. A volume pumping system is used to apply the slurry to the sites. As with the air blast seeders, application is through a gun that can be moved to direct seed over a range of area. This type of seeder is used primarily for road side seeding as it gives good results on road cuts. Hydro seeders have also been slung from helicopters and used to seed steep sensitive areas after wildfires. Refer to Carr, W.W.,*1980,* for additional information.

7. Helicopter slung cyclone seeders

This type of seeder consists of a seed hopper that is capable of holding 150 to 200 kg. of seed. Below the hopper is a gas motor that drives a cyclone that spreads seed in a swath, (usually 15 to 20 meters). The seeder is slung from a helicopter and the helicopter usually flies 15 to 50 meters off the ground at speeds between 30 and 60 km/hr. At flight speeds of 50 km/hr it is possible to seed up to 100 hectares an hour and over 600 hectares in a day. At a seeding rate of 10 kg/ha this would mean seeding 1000 kg of seed per hour with a capability of applying over 6000 kg of seed in a day. At seeding rates 4 to 6 kg/ha , (interim grazing rate), it takes twice as long to apply the same volume of seed but the area covered is the same, 100 ha/hr, (the volume of seed is 400 to 600 kg/hr instead of 1000 kg).

This type of seeder is used when there is a lot of work to be done including large collections of small sites such as skid trails and landings and large sites such as cut blocks. Large acreages and large volumes of seed are involved and goals are dependent on the seeding rate therefore accurate calibration of this type of seeder is critical. It takes a minimum ground crew of 3 to swamp the seed, and the ground crew should be well briefed and equipped with hard hats and ear and eye protection.

Table 2. Summary of application methods, their appropriate uses, the time and cost required to carry out a project per hectare (ha) and some advantages and limitations to each method.

Method	Appropriate Use	Time (ha/day)	Advantages and Limitations	Estimated Costs ($/ha)
hand seeding	small areas of disturbance	1	can be done anywhere but only small areas	
seeders on disturbance equipment	when site prepping or ripping roads, landing skid trails - anywhere equipment is used	5	seeding is done at the most appropriate time, during the disturbance	55
motor driven cyclones	roads, landings, skid trails, fence lines, etc.	5	good for medium sized jobs	115
air blast seeders	primarily roads but can also be used on skid trails and landings	10	inexpensive way of seeding roads but slopes must be less than 2:1	75
hydro seeders	road cuts and steep sloped sensitive areas		best method for steep slopes	200 - 300
helicopter slung cyclones	cut blocks for interim grazing - when there are a lot of roads, trails & landings to do	100 - 1000	low cost and can seed a large area	45 - 110

3.2 Seeding Rates

There are thresholds in seeding rates, below or above which goals and economies may not be achieved.

Seeding rate is the amount of seed applied to a given area and is usually in kg/ha but can also be given in seeds per area (seeds/m^2, live pure seed LPS/1000 cm^2). It is important to remember that there is great variance in the weight of seed of various species. For example, timothy has 2.7 million seeds/kg whereas fall rye has about 40,000 seeds per kilogram. Applying 10 kg/ha of timothy seed would equate to applying 27 million seeds/ha or 2700 seeds/m^2 whereas applying 10 kg/ha of fall rye would equate to applying 40 seeds/m^2.

Seeding provides ground cover. The degree and density of the ground cover required to attain goals will be determined, in part, by the seeding rate. Seeding rates range from 2 kg/ha to 100 kg/ha. For interim grazing of cutblocks bare ground between seeded species is often desirable to allow for tree regeneration and planting sites. For this treatment a light seeding rate of 4 to 6 kg/ha can be used.

Seed beds influence seeding rate prescriptions. A well prepared seed bed will have a higher rate of germination and survival of seeded species and will allow some flexibility

in reducing seeding rates. The health, germination, viability and competitiveness of the seed should also be considered in prescribing seeding rates. The presence of weed seed, diseases and minimum percent germination allowed for seed is regulated through the *Seeds Act*. The allowable minimum percent germination for seeds commonly used in a forest setting ranges from 75% for Common No.1 Trefoil to 90 to 95% for most of the grasses used. Storage of seed can reduce this germination and a quick table top germination test with damp paper in a petri dish should be done to give an indication of germination. Decline in germination is to a certain extent dependent on the type of seed. Small hard seed like timothy tends to maintain its germination longer than large soft seed, like crested wheat grass. If there is a suspicion that germination has declined, then increase the seeding rate to compensate.

For erosion control, prescribed seeding rates range from 15 to 30 kg/ha and 30 to 80 kg/ha for hydro seeding. For interim forage production on cutblocks the rates should be significantly lower, from 4 to 6 kg/ha.

Some considerations in determining a seeding rate include:

- Goals of the seeding
- Rates indicated by research and operational experience
- Indications from advisers and referrals
- Site specific conditions or considerations
- **N**umber of seeds/kg of the seed in the mix. If using fall rye remember that because of its weight it will dramatically affect the application of other seed and should probably be applied separately.

4. FERTILIZATION AND SOIL TESTING

Severely disturbed soils are generally infertile lacking nutrients available for plant growth. Fertilizer applications of nitrogen (N), phosphorous (P), potassium (K) and possibly sulfur (S) are often needed for successful plant establishment.

Seeding and fertilizing is considerably more effective if done immediately after the disturbance and definitely more effective before the first rainfalls after that disturbance.

Rains after a disturbance (especially on fine textured soils) render the rough surface grooves smooth again with vertically inclined spillways. Some soils then form a smooth hard crust that seed and fertilizer bounce off of into a ditch or watercourse. For example, a bridge abutment or culvert installation that could have been dry seeded and fertilized for $200 now has to be hydroseeded for $2,000 because the hydroseeding provides the adhesion and the growth medium that was lost.

Extrapolate the cost to a whole road system or watershed project. Ponder the effect on siltation exposure time over vast land exposures.

4.1 Application Rates

Fertilization rates vary according to the level of nutrients needed for establishment with possible refertilization in 3 to 5 years to maintain plant vigor on the severely degraded sites. A soil test in areas of questionable fertility should be completed prior to commencing a large project.

Table 3. General fertilization rates for different nutrients on grass and grass-legume mixes.

Nutrient	Grass Mixes	Grass-Legume Mixes
Nitrogen (N)	50-80 kg/ha	10-50 kg/ha
Phosphorous (P_2O_5)	30-50 kg/ha	30-50 kg/ha
Potassium (K_2O)	50-75 kg/ha	50-75 kg/ha
Sulfur (S)	(soil test)	(soil test)

The standard recommended fertilizer application is 300 kg per ha of 13-16-10. This application rate would give 300 kg times 13% Nitrogen or 39 kg per ha of actual Nitrogen. A more concentrated fertilizer, such as 19-19-19 and 20-24-15, may be used at 200 kg per ha. Apply fertilizer by broadcasting on the soil surface at the time of seeding.

Safety Restriction - Slow release fertilizers (e.g., nitrogen in the form of Sulphur Coated Urea, SCU) and Coated Seed should not be applied within 3 m of watercourses. Large continuous slopes over water shall not be fertilized before a forecasted rain event or when ground is frozen.

General Rules of Thumb for Fertilizer Use

1. Seed and fertilizer should be stored in a dry location.
2. If fertilizer supplies are limited, apply fertilizer to critical locations such as large fills and cut banks, culverts and bridge sites.
3. Fertilizer application is usually done along with the seeding operation.
4. Initial fertilizer application generally requires a complete fertilizer (N-P-K) such as 20-24-15 or 19-19-19 applied at a rate of 200 kg/ha.
5. If legumes comprise a substantial proportion of the seed mix (greater than 30%), a lesser amount of N should be used, 10 - 50 kg/ha (N).
6. Another application of fertilizer within 3 to 5 years will help maintain plant vigour at critical erosion control sites and severely degraded soils.
7. Fertilizer used for hydroseeding should dissolve readily.

4.2 Soil Sampling and Testing

4.2.1 Soil sampling overview

A chain of events is required to develop a sound fertilization program. The first link in this chain is to gather a soil sample that represents the fertility status of, for example, landing respread material, road and skid trail contouring material, the top profile of a

degraded site, a backyard garden, a problem area in a larger agricultural field situation, or any large area that will be site prescribed.

