Conceptual Reclamation Plan for the Elkview Coal Property at Sparwood, B.C.

Elkview Coal Corporation

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Executive Summary

This reclamation plan replaces the 20-year plan that was prepared by Westar Mining Ltd. (Westar 1983). It incorporates information that was presented in the 1983 plan, the wildlife mitigation plan prepared in support of the Bodie development (Interior Reforestation 1993), the reclamation and wildlife mitigation plan prepared for the Bodie Development (Interior Reforestation 1996), the draft ECC Property Wide GIS report (1998) and various studies conducted on the Elkview property over the past 20 to 30 years.

The reclamation program at Elkview Coal Corporation (Elkview) continues to focus on the re-establishment of functional ecosystem processes and biological capability for specific reclamation treatment units (RTU's). This conceptual reclamation plan provides direction for future reclamation planning and implementation. It provides a vision for the horizontal distribution, vertical structure, and species composition of the plant communities that will be established at Elkview. It also provides for a monitoring program that will generate information for improving reclamation treatments over time and assess whether reclamation objectives have been achieved. The plan acknowledges that reclamation science is a relatively new field and that revisions to the plan should be expected as operational experience and research indicate that specific practices should be continued, discontinued, or modified.

The focus of this conceptual reclamation plan is to ensure that soil erosion by water and wind is minimized and controlled, water quality is maintained, aesthetic impacts are mitigated and acceptable habitats for a range of wildlife species are created over time. The success of this plan depends on reclamation treatment regimes that will promote the re-establishment of basic ecological functioning and ensure the development of self-sustaining plant communities. The reclamation program is based on a philosophy of ecological replacement. This will ensure that pre and post-mining landscapes have similar functional characteristics, but does not imply that they will be the same (Cooke and Johnson 2002). Elkview's reclamation philosophy is focused on establishing geologically stable landscapes that support a mosaic of ecosystems because this will provide the widest range of options for the future (NRC 1981).

Nine ecologically relevant reclamation treatment units (RTU's) form the link between this conceptual plan and operational treatments. RTU's are a simple form of capability unit (Smyth and Deardon 1998) and will also form the basis for all monitoring program components that assess soil and vegetation development and for selected wildlife species. RTU stratification criteria allow for their delineation using aerial photographs, topographic maps, and standard GIS products. RTU's will facilitate the preparation of estimates for life of mine costing and provide a framework that can adjust quickly to any mine plan changes.

Elkview believes that reclamation efforts that are focused on ecological factors that directly affect biogeochemical cycles and ecological diversity will provide for a mosaic of self-sustaining plant communities. Targeting diversity at all levels of detail including plant species composition, spatial arrangements of plantings and introduction of a range of habitat elements will ensure that an effective mosaic results. This plan includes Elkview's first attempt at developing results based standards for assessing reclamation success including a generalized monitoring program. Implementation of the plan will ensure that end land use and reclamation objectives are achieved, reclamation activities are progressive, and that the reclamation program remains flexible and responsive to new ideas and information.

Acknowledgements

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1. Introduction

1.1 Preamble

Elkview Coal Corporation (Elkview) is located in south eastern British Columbia near the town of Sparwood (Figure 1). This reclamation plan replaces the 20-year plan that was prepared by Westar Mining Ltd. (Westar 1983) and it promotes a number of the basic concepts and approaches that were proposed in the 1983 plan. The focus of the reclamation program at Elkview continues to be the re-establishment of functional ecosystem processes and biological capability for specific reclamation treatment units (RTU's).

This reclamation plan acknowledges that reclamation science is a relatively new field and that revisions to the plan should be expected as operational experience and research indicate that specific practices should be continued, discontinued, or modified. The plan incorporates information that was presented in the previous reclamation plan for the Balmer Property (Westar 1983), the wildlife mitigation plan prepared in support of the Bodie development (Interior Reforestation 1993), the reclamation and wildlife mitigation plan prepared for the Bodie Development (Interior Reforestation 1996), the draft ECC Property Wide GIS report (1998) and various studies conducted at the Elkview property over the past 20 to 30 years. Information from selected current literature has also been incorporated where possible.