The purpose of this section is to help you develop a reliable sampling procedure to obtain a valid soil sample. Remember that a good fertilization program requires that:

1. Soil samples be analyzed by an approved laboratory.
2. The most advantageous fertilizer or soil amendment ingredients be selected.
3. Recommendations in the soil test report be converted into rates of actual fertilizer.
4. Fertilizer and/or soil amendments be applied to the soil in a manner that will maximize its efficient utilization.

A soil analysis obtained from a recognized laboratory using valid scientific tests is the most reliable method to assess the fertility status of a soil, and its fertilizer and amendment requirement. A sound management program should maintain optimum soil productivity and economic returns over an extended period.

A soil test can be used to determine if a soil has levels of plant nutrients adequate for optimum growth and relates best to domestic grasses and legumes. Soil analysis is a valuable management tool and soil test reports should be kept as required over time to enable you to follow fertility trends.

Soil samples can be taken and analyzed at any time during the year. Plant available levels of phosphorus, potassium, magnesium, calcium, micronutrients, and the soil's lime requirements usually do not fluctuate significantly unless important additions have been made to the soil.

If there is an area of concern, then it is usually best sampled when acute symptoms are shown. A sample from the affected as well, as one from an adjoining area, showing good growth should be submitted to help identify the problem.

The information in your soil test reports has future value as it allows you to follow soil fertility trends over time. This means you can maintain or improve soil fertility. To obtain this information site specific sample areas must be sampled on a maintenance schedule. They should be carefully identified on the reclamation planning map using the same identification for a site year after year.

For most situations, samples are taken to a depth of 15-20 cm (6-8 inches). Plants obtain part of the nutrient requirements from below this layer and, therefore, the fertility of the soil at depth is of consequence. Soils with lower levels of available plant nutrients at depth could require higher fertilization rates. On the other hand, a soil well supplied with plant nutrients at depth may require smaller quantities of fertilizer.

Although it is worthwhile to determine the fertility level of the soil at depth, it is suggested this need only be done once as it will not vary appreciably over a five year

fertilization period. Generally, the fertility at depth will be affected only when an excess of plant nutrients is applied and gradually moves through the soil profile.

4.2.2 Procedure for soil sampling and testing

1. Obtain sample boxes and information sheets from private labs or fertilizer dealers.
2. Gather the following clean sampling equipment:
   - sampling probe, auger, spade or shovel;
   - a plastic bucket to hold the sample cores before mixing.
3. On the planning map identify each site with a number or letter.
   - A sampling field may vary in size from a landing to a complete watershed (landing and road deactivation) project; typically it will be 1 to 10 ha.
   - Areas which are different in appearance, slope, drainage, soil type, past fertilization or reclamation practices should be sampled separately.
4. Take a minimum of 5 samples (from a landing) and preferably 10-20 samples from a deactivated road. The samples should be taken from areas in the project that are reasonably uniform and are expected to be fertilized as a unit.
   - Whether a soil sampling tube, auger, shovel, spade or trowel is used to actually collect a soil sample is immaterial. Under certain conditions some tools are more convenient than others. If your soil is not too stony, a soil sampling tube (T-bar) is probably the most precise, rapid and convenient.
   - Avoid contamination and use clean, rust-free implements.
5. Clean the soil surface of plant residues.
6. When using a sampling tube, push the probe into the soil to a depth of about 20 cm (8") and collect samples.
7. When using a shovel (or trowel, etc.), dig a V-shaped hole and take a 2 to 3 cm (1") slice to sampling depth. Trim away the sides, leaving a 2-3 cm (1") centre core and collect these samples.
8. Whatever procedure is followed, collect samples in a clean plastic bucket. Mix the 20 or so samples very thoroughly, remove large stones and keep enough to fill the soil sample box (about ½ kg or 1 lb. of soil) to form the composite sample.
9. Do not sample near burn piles, old manure pile locations, fertilizer bands or livestock droppings.
10. Identify the soil sample carefully, fill out a corresponding sample information sheet and attach it to the outside of the soil box. Do not place the sample information sheet inside the sample box as soil humidity will make it unreadable.
11. Identify and keep a record of each sample location so that you know which field should receive a particular fertilization.
12. Wrap the samples carefully before shipping. If you are sending several samples, pack them in a box and ship them together, as you will save in shipping costs and obtain results simultaneously.
13. Although air-dried samples are preferred, they are not mandatory. If samples cannot be air-dried, place each composite soil sample in a plastic bag which is then inserted into the sample box. Field-moist samples should be shipped by bus. Samples sent by mail should be air-dried before shipping. This can best be done

by spreading the composite sample on a clean plastic garbage bag and stirring the soil periodically.

5. PLANT SPECIES

5.1 Native Species

The use of native plant species for seeding projects in the Peace Region has been limited to small, environmentally-sensitive areas. However, there are large tracts of land in the Muskwa-Kechika Management Area and along main watercourses in the Peace Region where native seed is recommended (Figure 1). Seed mixes of native plants can be used to help maintain ecosystem integrity and areas reseeded with such mixes are aesthetically more pleasing because they fit well into the surrounding landscape. Seeding disturbed sites with native species reduces the adverse effects on biodiversity that result when domestic plants are used.

5.1.1 Native grasses and forbs

Native grasses and forbs can be used in the same situations and applications that are appropriate for the use of domestic species. The benefits to using native grass and forb seed in your project are:

- native grasses and forbs provide a good source of forage for both domestic livestock and wildlife,
- at high elevations, native species are adapted to the short, harsh growing seasons where domestic grasses do not grow well, and
- native grasses and forbs are generally better adapted to low nutrient conditions and need fewer inputs to establish and maintain a vigorous stand.

One problem with using native species is finding an inexpensive and local source of seed. As the demand for seed of native plants has increased, seed sources for these plants have developed. There are several seed vendors in the Peace area who provide native seed. The Peace Region Forage Seed Association maintains a current list of seed venders available within the Peace area: http:www.peaceforageseed.ca. There are also many forage seed growers who could grow native seed on contract, given the appropriate amount of time. It is always preferred to use seed grown as close to the disturbed area as possible to ensure the best climatic suitability and to reduce the introduction of new invasive plant species. Another option is to collect native seed from an area, ideally before the area is disturbed, and use that seed to revegetate the area after disturbance.

Establishing native grasses and forbs is very similar to establishing domestic species. Seeding methods are similar although it is important that small-seeded species be seeded shallow. Seed is often broadcast onto the soil surface and then harrowed if possible. In general, native grasses and forbs do not compete well with non-native or weedy plants, so it is important to seed them immediately after a disturbance. Site preparation to remove

weedy species is essential and application of fertilizer should be avoided on all but most severely degraded sites, because it may encourage the growth of weeds.

5.1.2 Revegetating with shrubs

See appropriate sections of Soil Rehabilitation Guidebook

http://www.for.gov.bc.ca/tasb/LEGSREGS/FPC/FPCGUIDE/soilreha/rehabtoc.htm

http://www.for.gov.bc.ca/tasb/LEGSREGS/FPC/FPCGUIDE/soilreha/app2.htm

http://www.ducks.ca/conserve/programs/nativeplants/product.html

Native shrubs can be used in environmentally-sensitive areas such as wetlands, recreation areas and grasslands. Several characteristics of shrubs make them useful additions to your seed mix, especially when combined with grasses and forbs.

1. **Erosion control**
   Shrubs have deep woody roots which give mechanical support to slopes. When planted with grass, they can help to prevent sloughing of the shallow sod layer. The woody top growth of shrubs can also help to stabilize reclaimed areas by reducing the surface wind velocity and its associated erosion.

2. **Wildlife habitat**
   Shrubs provide a good source of food and protective cover for wildlife. Ungulates make use of many species of shrubs as browse, especially during winter when other food sources are buried beneath snow.

3. **Aesthetics**
   Shrubs are very useful for screening areas of activity from public view and for softening the harsh lines of disturbed sites.