The purpose of this conceptual plan is to provide direction for reclamation planning and implementation into the future. This plan provides a vision for the horizontal distribution, vertical structure, and species composition of the plant communities that will be established at Elkview. It also provides for a monitoring program that will generate information for improving reclamation treatments over time and for indicating whether reclamation objectives have been achieved.

The scope of this plan is limited to the area that has been disturbed since Elkview took over operation of the mine in December 1992. All attempts will be made to implement this plan on previously disturbed areas but there are conditions that are beyond Elkview's control that may limit reclamation success (e.g., dump height). Existing conditions will require a set of unique standards that will be used to judge reclamation success on these areas and they will be outlined in future annual reclamation reports.

1.2 End Land Use and Reclamation Objectives

The focus of this conceptual reclamation plan is to ensure that reclaimed slopes are geologically stable, soil erosion by water and wind is minimised and controlled, acceptable water quality is maintained, aesthetic impacts are mitigated, and acceptable habitats for a range of wildlife species are created over time. Creating conditions that will promote the re-establishment of basic ecological functioning (biogeochemical cycling) and ensure the development of self-sustaining plant communities is critical to the success of this plan.

Reclamation permit C-2 specifies a wildlife end land use for the reclaimed land at Elkview Coal Corporation's operations at Sparwood, B.C. Elk (*Cervus elephus nelsonii*) and mule deer (*Odocoileus hemionus*) continue to be the "featured species" for reclaimed habitats. However, additional animal species are expected to benefit from the proposed reclamation treatments (Westar Mining Ltd. 1983).

The specific objectives that will be achieved through implementation of this plan are to:

1. Ensure that reclaimed slopes are geologically stable;
2. Reduce and control surface erosion by water and wind;
3. Maintain acceptable water quality standards;
4. Create acceptable habitats that, in combination with habitat adjacent to the mine property, will continue to support viable populations of elk and mule deer;
5. Create conditions that will promote the re-establishment of basic ecological functions (biogeochemical cycling);
6. Introduce habitat elements and structure that will provide habitats for a range of wildlife species in addition to elk and mule deer;
7. Create conditions that will allow for re-colonization by native plant species;
8. Monitor, within an adaptive management framework, to ensure that reclamation treatments are effective and that program objectives are achieved; and,
9. Provide a framework for life of mine costing that is easily adjusted to changing mine plans.