Shrubs can be grown either from seed or from cuttings. Collecting a variety of cuttings from the area surrounding a site is an effective and inexpensive way to include shrubs in your seeding project. The following describes principles and techniques used in the growth of shrubs from cuttings as applied to small projects.

1. Shrub selection

- Shrubs used in your project should be "pioneer" species, which are specifically adapted to invading an area after disturbance. They are tolerant of low moisture and nutrient conditions, and can withstand the temperature extremes typically experienced on disturbed sites. The best way to identify pioneer species is to look at areas of old disturbance near the site of your project. The plants growing on these sites will have the greatest chance of success as reclamation species.

- Shrubs should be planted in areas with climatic conditions similar to the areas where they were originally grown. As a rule of thumb, seedlings should be planted within about 150 m (500 ft) elevation of where they were originally grown.
- Consider the influence of aspect (direction of slope). Shrubs grown on northern aspects are, in most cases, adapted to moist, cool conditions and would grow poorly on dry, south-facing slopes. Similarly, shrubs grown on southern aspects would have poor success on north-facing slopes. In general, however, if shrubs are taken from areas with natural vegetation similar to that adjacent to your project site, this type of problem can be avoided.
- Ease of propagation is a limiting factor in obtaining planting stock.
- Produce the desired effect (i.e., short or tall form, browse resistant, deep rooting).
- Shrubs should be adaptable to site characteristics - particularly soil moisture and fertility.

2. Propagation of shrubs

There are a number of different procedures for taking cuttings from the stems and roots of shrubs. The techniques described below should provide a high probability of success, although sometimes the best methods for a particular area or species must be determined through trial and error.

a. **Hardwood stem cuttings (eg. Cottonwood, willow, red osier dogwood)**

Hardwood cuttings may be taken during the autumn or early spring from dormant shoots of the past year's growth of deciduous species.

- Cutting procedures - cuttings should:
  - be taken with a sharp knife or good quality shears;
  - clean cuts with un-split ends;
  - have a length of 15-20 cm or more, with the lowest cut 2 cm below a bud and the upper cut 2 cm above a bud;
  - have a mid-stem diameter of 1-2 cm minimum;
  - have at least two healthy buds.
- Planting procedures:
  - timing: ideally planting should take place in the autumn immediately after leaves have changed colour or after snowmelt when moisture stress is low;
  - planting system: dependent upon species selection, planting pattern, and desired species frequency. In general, grid plant on a 1 m x 1 m spacing;
  - linear plant with higher plant density with rows spaced 2 - 10 m apart
- Planting depth:
  - cuttings should be planted with as little stem exposed as possible, usually with the upper bud slightly above the soil surface;

- cuttings must be firmly planted in the ground as vertically as slope will allow, so that it cannot be readily moved or pulled out.

- Survival rate:
  - in general, 30 - 50% mortality can be expected with direct cuttings.

b. **Softwood stem cuttings (current year's growth of deciduous species)**
Softwood cuttings should be taken from leafy slips of the present year's growth of deciduous species. They should be 10 to 15 cm long with all but the top few leaves stripped off. The cuttings should be planted with the lowest leaf about 3 cm above the soil surface. The leaves stimulate rooting but can lead to the drying out of the cutting. In nurseries, these types of cuttings would normally be shaded in tent. Since this will most likely not be practical, this method should only be used on moist or shaded sites.

c. **Evergreen stem cuttings**
Evergreen cuttings (from broadleaf evergreen and coniferous species) should be treated in the same way as softwood cuttings but must be prepared and planted in the early fall, after the first frosts. Cuttings may be taken from coniferous species such as juniper, or from broadleaf evergreens such as kinnikinnik. Pine, fir, balsam and spruce do not root well.

d. **Root cuttings**
Root cuttings may often be taken from shrubs which have been uprooted by construction. They should be taken from young roots of about pencil thickness and cut into 5 to 8 cm lengths. Cuttings should be planted about 5 to 8 cm deep either horizontally or vertically, with the end cut from nearest the stem placed uppermost. This end will sprout and grow new stems.

The successful rooting of stem cuttings can be aided by wounding the base of the stem. This can be done by crushing or cutting with a knife so that the bark is broken in several places. The wounded area can then be treated with a rooting hormone to stimulate root initiation. Powdered hormone preparations are commercially available under names such as "Rootone" and "Seradix".

3. Planting and Installation

a. **Planting of rooted cuttings**
The following have been successfully propagated by the Ministry of Forests, Lands and Natural Resource Operations and are appropriate for northeastern BC:

Rubus spectabilis	salmonberry
Cornus sericea	Red-osier dogwood
Rubus parviflorus	Thimbleberry
Spirea douglasii	Pink Spirea, Hardhack

Vaccinium parvifolium	Red huckleberry
Symphoricarpos albus	Common snowberry
Betula papyrifera	Birch
Rosa sp	Rose
Alnus sp.	Alder
Lonicera involucrata	Twinberry
Sambucus racemosa	Red elderberry
Salix spp.	Willow

- Root cuttings may be planted in a container or as a bare root.
- Obtain planting stock from local commercial nurseries.
- Both container and bare-root stock have proven very successful in planting operations. Although bare-root stock is less expensive, container stock is easier to handle and offers a longer planting season.
- Planting procedures:
    - timing: planting is preferred during the dormant season (October-March), but may be extended into May-June if moisture stress is not a critical factor (frozen ground may prevent successful planting during the dormant season).
    - planting system: dependent upon species selection and desired frequency. Both grid and linear planting patterns are possible.
- Survival rate may exceed 90% if proper species selection and time of planting are observed.
- Precautions must be taken to not allow the planting material to dry out during handling prior to planting.

b. **Methods for slope protection and stabilization**

Vegetation protection techniques use live or dead plant parts (stem and branches) which are inserted, driven, buried in the ground to control erosion, minimize shallow sliding, protect erosion control structures, and to provide a favourable environment for the establishment of a permanent vegetative cover. If these techniques are being considered a bioengineering manual should be consulted.

1. Live Staking

Live staking is suited for persistent wet areas – on road cut and fill slopes, and bare soil surfaces on slumps and earth flows. Sites best suited to staking are the floors and banks of small incipient gullies, sediment fill behind - creek dams, bare gully banks, berms of water bars, and areas just below water bar outlets. Live staking can also be employed in conjunction with porous revetments, such as willow cuttings inserted or driven through the interstices or openings in gabious and riprap. This may also help to blend the wall into the surrounding landscape.

2. Wattling

Wattling consists of placing bundles of suitable plant materials in shallow trenches on contour on either cut or fill slope. Wattling is most effective on loose surface soil with sheet or small gully erosion and functions to stabilize surface soil layers and vegetation establishment.

- **Wattle bundle preparation**
  - a wattle bundle resembles a cigar-shaped bundle of alternating twigs with slender tips extending 40 cm beyond the larger butt ends.
  - brush stems are 5 cm or larger in diameter; 1 m and longer in length (approximately 3 m long is best).
  - the bundle is compressed to approximately 20 cm in diameter and tied every 30 to 40 cm.
  - material should be in leaf, or if not, straw or forest litter should be incorporated into the bundles .

- **Procedures for wattling a bare slope**
  1. Perform a site survey to determine need for slope preparation and to determine the location of suitable plant materials.
  2. Prepare the slope by constructing or repairing water drainage structures and ditches. Round off the slope or scale failing materials.
  3. Install wattles working from the bottom to the top of the slope. Space the wattles 3-10 m apart. Actual distance apart must be determined on a site specific basis. The more erodable a slope, the closer the wattles are spaced.
  4. Stake on contour, use an Abney or Suunto type level. Contour staking is of particular importance on wide slope with erodable soils. Stakes should be about 40 to 60 cm long, placed about 50 cm apart and driven to a firm hold.
  5. Trench above the stakes to 1/2 the diameter of bundles. Material dug from the trench should be wasted down-slope to cover lower wattles.
  6. Bundles are placed in the trench. Stake success bundles together by driving stakes through the bundles close to bundle ties.
  7. Cover the bundle with soil; tamp the soil firmly into place, walk along bundles to add additional tamping.

8. Interplant with shrubs and grass seed where appropriate.

6. SEED MIXES

6.1 How To Formulate Seed Mixes.

Some of the things considered when formulating seed mixes are:

- Goals for the seeding project.
- Characteristics of various plant species that will assist in obtaining goals. (e.g., quick establishing, deep rooted, nitrogen fixing, etc.).
- Characteristics of specific varieties of species that make them particularly suitable to the situation or site to be seeded.
- Alternate species and varieties that can be used.
- Price of the different species and varieties.

Goals for seeding. One, all or any combination of the following goals can be the objectives of a seeding project.

- Erosion Control
- Weed control
- Site enhancement through the addition of nitrogen and organic matter and improving soil structure.
- Displacement and replacement of unwanted vegetation.
- Improving the site for integrated resource management by increasing and or improving its forage producing capabilities.

Characteristics of plant species.

Some of the characteristics that are considered when choosing plant species are:

- Rooting profile of the species.
- Nitrogen fixing ability.
- Growth nature of the plant and its ability to provide ground cover, i.e., creeping rooted, mat forming, tufted, or bunch plants.
- Ability and rapidity of establishment.
- Aggressiveness of the plant and its ability to occupy a site.
- Persistence of the plant, i.e., how long will it live and will it produce seed and maintain itself on the site.
- Height of the plant and its ability to snow press conifers.
- Forage quality and yield.

These characteristics are summarized in Appendix 6.1.

Alternate species and varieties and seed prices.
There are hundreds of species and varieties to choose from for seeding prescriptions. For example, there are 6 species and 86 varieties of fescues registered in Canada.

Some considerations in choosing alternate species and varieties are:

- Specific site characteristics such as soil acidity and drainage have to be matched to species and variety characteristics.
- Special attributes of varieties such as winter hardiness or alkaloid levels.
- Supply of seed. Supply can be dramatically effected by growing conditions and pest and disease outbreaks in seed producing areas. For example, extended droughts over large areas can have dramatic effects on seed prices.
- Demand on seed from large users such as the agriculture sector or golf courses can have a dramatic impact on seed prices.

Generally an alternate species or variety of seed can be found and ordered.

Mix formulation
Seed mixes are usually formulated by developing a legume and a grass component.

Legumes are used to fix or add nitrogen, improve soil conditions with their root development, prevent weed infestation and provide quality forage. Grasses are used to displace or replace unwanted vegetation including weeds, reduce erosion by providing cover for the interception of rain, stabilize sites by adding organic matter to the soil and providing a root profile through the soil stratum and enhance the site for integrated management by improving the forage production.

Legumes should always be included as enhanced nitrogen fixation is beneficial on most sites, (enhance nitrogen fixation is dependent on proper inoculation of the seed with rhizobium bacteria, see section 6.3 and 6.6 for instruction on specifying inoculation and checking inoculation on seed orders). Grasses can be left out of the mix if a problem with unwanted vegetation is not expected and the native plants present will prevent erosion and provide forage production.

Generally two to three legumes are included. A quick establishing short lived legume such as alsike clover occupies the site quickly and provides nitrogen shortly after the disturbance. Longer lived, persistent legumes like birdsfoot trefoil occupy the site and provide nitrogen fixation in the medium term. Long term occupation of the site is usually woody species with nitrogen coming both from fixation and debris. Legumes have different rooting profiles. For example, white clover has a shallow tap root and stolons that allow it to form a mat and is beneficial for preventing surface erosion. Birdsfoot trefoil has a tap root and is beneficial in enhancing degraded sites by improving soil structure characteristics such as porosity and organic matter.

When choosing a grass species consider the quickness to establish, the height, the rooting profile, the aggressiveness, the winter hardiness, the persistence and the forage qualities. If erosion is predicted to be a problem it is prudent to include a deeper rooted bunch grass such as timothy or orchard grass to give a better rooting profile in the soil stratum.

6.2 Silviculture Mixes, Vegetation Management and Rehabilitation of Roads and Landings.

Revegetation for silviculture or vegetation management purposes is very rare in the Peace-Liard area. For information on seeding for these purposes please contact the Ministyr of Forests and Range regional silviculture specialist.

Rehabilitation Of Roads And Landings.
Roads, landings and skid trails are sites that require special attention in reforestation practices. There are three procedures to consider in rehabilitating roads, skid trails and landings: mechanical treatment (ripping), re vegetating the site through seeding, and planting the site to produce fibre. In prescribing for a particular site generally all three procedures should be considered. M**inimizing the area of roads, skid trails and landings is very important.**

6.3 Native forage species recommended for revegetation calculation of seeding rates

(refer to Appendix 6.3 where native species would be applied on Crown land within Peace Forest District)

	Common name	Latin name	Seeds per gram	grams for 2000 seeds	kg/ha rate to obtain 2000 seeds/m^2
Wet sites					
	Fowl blue grass*	*Poa palustris*	6,957	0.28748	2.8
	Tufted hair grass	*Deschampsia caespitosa*	5,510	0.362976	3.6
	Hair tickle grass	*Agrostis scabra*	11,000	0.181818	1.8
	Slough grass	*Beckmania syzigachne*	1,603	1.247661	12.4
possible	Bluejoint	*Calamagrostis canadensis*	8,460	0.236407	2.4
possible	Whitetop/Rivergrass/ Spangletop	*Scolochloa festucacea*	386	5.181347	51.8
Medium to Dry sites					
	Fringed brome	*Bromus cilatus*	520	3.846154	38.5
	Tufted hair grass	*Deschampsia caespitosa*	5,510	0.362976	3.6
	Slender wheat grass	*Agropyron trachycaulum*	353	5.665722	56.7
	Rocky Mtn fescue	*Festuca saximontana*	1,050 to 1800	1.9 to 1.1	11 to 19
	Green needle grass	*Stipa viridula*	360 to 400	5.6 to 5.0	50 to 56
	Violet wheat grass	*Agropyon violaceum*	225 to 350	8.9 to 5.7	57 to 89
	Glaucous blue grass	*Poa glauca*	2,910	0.687285	6.8
possible	Hairy wildrye	*Leymus(=Elymus) innovatus*	390	5.128205	51.3
possible	June grass	*Koelaria hacrantha*	3,300	0.606061	6.1
possible	Northern wheatgrass	*Agropyron dasystachyum (=Elymus lanceolatus)*	345	5.797101	58
possible	Indian ricegrass	*Oryzopsis hymenoides*	518	3.861004	38.6

* On private land, consult with the landowner prior to use or transport of Fowl blue grass. This species can be difficult to control and clean from forage seed grower's fields.

6.4 Forage Mixes.

Increase and Enhance Forage Producing Capabilities for Wild and Domestic Animals.

Livestock Forage Summary

Codes L = long lived, S= short lived, 1 = preferred, 2 = additional or alternate
3 = not recommended, D = dry sites

Legumes	Longevity	Livestock Objectives	Riparian Areas	Comments	Seeds / gram
Alfalfa	L	2D	3		485
Birdsfoot trefoil	L	1	3		925
White clover	L	3	3		1870
Cicer milk vetch	L	3	3		285
Red clover	S	1	1		605
Hairy vetch	S	?	?		440
Alsike clover	S	2	2	Not appropriate for horses	1500
Non-Native Grasses					
Crested wheat grass	L	2D	3		385
Chewings fescue	L	3	3		1400
Creeping red fescue	L	1	3		1355
Kentucky bluegrass	L	3	3		4800
Tall fescue	L	2	1	Winter kills (use forage varieties only, not turf varieties)	500
Sheep/hard fescue	L	3	3		1500
Red top	L	3	3		11000
Reed canary grass	L	3	3		1175
Meadow brome	L	1	1		155
Timothy	L	2	2		2700
Annual ryegrass	S	3	1		500
Perennial ryegrass	S	3	1		515
Orchardgrass	S	2	2		1440
Fall rye	S	1	1	Fall seeding & establishment	40

Example of a Seeding Rate Calculation using Livestock Forage Rank 1 species:

Species	% of mix	Pure live seed/ m^2	Mix pls/m^2	Mix seeds/m2 /seeds/ gram	Mix grams/ m^2 * 10000 m^2/ ha	Grams / 1000 = **kg per ha**
Birdsfoot trefoil	**35**	650	650 * 0.35 = 227.5	227.5 / 925 =0.25	0.25 * 10000 = 2500	2.5
Red clover	**15**	550	550 * 0.15 = 82.5	82.5 / 605 = 0.14	0.14 * 10000 = 1400	1.4
Creeping red fescue	**15**	550	550 * 0.15 = 82.5	82.5 / 1355 = 0.06	0.06 * 10000 = 600	0.6
Meadow brome	**25**	450	450 * 0.25 = 112.5	112.5 / 155 = 0.73	0.73 * 10000 = 7300	7.3
Timothy	**10**	1000	1000 * 0.1 = 100	100 / 2700 = 0.04	0.04 * 10000 = 400	0.4
Fall rye	**100**	240	240 * 1.0 = 240	240 / 40 = 6.0	6.0 * 10000 = 60,000	60

If a Pure Live Seed (PLS) percentage is not available, use the following formula:

% PLS = (% germination x % pure seed) ÷ 100

Example:

Meadow brome with 79% germination and 95% pure seed.