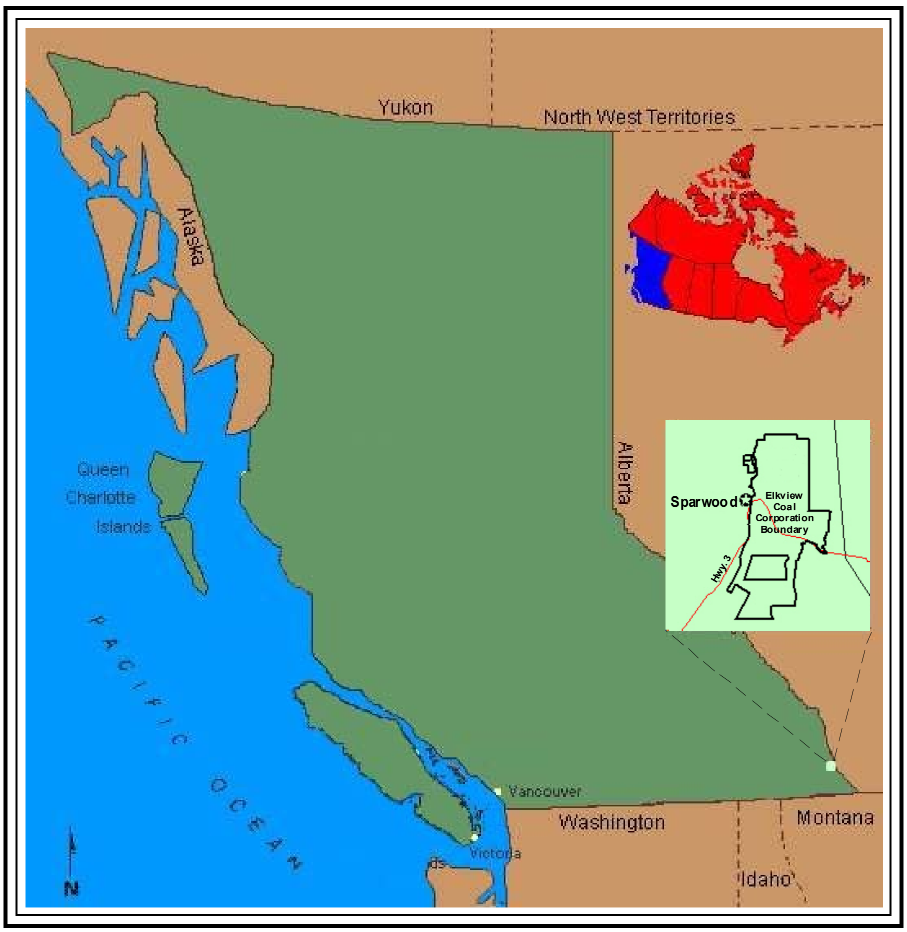

Figure 1. Location of Elkview Coal Corporation.

1.3 Reclamation Philosophy

The reclamation program is based on a philosophy of ecological replacement. This will ensure that pre and post-mining landscapes have similar functional characteristics, but does not imply that they will be the same (Cooke and Johnson 2002). Elkview's reclamation philosophy is focused on establishing geologically stable landscapes that support a mosaic of ecosystems because this approach will provide the widest range of options for the future (NRC 1981). Implementation of the plan will ensure that end land use and reclamation objectives are achieved, reclamation activities are progressive, and that the reclamation program remains flexible and responsive to new ideas and information.

Elkview is committed to creating a reclaimed setting that has diverse wildlife habitats distributed throughout the property. Diversity will be targeted at all levels of detail including landscape, site and micro-site. Plant species composition and establishment, spatial arrangements of plantings (size, shape, and distribution), introduction of a range of habitat elements (e.g., snags, brush piles), and maintenance or establishment of special habitats (e.g., seeps, riparian areas) will all be considered when assessing the potential to promote diversity. Plant communities established through reclamation efforts will allow for the re-establishment of native species over the medium to long term.

Elkview will strive to ensure that reclamation efforts are focused on ecological factors that directly affect biogeochemical cycles and ecological diversity (e.g., soil organic matter, vertical structure). Ecologically relevant reclamation treatment units (RTU's) form the link between this conceptual plan and operational treatments. RTU's are a simple form of capability unit (Smyth and Deardon 1998) and will also form the basis for all monitoring program components that assess soil and vegetation development and selected wildlife populations (e.g., voles, mice). RTU's were stratified using biogeoclimatic unit, aspect class, and slope class as the criteria because they are believed to significantly influence plant community establishment, survival, and long-term development at Elkview. The interaction of these factors influences vegetation development, various soil characteristics, and the re-establishment of biogeochemical cycles. These are all important considerations for promoting long-term reclamation program success. The stratification criteria also allow for the delineation of RTU's using aerial photographs, topographic maps, and standard GIS products (e.g., slope and aspect themes). RTU's that are easily mapped will facilitate the preparation of estimates for life of mine costing and provide a framework that can adjust quickly to any mine plan changes.

2. Ecological Setting and Growth Limiting Factors

The Elkview mine is located near Sparwood in southeastern British Columbia. It is within the dry cool Montane Spruce (MS dk) and Engelmann Spruce - Subalpine Fir (ESSF dk) biogeclimatic subzones (Braumandl and Curran (eds.) 1992) and ranges from 1300 – 2100 meters a.s.l. Summers range from warm and dry in the MS dk to cool and moist in the ESSF dk while winters are cold with light snow and very cold with heavy snow respectively.