(79 x 95) ÷ 100 = 75% PLS

6.5 Erosion control Mixes.

Road construction and Maintenance, and the Protection of Unstable Sites & Soils

In areas with severe erosion hazard activities other than seeding should be considered.

Codes L = long lived, S= short lived, 1 = preferred, 2 = additional or alternate, 3 = not recommended, D = dry sites, W = wet sites

Legumes	Longevity	Perm Road	Temp Road	Pipe line	Range Improv ments (dugouts)	Riparia n areas (eg bridge crossings	Com ments	Seeds / gram
Alfalfa	L	2D	2D	2D	2D	3		485
Birdsfoot trefoil	L	1	1	1	1	3		925
White clover	L	3	3	3	3	3		1870
Cicer milk vetch	L	2D	2D	2D	2D	3		285
Red clover	S	1	1	1	1	1		605
Hairy vetch	S	?	?	?	?	?		440
Alsike clover	S	2	2	2	2	2		1500
Non-Native Grasses								
Crested wheat grass	L	2D	2D	2D	2D	3		385
Chewings fescue	L	3	3	3	3	3		1400
Creeping red fescue	L	1	1	1	1	3		1355
Kentucky bluegrass	L	3	3	3	3	3		4800
Tall fescue	L	2	2	2	2	3		500
Sheep/hard fescue	L	2D	2D	2D	2D	3		1500
Red top	L	3	3	3	3	3		11000
Reed canary grass	L	2W	2W	2W	2W	?		1175
Meadow brome	L	2	2	2	2	3		155
Timothy	L	3	3	3	3	3		2700
Annual ryegrass	S	1	1	1	1	1		500
Perennial ryegrass	S	1	1	1	1	1		515
Orchardgrass	S	3	3	3	3	3		1440
Fall rye	S	1	1	1	1	1	Fall seeding	40

*Smooth brome is considered invasive in native grasslands.

Example of a Seeding Rate Calculation using Erosion Control Rank 1 species:

Species	% of mix	Pure live seed (PLS)/ m^2	Mix PLS/m^2	Mix seeds/m2 /seeds/ gram	Mix grams/ m^2 * 10000 m^2/ ha	Grams / 1000 = **kg per ha**
Birdsfoot trefoil	**33**	650	650 * 0.33 = 214.5	214.5 / 925 = 0.23	0.23 * 10000 = 2300	2.3
Red clover	**33**	550	550 * 0.33 = 181.5	181.5 / 605 = 0.3	0.3 * 10000 = 3000	3
Creeping red fescue	**33**	550	550 * 0.33 = 181.5	181.5 / 1355 = 0.13	0.13 * 10000 = 1300	1.3
Annual or perennial ryegrass	**100**	600	600*1.0 = 600	600 / 515 = 1.17	1.17 * 10000 = 11700	11.7

If a Pure Live Seed (PLS) percentage is not available, use the following formula:

% PLS = (% germination x % pure seed) ÷ 100

Example:

Meadow brome with 79% germination and 95% pure seed.

(79 x 95) ÷ 100 = 75% PLS

6.6 Fire Hazard Mitigation Mix: Seeding Near Infrastructure

Codes L = long lived, S= short lived, 1 = preferred, 2 = additional or alternate, 3 = not recommended

Legumes	Longevity	Rank	Comments	Seeds / gram
Alfalfa	L	3		485
Birdsfoot trefoil	L	3		925
White clover	L	1		1870
Cicer milk vetch	L	1		285
Red clover	S	3		605
Hairy vetch	S	3		440
Alsike clover	S	3		1500
Non-Native Grasses				
Crested wheat grass	L	3		385
Chewings fescue	L	1		1400
Creeping red fescue	L	3		1355
Kentucky bluegrass	L	3		4800
Tall fescue	L	3		500
Sheep/hard fescue	L	1		1500
Red top	L	3		11000
Reed canary grass	L	3		1175
Meadow brome	L	3		155
Timothy	L	3		2700
Annual ryegrass	S	1		500
Perennial ryegrass	S	1		515
Orchardgrass	S	3		1440
Fall rye	S	3		40

Example of a Seeding Rate Calculation using Fire Hazard Mitigation Rank 1 species:

Species	% of mix	Pure live seed (PLS)/ m^2	Mix PLS/m^2	Mix seeds/m2 /seeds/ gram	Mix grams/ m^2 * 10000 m^2/ ha	Grams / 1000 = **kg per ha**
White clover	**30**	750	750 * 0.3 = 225	225/1870 =0.12	0.12*10000 =1200	1.2
Chewings fescue	**25**	400	400*0.25 =100	100/1400 =0.07	0.07*10000 =700	0.7
Sheep / hard fescue	**25**	400	400-0.25 =100	100/1500 =0.067	0.067*10000 =670	0.7
Annual or Perennial ryegrass	**20**	600	600 * .2 =300	600/500 =1.2	1.2*10000 =12000	12

If a Pure Live Seed (PLS) percentage is not available, use the following formula:

% PLS = (% germination x % pure seed) ÷ 100

Example:

Meadow brome with 79% germination and 95% pure seed.

(79 x 95) ÷ 100 = 75% PLS

6.7 Wildfire Rehabilitation

In areas with severe erosion hazard, activities in addition to seeding should be considered.

Codes L = long lived, S= short lived, 1 = preferred, 2 = additional or alternate, 3 = not recommended

Legumes	Longevity	Rank	Comments	Seeds / gram
Alfalfa	L	3		485
Birdsfoot trefoil	L	3		925
White clover	L	3		1870
Cicer milk vetch	L	3		285
Red clover	S	3		605
Hairy vetch	S	3		440
Alsike clover	S	3		1500
Non-Native Grasses				
Crested wheat grass	L	3		385
Chewings fescue	L	3		1400
Creeping red fescue	L	3		1355
Kentucky bluegrass	L	3		4800
Tall fescue	L	3		500
Sheep/hard fescue	L	3		1500
Red top	L	3		11000
Reed canary grass	L	3		1175
Meadow brome	L	3		155
Timothy	L	3		2700
Annual ryegrass	S	1	Short lived species are preferred to allow re-establishment of native plant community	500
Perennial ryegrass	S	1		515
Orchardgrass	S	3		1440
Fall rye	S	1		40

Example of a Seeding Rate Calculation using wildfire rehabilitation Rank 1 species:

Species	**% of mix**	Pure live seed (PLS)/ m^2	Mix PLS/m^2	Mix seeds/m2 /seeds/ gram	Mix grams/ m^2 * 10000 m^2/ ha	Grams / 1000 = **kg per ha**
Annual ryegrass	**33**	600	600*.33 =198	198/500 =0.396	0.396*10000 =3960	3.96
Perennial ryegrass	**33**	600	600*.33 =198	198/51 =0.384	0.384*10000 =3840	3.84
Fall rye	**33**	240	240*.33 =79.2	79.2/40 =1.98	1.98*10000 =19800	19.8

If a Pure Live Seed (PLS) percentage is not available, use the following formula:

% PLS = (% germination x % pure seed) ÷ 100

Example:

Meadow brome with 79% germination and 95% pure seed.