Braumandl and Curran (1992) identify a number of factors that may limit plant growth on various forested site series in the MS dk and ESSF dk biogeoclimatic subzones. The primary factors include excessively dry or wet soils, lack of nutrients, cold soils, and cold air temperature. They also state that conservation of the limited organic matter in these forested ecosystems is an important management consideration. Many of these limiting factors will be amplified through the mining and resloping component of the reclamation process. Conifers planted in 1999 - 2001 on the Bodie Dump have had poor survival and winter desiccation, in combination with the southerly aspect, is believed to be a significant contributing factor[1]. Winter desiccation has been a problem for establishment of lodgepole pine (*Pinus contorta* var. *latifolia*) at the Sullivan Mine near Kimberley B.C.[2] and Macyk (2002) found that strong winds accompanying cold spells can be particularly harmful to young seedlings.

Additional growth limiting factors associated with reconstructed soils will also have to be considered in achieving reclamation objectives. These often include increased soil bulk density, poor porosity, low levels of organic matter, low nutrient levels, and the lack of soil flora and fauna (Haigh 2000, Munshower 1994). High surface temperatures may also impact the establishment of seedlings planted on warm aspects.

3. Targeting Habitat Diversity

Although elk and mule deer are the featured species for Elkview's reclamation program, the reclamation plan encourages the re-establishment of local populations of a wide range of vertebrate and invertebrate species. However, there are a number of factors that affect the potential for re-establishment of a species into a reclaimed environment and there are no guarantees that individuals or populations will re-establish simply because appropriate habitats exist (Black, *et al*, 2001). Reclamation planning cannot focus on one or two specific habitat elements for a species (e.g., distance to hiding cover) since all of the important elements must be met for an area to be used in specific seasons. Also, the optimal balance of various habitat elements to promote specific combinations of wildlife species is not known (Bunnell et al. 1999). For example, until recently, many biologists believed that thermal cover was a critical component of ungulate winter range. However, recent work by Cook et al. (1998) clearly shows that thermal cover is not as important to elk as an available supply of good quality forage and most wildlife biologists have discounted the need for thermal cover at low temperatures in winter (Stuart-Smith et al. 2002). Providing habitats that allow for good animal nutrition is more important than providing conventional thermal cover on winter range sites. Gibson and Sheets (1997) have indicated that the lack of water may be an important limiting habitat element for ungulates that use the mine site.

In many cases, pre-mining faunal communities cannot be re-established on reclaimed sites (Parmenter and MacMahon 1992) and Allen (1992) points out that "naturally high levels of diversity can seldom be economically replicated on mined land…" Also, any management decision, including the decision to do nothing, favours some species while disadvantaging others (Bunnell et al 1999). Elkview believes the key to successfully achieving a wildlife end land use will be establishing a variety of habitats along with specific habitat elements that are known to be important in forested settings (Bunnell et al 1995, Bunnell et al 1999). Elkview's reclamation program will not provide all of the habitat requirements for all of the vertebrate and invertebrate species that were present prior to mine development. Habitat that will be created at the mine needs to be considered in the context of the surrounding undisturbed habitats (Black, *et al* 2001) and within the financial context of what can be expected on severely disturbed sites. Measures of reclamation success will include how well a variety of vertebrate species use the mine site and how well various habitat elements in the reclaimed landscape are connected with the surrounding undisturbed area.

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1 Dave Ryder, Senior Environmental Coordinator, Elkview Coal Corp., 2002, pers. communication.