(79 x 95) ÷ 100 = 75% PLS

7. APPENDICES

7.1 Plant species. Their attributes and uses.
7.2 Field Guide to Nodulation and Nitrogen Fixation Assessment
7.3 LRMP native seed map
7.4 Summary of Climate data by biogeoclimatic unit for the Peace-Liard
7.5 An example of a seedlot certification analysis
7.6 Bibliography.

APPENDIX 7.1 - ATTRIBUTES FOR THE BWBS, SBS, & ESSF ZONES IN THE PEACE-LIARD FOREST DISTRICTS

The following tables do not represent all species available for revegetationin the Peace -Liard. The most current information on seed availability and tolerances should be sought from seed retailers.

Species	Use	Life Span	Winter Hardiness	Drought Tolerance	Flooding Tolerance	Salinity Tolerance	Alkalinity Tolerance	Acidity Tolerance	Rooting Profile	Preferred Moisture and Climatic Regimes	Growing Period	Positive Attributes	Negative Attributes
LEGUMES													
Alfalfa, *Medicago falcata Medicago media*	Hay and pasture	4 to 10 years	Good	Good	Low	Low to Moderate	Moderate to High	Low	Tap Rooted, creeping rooted	adapted to a wide range of climatic conditions, but does not survive extended flooding	Spring - Fall	Easy to establish, high yields, rapid regrowth. Highest nutrition of all forages. good N fixer and beneficial in enhancing degraded sites such as landings.	Bloat hazard. Needs good drainage. Up to 1 meter tall and can impact young tree seedlings. can be very competitive
Alsike clover, *Trifolium hybridum*	Hay and pasture	declines after 3 to 5 years	Good	Low	Moderate	Low	Low to Moderate	Moderate	Branched root but not creeping	Adapted to a wide variety of conditions, does well in low lying moist areas	Spring	easiest and quickest legume to establish used as a nurse crop for slower establishing species good soil improver and N fixer	Can be competitive on mesic to rich sites. Can be toxic to horses. Short life span and low yield
Birdsfoot trefoil, *Lotus corniculatus*	Pasture, roadside	Long	Good	Moderate	High	Low to Moderate	Moderate	Moderate to High	deep tap root with many side branches	requires a firm seed bed and prefers moist areas.	Spring to Fall	Non bloating. Reseeds itself. Long lived. Feed value similar to alfalfa.	Poor seedling vigour. Poor competitor and low yield.
Cicer Milkvetch, *Astragalus cicer*	Pasture	Long	Good	Moderate to High	Low	Moderate	Moderate	Moderate	Creeping Rooted	Widely adapted, but exhibits its creeping habit best on coarse textured soil	Late Spring to Fall	Non bloating. Hardier than alfalfa. Very aggressive once established.	Slow to establish. Slow regrowth after grazing.
Hariy Vetch, *Vicia villosa*	Hay and pasture, Bank stabilization	Short (annual or biennial)	Good	Good	Fair	Poor	Moderate	Low	Tap Rooted with many side branches	Prefers sandy soils. Winter hardy, but may die out if no snow cover.	Fall seeding	Good Nitrogen fixer. Good for soil improvement and bank stabilization.	Can be aggressive once established.
Red Clover, *Trifolium pratense*	Hay and Pasture	Short	Poor	Low	High	Low	Moderate	Moderate	Tap rooted with side branches	Best suited to humid areas with moderate temperature.	Spring	Easily established. Tolerates wetter and more acidic soils than alfalfa.	Causes bloat. Short life span. Can be competitive on mesic to rich sites.
Sweet Clover, *Melilotus alba, M. officinalis*	Hay and Silage	2 years (biennial)	Fair	Moderate to High	Low	Moderate	Moderate	Low	Tap rooted	Especially productive on fertile and well drained soil. Intolerant of water-logged soils.	Spring of second year	Good for drainage or sub-surface compaction improvement. Good Nitrogen fixer.	Low palatability unless harvested early. Self seeds. Tall and may cause problems for tree seedlings for 3 to 4 years. **Considered an invasive plant in Alaska**.
White Clover *Trifolium repens*	Pasture	Short to Long	Good	Low	Low to Moderate	Low	Low	Moderate	Rhizomatous	Requires a constant supply of moisture. Intolerant of prolonged flooding.	Spring - Fall	Will reseed. Resistant to grazing with good regrowth. Once established can be persistent. Forms a mat that is effective in preventing soil erosion and enhances surface soils.	Bloat hazard. Slow to establish. Shallow root system.

Species	Use	Life Span	Winter Hardiness	Drought Tolerance	Flooding Tolerance	Salinity Tolerance	Alkalinity Tolerance	Acidity Tolerance	Rooting Profile	Preferred Moisture and Climatic Regimes	Growing Period	Positive Attributes	Negative Attributes
NATIVE GRASSES													
Bebb's sedge *Carex bebbii*				Low	High	Low					Spring - Summer		
Bluejoint *Calamagrostis canadensis*				Moderate	High	Moderate	Low	Moderate	Sod Forming	Adapted to fine to Coarse textured soil on wet to mesic sites.	Spring	Good erosion control.	
Fowl bluegrass, *Poa palustris*				Poor	High	Moderate	Low	Moderate	Bunch Grass	Adapted to peat soils to clay on wet to mesic sites.	Spring - Summer		
Fringed brome *Bromus ciliatus*	Pasture	Perennial	Good	Moderate	Low	Low	Low	Moderate	Bunch Grass	Prefers mesic sites..	Spring - Summer	Effective for erosion control. Excellent forage species, palatable throughout season.	
Glaucous Bluegrass *Poa glauca*			Good	Low	Low	Low				Prefers coarse textured soils	Spring - Summer		
Green Needlegrass *Nassella viridula*	Pasture	Long	Good	High	Moderate	Low to Moderate	Moderate	Moderate	Bunch Grass	Prefers moist sites with good drainage. Performs best on medium to heavy textured soils.	Spring - Summer	Palatable and nutritious. Tolerant to drought and grasshopper damage. Good forage value through all stages of growth. Used for mine revegetation.	Easily overgrazed. Seed has high level of dormancy.
Hair ticklegrass, *Agrostis scabra*				High	Moderate	Low	Low	Moderate	Bunch Grass				
Hairy Wildrye *Elymus innovatus*				High	Moderate	Moderate	Low	Moderate	Bunch Grass	Adapted to a wide range of soil conditions.	Spring - Fall		
Indian Ricegrass *Achnatherum hymenoides*				High	Low	Low to Moderate	Low	Moderate	Bunch Grass	Prefers coarse textured, well drained soil.	Spring - Fall		
Junegrass *Koeleria cristata*	Pasture	Long	Good	High	Low	Low	Moderate	Low	Bunch Grass	Prefers Clay Loam soil types.	Spring - Fall	Highly palatable in spring and after curing in the fall.	Rarely eatend during the summer by livestock.
Northern wheatgrass *Elymus lanceolatus*	Pasture	Long	Good	Very High	Moderate	Moderate	Moderate	Low	Sod Forming	Prefers medium to coarse textured soil.	Spring - Fall	Suitable for erosion control. Easy to establish. Produces good ground cover. Good forage value through summer. Tolerant of heavy grazing.	Becomes wiry and unpalatable in the fall.
Rocky Mountain fescue *Festuca saximontana*	Pasture	Perennial	Good	High	Low	Low	Low	Low to Moderate	Bunch Grass	Prefers sandy soils to well drained loam.	Spring	Suitable for reclamation of high elevation disturbances. Erosions control on sandy or gravelly soils.	Overall forage production is low.

Slender wheat grass, Elymus *trachycaulus*	Hay and Pasture	Short	Good	Moderate	Low	High	High	Low	Bunch Grass	Prefers sandy loam soil.	Spring	High salinity tolerance. Palatable and nutritious at all stages. Good seedling vigou and fast establishment. Often used as a nurse crop with slower establishing species grasses. An important species for high-altitude land reclamation.	Less competitive and persistent than other wheatgrass. Not tolerant to close, heavy grazing.
Slough grass *Beckmannia syzigachne*				Low	High	High	Moderate	Low	Bunch Grass		Spring - Summer		
Tufted hiargrass *Deschampsia caespitosa*			Good	Low	High	Low	Moderate	Moderate	Bunch Grass	Grows in sloughs, moist draws, wet meadows, or stream banks. Prefers poorly-drained, fertile soil.	Spring – Early Summer	Tolerant of heavy metal contamination. Highly palatable and resistant to grazing.	
Violet wheatgrass *Agropyron violaceum*				High	High	Low	Moderate	Moderate	Bunch Grass				
White Top/ Rivergrass/ Spangletop *Scolochloa festucacea*				Low	High	Low to Moderate	Low	Moderate	Bunch Grass		Spring - Summer		

Species	Use	Life Span	Winter Hardiness	Drought Tolerance	Flooding Tolerance	Salinity Tolerance	Alkalinity Tolerance	Acidity Tolerance	Rooting Profile	Preferred Moisture and Climatic Regimes	Growing Period	Positive Attributes	Negative Attributes
NATIVE FORBS													
American Vetch *Vicia americana*	Pasture	Long	Good	Moderate							Spring to Summer		
Golden rod *Solidago canadensis*		Long	Good							Prefers mesic to moist sites.	Spring to Fall	Provides a rapid and complete cover for erosion control and persists in suitable areas. Good wild ungulate forage value.	Due to non-rhizomatous habit, it takes longer to spread. Poor livestock forage value.
Yarrow*Achillea millefolium*		Long	Good	High						Grows well on a wide range of climates.	Spring to Fall	Seeds exhibit great longevity in the soil seed bank.	Poor forage for cattle, may cause skin irritation, may be poisonous to horses.

Species	Use	Life Span	Winter Hardiness	Drought Tolerance	Flooding Tolerance	Salinity Tolerance	Alkalinity Tolerance	Acidity Tolerance	Rooting Profile	Preferred Moisture and Climatic Regimes	Growing Period	Positive Attributes	Negative Attributes
NON-NATIVE GRASSES													
Annual (Italian) ryegrass, *Lolium multiflorum*	Hay and Pasture	Short	Poor	Low	High	Low	Moderate	Moderate	Bunch Grass	Produces best on soils of medium to high fertility and grows best with adequate moisture.	Spring to Fall	Nurse crop for slower establishing species. Easy to establish. Very palatable. Makes good hay or sileage. Can be used for companion crop.	Does not withstand drought or hot weather.
Chewings fescue, *Festuca rubra commutata*		Long perennial							Sod Forming			broadcast burns have been seeded successfully. suppresses unwanted vegetation such as fireweed and thimbleberry on cutblocks.	
Creeping red fescue, *Festuca rubra rubra*	Pasture Lawn	Long	Excellent	Moderate	Moderate	Low	Moderate	Moderate	Sod Forming	Does best in high rainfall areas. Will grow in wide range of soil types, but prefers well disturbed seed bed.	Spring to Fall	Tolerates close grazing. Tolerates areas too dry for Timothy. Grows well late summer to freeze up and retains good quality.	High moisture requirement. Competitive problems noted, especially in moist soils. Vulnerable to crown and root rots and snow mold.
Crested Wheatgrass *Agropyron cristatum*	Pasture and Hay	Long	Excellent	Moderate to High	Low	Low to Moderate	Moderate to High	Low	Bunch Grass	Adapted to dry areas with good soils but will also establish on lighter soils.	Early Spring	Excellent for Spring pasture. Easy to grow. Withstands close grazing and trampling.	Does not tolerate cool, wet soils. Poor quality after heading out.
Fall rye, *Secale spp.*										More tolerant than other grains to soils low in acidity or fertility, high in clay or sand content, or poorly drained		a nurse crop that quickly establishes providing erosion and weed control and esthetic benefits	
Kentucky bluegrass, *Poa pratensis*	Pasture Lawn	Long	Excellent	Moderate	Moderate	Low	Low	Low	Sod Forming	Prefers cool and humid. Grows on moist soils. Very responsive to N fertilization	Spring to Fall	Tolerates close and frequent defoliation. Useful in erosion control.	Goes dormant in hot, dry weather. Slow to establish and can be very agressive. High moisture requirement. Lower yielding.
Meadow Bromegrass *Bromus biebersteinii*	Hay and Pasture	Long	Good	High	Low	Low	Moderate	Moderate	Bunch Grass	Well adapted to a wide range of soils.	Early Spring to Late Summer	Very palatable. Good regrowth after grazing or cutting. Less aggressive than Smooth Brome.	Mainly a pasture grass. Difficult to put up as hay when in pure stand.
Orchard grass, *Dactylis glomerata*	Hay and Pasture	Short	Fair	Moderate	Low to Moderate	Low	Low	Moderate	Bunch Grass	Prefers moist conditions. Sandy soils are too dry for good growth unless in high rainfall areas.	Spring to Fall	Easy to establish. Very palatable. Fast regrowth. Makes good hay with alfalfa.	Needs high nitrogen for good production. Only moderately winter hardy. Subject to overgrazing.
Perennial rye grass, *Lolium perenne*	Hay and Pasture	Short								adapted to a wide range of soils including heavy clay and imperfectly drained soils prefers medium to high fertility. Survives short		establishes quickly providing erosion and weed control may assist longer lived species to establish .	

										periods of flooding but is not very drought tolerant			

Species	Use	Life Span	Winter Hardiness	Drought Tolerance	Flooding Tolerance	Salinity Tolerance	Alkalinity Tolerance	Acidity Tolerance	Rooting Profile	Preferred Moisture and Climatic Regimes	Growing Period	Positive Attributes	Negative Attributes
NON-NATIVE GRASSES cont													
Red top, *Agrostis alba, Agrostis gigantia*		Long								grows on very acid soils, on poor clayey soils of low fertility and on poorly drained land			very aggressive even on poor acid soils has low palatability
Reedcanary grass, *Phalaris arundinacea*	Hay and Pasture	Long	Good	Moderate	Very High	Low	Moderate	Moderate	Sod Forming	Moist, cool climate. Poorly drained areas subject to temporary flooding.	Spring to Summer	Grows well in wet areas. Withstands flooding for up to 2 months. Grows tall, good yield.	Slow to establish. Nutrition and palatability low when mature. do not use in tree plantations.
Sheeps Fescue *Festuca ovina*		Long		High	Low	Low			Bunch Grass				
Smooth bromegrass, *Bromus inermis*	Hay and Pasture	Long	Excellent	Moderate	Moderate	Low to Moderate	Moderate	Moderate	Sod Forming	Well adapted to a wide range of soils.	Mid Spring to Mid Summer	Winter Hardy. Good yield. Palatable even at mature growth stage.	Seed is long, light, and difficult to sow due to bridging. Becomes sod bound. Slow regrowth. once established it is very difficult to get rid of. **Smooth brome is considered invasive in native grasslands.**
Tall fescue, *Festuca arundinacea*	Pasture	Long	Good	Moderate to High	Moderate to High	High	High	Very High	Bunch Grass	Adapted to a wide range of soil conditions. Does well on wet, poorly drained soils	Late Spring to Fall	Suitable for late fall grazing or stock piling. Good regrowth. Drought resistant.	Slow to cure when used for hay. Starts growing later than many spring grasses.
Timothy, *Phleum pratense*	Hay and Pasture	Medium	Good	Low	High	Low	Low	High	Bunch Grass	Cool moist areas with good drainage. Suited to low lying peat areas. thrives on clay, silt and sandy soils	Spring to Summer	Low seed costs. Easily established. Excellent hay for horses. A good choice for areas not wet enough for reed canary grass but too wet for orchard grass.	Susceptible to heat and low moisture conditions. Low palatability at maturity.