2 John E. Przeczek, R.P.F., Interior Reforestation Co. Ltd., 2002, pers. observation.

Data synthesis for the property wide GIS project (Elkview Coal Corp. 1998) indicates that elk diets are adequate and cow: calf ratios are similar to those calculated over the past 20 years. Elk and mule deer continue to use the mine site and there is no indication that their numbers are threatened by current mine activities. Hunting and poaching are the two largest mortality factors for elk and deer that use the Elkview property and they are due to off-property hunting which is not within Elkview's control (Elkview Coal Corp. 1998). There are many unknowns regarding the outcome of reclamation efforts on wildlife populations. For example, Gibson and Sheets (1997) are unsure of the impact that losing tree and shrub cover will have on elk calving success. Promoting a variety of habitats throughout the mine property should help to ensure that populations are maintained.

Figure 2. Mosaic of native and reclaimed habitats above the southern end of the Bodie Waste Dump.

4. Reclamation Treatments and Rationale

Elkview Coal Corp. is committed to the concept of restoring biological diversity. However, biological diversity is defined as the variety and variability among living organisms and the ecological complexes on which they occur (OTA 1987) and it is usually considered at three basic levels of organisation including genetic, species, and ecosystem. Reclamation of the post-mining environment will re-establish basic ecological processes, relatively simple plant communities, and some wildlife populations but it could take centuries to re-establish the complexity that developed after the most recent (Wisconsin) glaciation. None the less, the over-riding objective for all reclamation treatments is to establish diverse habitats that will persist and continue to develop over time. Accomplishing this objective will require adhering to a number of basic ecological principles along with the application of specific treatments and treatment combinations that are effective and consistently successful. This functional approach to reclamation is appropriate because it aims at establishing desirable physical, chemical and biological processes (NRC 1981, Smyth and Dearden 1998) rather than simply replacing soil horizons or native vegetation. The mosaic of plant communities that are established through reclamation will have similar structure and functioning[3] to the pre-mining plant communities on similar sites.

4.1 Reclamation Treatment Units (RTU's)

Reclamation treatment units are delineated on the basis of the climatic and site characteristics that are believed to have the strongest influence on ecological processes and reflect anticipated differences in the development of plant communities, productive soils, and wildlife habitat. The specific criteria are biogeoclimatic subzone, slope angle class, and aspect class. Figure 3 shows how the three factors were considered in defining the RTU's. Slope and aspect classes (Figure 4) were derived based on past experience with establishing vegetation on a range of post-mining conditions at Elkview Coal. Westerly aspects were included in the "warm" class because current perception includes anecdotal evidence that western slopes have similar, although less severe, soil moisture deficits and solar energy inputs as south facing aspects.[4]

Reclamation treatment units are simplified capability units that provide the framework for developing treatment regimes that focus on the specific ecological factors that are limiting to the establishment of target plant communities including grasses, forbs, trees, and shrubs. They also provide a formalized framework for adaptive management decision making by providing the context for establishing research trials and operational monitoring programs that will assess reclamation program assumptions and whether program objectives are achieved. The RTU framework will work well with monitoring program components that evaluate soil and plant community development. However, on their own RTU's will probably be too small for assessing the success of treatments in promoting wildlife species with large home ranges (e.g., ungulates) and some wildlife species that may respond to specific habitat elements (e.g., brush piles). Nonetheless, application of the RTU framework over the mine site will provide a focus for making many of the assessments that will be required to evaluate and improve reclamation success.

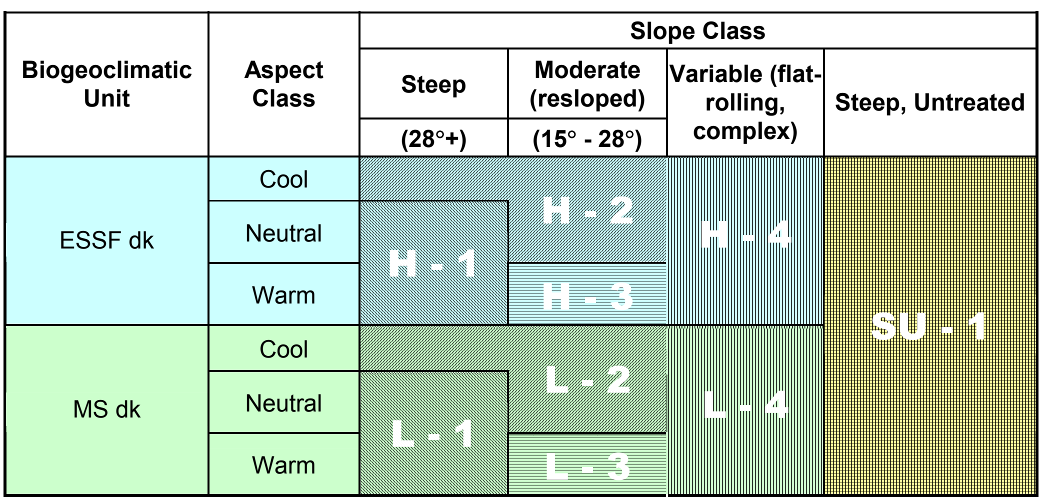

Figure 3. Reclamation treatment unit stratification rationale showing nine RTU's for the Elkview property.

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3 Function refers to the exchange of energy and nutrients within an ecological system. Functional processes include accumulation of organic matter, nutrient cycling and accumulation, respiration and net primary production.

4 Dave Ryder, Senior Environmental Coordinator, Elkview Coal Corp., personal communication, 2002.

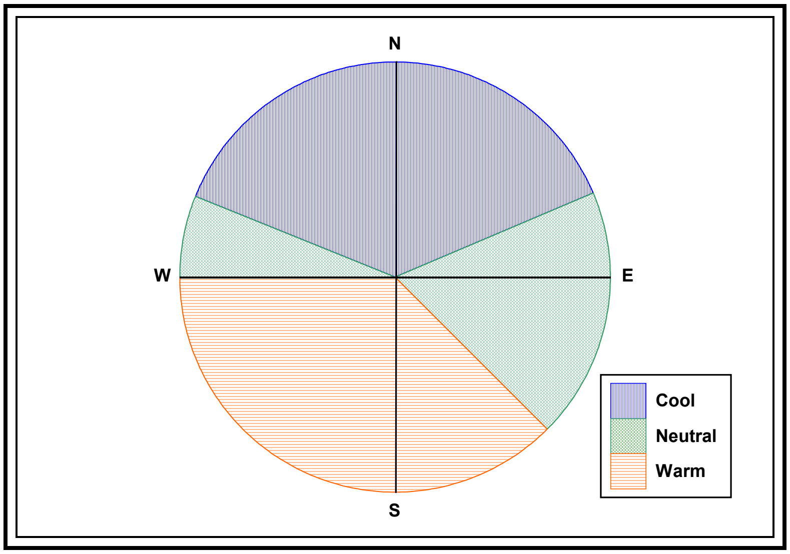

Figure 4. Aspect classes used in stratifying reclamation treatment units.

RTU's simplify operational reclamation planning and treatments by reducing the number of regimes that will be applied over the post-mining landscape. It is possible that additional units may be recognized in the future, however, there is no current evidence that indicates that a higher level of complexity is required. Monitoring programs will indicate whether RTU's should be grouped or split, or if additional factors should be added to the RTU matrix. It is probable that coarse and fine subunits of RTU's will be recognized (e.g., H-1coarse, H-1fine) due to the importance of this parameter on vegetation productivity (Smyth and Paton 2000).

4.2 The Soil System

Re-establishing the functional characteristics of productive reconstructed mine soils is the most important objective for ensuring that plant communities become self-sustaining. Resloping dumps and applying treatments that will accelerate the re-establishment of biological activity are the focus of this reclamation plan.

4.2.1 Resloping

Resloping treatments will ensure that dumps are geologically stable and redistribute fines that are required for successful vegetation establishment. Resloping will homogenize the topography in localized areas (Figure 5) but treatments will create varying components of 26°and angle of repose (34° - 37°) slopes along with benches and areas with variable hill and swale topography (Table 1). This will promote some diversity in topography, which is important for upland wildlife (Michalski et al. 1987). When combined with other reclamation treatments, resloped landscapes will be consistent with end land use objectives.