APPENDIX 7.2: FIELD GUIDE TO NODULATION AND NITROGEN FIXATION ASSESSMENT

Digitally accessible at: *http://www.for.gov.bc.ca/hfd/pubs/Docs/Fgi/Fgi04.pdf*

APPENDIX 7.3: LRMP NATIVE SEED MAP FOR THE PEACE FOREST DISTRICT

Appendix 7.4: SUMMARY OF CLIMATE DATA FOR COMMON BIOGEOCLIMATIC UNITS WITHIN THE PEACE[A]

Climate Charteristics		BWBSmw1	BWBSwk1	BWBSwk2[c]	SBSwk2	ESSFmv3	ESSFmv4[d]	SWBmk
Annual Precipitation (mm)	Mean	515	743	586	1009	700	605	685
	SD[b]	64	62	N/A	393	105	67	101
	Range	424-749	644-897	N/A	531-1898	568-911	515-724	496-816
Mean Growing Season Precipitation (mm)	Mean	315	389	420	389	316	343	410
(May - September)	SD	27	21	N/A	67	29	50	82
	Range	266-404	356-421	N/A	223-538	273-369	273-414	316-512
Annual Snowfall (cm)	Mean	156	241	146	452	333	252	256
	SD	26	35	N/A	250	74	36	126
	Range	110-242	197-332	N/A	172-958	244-476	174-293	160-449
Annual Temperature (^{o}C)	Mean	1.9	2.9	0.7	2.2	0.2	-1.0	-0.9
	SD	0.6	0.3	N/A	0.6	0.7	0.9	0.9
	Range	-0.8-3.6	2.1-3.3	N/A	1.3-3.4	-1.2-1.0	-1.9-0.9	-2.5-0.0
Mean Warmest Month Temperature (^{o}C)	Mean	15.0	14.6	13.2	14.4	11.8	11.2	12.2
	SD	0.5	0.4	N/A	0.7	0.9	1.1	1.2
	Range	13.1-16.4	13.4-15.4	N/A	12.5-15.6	10.1-13.0	9.9-13	10.3-13.5
Growing degree days (>5^{o}C)	Mean	1202	1137	887	1084	675	581	721
	SD	85	57	N/A	112	129	158	184
	Range	897-1421	990-1267	N/A	810-1299	452-852	426-852	443-933
Date of growing degree day >5^{o}C	Mean	May 13	May 15	May 31	May 23	Jun 12	Jun 15	Jun 07
reaches 100 (budburst)	SD	3	4	N/A	8	7	7	10
	Range	May 9-31	May 12-30	N/A	May 12-Jun 7	Jun 3-24	Jun 2-22	May 27-Jun 22
Frost-free period (days)	Mean	94	97	82	92	57	49	58
	SD	5	2	N/A	9	12	17	12
	Range	75-111	95-101	N/A	55-108	33-71	30-80	39-71
Number of frost-free days	Mean	157	162	147	159	130	120	126
	SD	5	2	N/A	8	10	13	9
	Range	137-173	157-167	N/A	130-174	111-140	107-148	111-135

[a] Updated from Reynolds (1989) for 1971-2000 climate normals using ClimateBC (Wang et al. 2006).

[b] Standand deviation of the mean.

[c] N/A not available due to lack of weather station data.

[d] no data available in Reynolds (1989), used Egginton (unpublished) climate station database.

Summary of climate data based for biogeoclimatic units within the BWBS[a].

Climate Charteristics		BWBSdk1	BWBSdk2	BWBSmw1	BWBSmw2	BWBSwk1	BWBSwk2	BWBSwk3
Annual Precipitation (mm)	Mean	498	479	515	506	743	586	570
	SD[b]	85	48	64	51	62	N/A	10
	Range	341-644	431-544	424-749	437-584	644-897	N/A	560-579
Mean Growing Season Precipitation (mm)	Mean	266	247	315	350	389	420	398
(May - September)	SD	55	16	27	39	21	N/A	10
	Range	145-443	229-267	266-404	302-416	356-421	N/A	388-407
Annual Snowfall (cm)	Mean	189	213	156	134	241	146	156
	SD	47	26	26	8	35	N/A	4
	Range	110-258	185-248	110-242	121-144	197-332	N/A	152-159
Annual Temperature (^{o}C)	Mean	1.2	-1.8	1.9	-0.2	2.9	0.7	0.4
	SD	1.1	0.8	0.6	0.6	0.3	N/A	0.3
	Range	-1.2-3.6	-2.4-(-0.6)	-0.8-3.6	-1-1	2.1-3.3	N/A	0.1-0.6
Mean Warmest Month Temperature (^{o}C)	Mean	13.6	14.1	15.0	15.5	14.6	13.2	13.0
	SD	0.9	1.0	0.5	1.0	0.4	N/A	0.3
	Range	11.7-16.0	12.8-15.1	13.1-16.4	13.6-16.7	13.4-15.4	N/A	12.7-13.3
Mean Coldest Month Temperature (^{o}C)	Mean	-12.5	-20.0	-12.5	-16.8	-8.6	-11.6	-11.9
	SD	2.0	4.1	1.6	3.4	0.6	N/A	0.1
	Range	-10.1-(-18.7)	-14.3-(-23.8)	-8.4-(-17.4)	-10.5-(-21.6)	-7.4-(-10.3)	N/A	-11.8-(-11.9)
Extreme Minimum Temperature (^{o}C)	Mean	-44.1	-48.2	-44.6	-46.9	-39.8	-43.2	-43.1
	SD	1.8	1.9	1.7	2.2	1.1	N/A	0.1
	Range	-41.3-(-48.2)	-45.5-(-49.7)	-39.6-(-47.9)	-41.8-(-49.0)	-37.3-(-42.4)	N/A	-43.0-(-43.1)
Growing degree days (>5^{o}C)	Mean	961	950	1202	1200	1137	887	849
	SD	161	110	85	137	57	N/A	47
	Range	702-1386	802-1064	897-1421	953-1368	990-1267	N/A	802-896
Date of growing degree day >5^{o}C reaches 100 (budburst)	Mean	May 27	May 29	May 13	May 14	May 15	May 31	Jun 01

APPENDIX 7.5: AN EXAMPLE OF A SEEDLOT CERTIFICATION ANALYSIS

APPENDIX II SEED GRADING REPORT FORM

SEED GRADING REPORT — RAPPORT DU CLASSEMENT DE SEMENCE

Name and Address of Owner / Vendor / Nom et Adresse du Propriétaire / Vendeur	
Variety / Variété	Kind / Espéce
Crop Certificate No./ N° du certificat de recolte	Lot No. / N°. du lot

NAME AND NUMBER OF IMPURITIES / NOM ET NOMRE D'IMPURETÉS

PROHIBITED NOXIOUS WEEDS MAUVAISES HERBES NUISIBLES INTERDITES	In / En g / Kg	per g/Kg	OTHER WEED SEEDS AUTRES GRAINES DE MAUVAISES HERBES	In / En g	per g/Kg
PRIMARY NOXIOUS WEEDS MAUVAISES HERBES NUISIBLES PRINCIPALES	In / En g / Kg	per Kg			
TOTAL PRIMARY / TOTALES PRINCIPALES					
SECONDARY NOXIOUS WEEDS MAUVAISES HERBES NUISIBLES SECONDAIRES	In / En g / Kg	per Kg	TOTAL WEED SEEDS GRAINES DE MAUVAISES HERBES NUISABLE EN TOTAL		
			OTHER CROP SEEDS SEMENCES D'AUTRES ESPÈCES		per g/Kg
			TOTAL OTHER CROP SEEDS SEMENCES D'AUTRES ESPÈCES EN TOTAL		
TOTAL PRIMARY PLUS SECONDARY SEMENCES DE MAUVAISES HERBES PRINCIPALES ET SECONDAIRES EN TOTAL	In / En g/ Kg	per Kg	ERGOT BODIES / ERGOT SCLEROTIA / SCLEROTIA	In / En g / Kg	per g/Kg

Germination Certificate No. N° du certificat de germination	Germination %	Date of Test Date de l'épreuve	Disease Test Certificate No. and Results N° du certificat de l'épreuve de maladie et les resultats
Comments / Commentaires		Name of Lab / Nom du laboratoire	
		Grade / Catégorie	
Signature of Grader / Signature du classificateur		Date	Licence No. / N° du permis

SWI 132.1.3 24 October, 1996 Seec Section

APPENDIX 7.6: ABBREVIATED BIBLIOGRAPHY

PAPERS USED TO DEVELOP THE PEACE-LIARD SEEDING GUIDELINES

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