Figure 5. Reloped section of the Bodie Waste Dump, looking north.

Table 1. Elkview Coal active mine area by slope class to December 31, 2002.

Slope Class (°)	Area (ha)
0 - 5	709
5 – 10	710
10 - 15	907
15 - 22	1393
22 – 28	1060
28 - 34	841
34 – 39	391
> 39[5]	204
Total	6215

In general, dumps will be resloped to approximately 26° or less, particularly where dump lifts are less than 50 meters. Where dump lifts are greater than 50 meters some angle of repose slopes will

[5] Includes highwalls and naturally steep areas (e.g., cliff bands).

be retained and dozers will be used to modify the crest of these dumps to create an average slope of approximately 34°. Where possible soil material will be salvaged and spread during resloping, particularly where steeper slopes are being modified and retained. However, the combination of steep slopes and shallow soils on the mine site will limit the availability of suitable material for salvaging and re-spreading. The redistribution of spoil fines, which occurs during the resloping process, will help to ameliorate the lack of available soil material. Surface conditions will be left as rough as possible after resloping to improve seed retention and to provide microsites that favour grass and legume establishment. Resloping activities will promote the establishment of vegetation and reduce surface erosion risk. Specific areas including highwalls, footwalls, talus and some angle of repose slopes will not be resloped and revegetation efforts will be limited to an initial seeding treatment with no additional follow-up.

4.2.2 Biological Activity

Revegetation with productive species will follow resloping treatments. The immediate objective is to reduce surface erosion. However, rebuilding the biologically active components of the soil resource is required for promoting self-sustaining plant communities (Whitford and Elkins 1986). The most critical component is soil organic matter due to its importance for increasing water holding capacity, contribution to the nutrient pool, initial formation of soil structure, and as a substrate for a wide array of soil organisms (Haigh 2000, Munshower 1994, Palmer 1992, Whitford and Elkins 1986). “Increasing evidence indicates that microbial grazing by the microfauna is important in mineralization. These interactions are particularly important during litter decomposition, an essential aspect of soil formation” (Zak 1992). Organisms in the soil subsystem that are important in decomposition and mineralization must be present and viable if a dynamic equilibrium is to be reached (Whitford and Elkins 1986). The most efficient approach to increasing organic matter is the establishment of a productive vegetation cover. This will also help to improve soil infiltration capacity and reduce surface erosion (Naeth et al. 1991). Re-establishing ecosystem functioning will take many years. Soil structure can develop in 10 – 20 years at some mine sites (Schafer et al. 1979) but may take 50 – 200 years at depths below 10 cm (Naeth et al. 1991).

The importance of mycorrhizal fungi to plant survival and growth has been well documented (Allen and Friese 1992). Most research efforts focused on understanding the distribution and ecology of mycorrhizae and have concentrated on small-scale studies or theoretical assessments of their distributions. Few studies have assessed the large-scale practical effects of land management practices (Allen and Friese 1992). Gould and Hendrix (1998) found that mycorrhizal species richness was low after reclamation but increased and stabilized after 5 years. In addition, Zak (1992) states that if a mycorrhizal fungus is actively reproducing it is actively associating with a plant.

A large diversity in mycorrhizal fungi species is probably not necessary to ensure that the benefits of mycorrhizal relationships are being realized. Cullings et al. (2000) found that there was very little mycorrhizal specificity in a mixed lodgepole pine – Engelmann spruce forest in Yellowstone National Park and Simard et al. (1998) demonstrated that there is a net flow of fixed carbon from birch (*Betula paperyifera*) and Douglas-fir (*Psudotsuga menzesii* var. *glauca*) via common ecto-mycorrhizal connections. All tree and shrub species will either be inoculated with mycorrhizal fungi at the nursery or at the time of planting. This will help to ensure that fungal relationships are established early and that seedling survival and growth are promoted. The intent is that there will be a wide enough variety of mycorrhizal fungi that all tree and shrub species will be colonized.

4.3 Revegetation

4.3.1 Grass and Legume Plant Communities

Seeding to establish grass and legume dominated plant communities will take place in the fall, although some spring seeding will be required to meet operational requirements. One of the mixes detailed in Appendix 2 will be applied at a rate of approximately 65 kg/ha. Seeding will occur on freshly resloped terrain and will primarily be accomplished through aerial applications. Small areas may be seeded with hand-held cyclone seeders and specific steep slopes or areas that will be difficult to establish may be hydroseeded to promote success. Fertilization will occur in the spring after snow melt and while plants can actively use the applied nutrients. Fertilizers will have balanced formulations based on soil test results. Three (3) applications of maintenance fertilizer are anticipated over the first 10 years after seeding to ensure that the plant community becomes self-sustaining. Application prescriptions will be based on a visual assessment of plant vigour and formal monitoring results.

Seed mixes were designed with consideration for aspect, slope, biogeoclimatic unit, and proven success for rapid establishment at Elkview. Agronomic species have proven performance due to their quick establishment that reduces surface erosion concerns and acceptable biomass production to increase organic matter content of surface soil horizons. Legumes are included in all mixes due to their nitrogen fixing capability and to improve overall biomass production. Halko et al. (1997) reported that biomass productivity was highest where plant communities include a significant forb (alfalfa) component and this is consistent with the productivity estimates at Elkview Coal (Interior Reforestation 2000, Przeczek and Colombo 2001). Przeczek and Colombo (2001) found that seed mixes similar to those proposed in this plan that were established from 1980 – 1984 on the Harmer reclaim area have allowed for the reinvasion of native plant species, although they contribute relatively small amounts to the cover and biomass. Strong (2000) found similar results on 20 year old reclaimed sites at the Coal Valley Mine in west central Alberta.

Naturally high levels of diversity can seldom be economically replicated on mined land but a functional diversity that includes the dominant life forms and plants of varying phenology can be achieved (Allen 1992). Smyth (2000) found that 20 year old reclaimed high elevation exploration trails showed favourable reclamation performance including an increase in native species, a decline in agronomic species, and identifiable, albeit slow, progress in soil profile development. The potential for re-establishment of native vegetation will be affected by the availability of viable seed sources and the process will take much longer in large reclaimed landscapes. Operational establishment of native species islands that will function as seed sources for the long term re-establishment of native plant dominated ecosystems will be integrated into RTU regimes where the potential for successful initial establishment is high and surface erosion concerns are low. The general approach will be to establish agronomic vegetation and then use ripping or herbicide treatments to prepare specific areas for seeding with a native mix. Reducing the competition created by agronomic swards will also be important where native trees and shrubs are planted. Establishing native grass and legume mixes will be considered in some of the areas planted with trees and shrubs.

4.3.2 Tree and Shrub Dominated Plant Communities

Establishing trees and shrubs is an important component of this reclamation plan. They will contribute to diversity at the site and landscape level and provide habitat characteristics and elements that influence a wide range of vertebrate (Appendix 1) and invertebrate species. Tree and shrub species that are native to the mine site and surrounding area have been selected for the reclamation program. Appendix 3 provides a list of species that are currently used in the reclamation program and a list of species that have the potential for successful establishment.

Seed for most species will be collected from undisturbed areas of the mine site and adjacent lands to ensure they are adapted to local conditions. Most deciduous shrubs can be collected and stored without significant loss of viability for 2 – 3 years and collections will be maintained to ensure that seed is available as required. Some species (e.g., cottonwood) will be collected annually because seed viability is short and they do not store well. Elkview has purchased Engelmann spruce and lodgepole pine seed that will supply some of the reclamation requirements for the next 20 years. Conifer seed can be stored for extended periods without loss of viability and Elkview stores their seed with the Ministry of Forests Tree Seed Center in Surrey. A detailed seed requirement plan will be prepared and updated regularly to ensure that a 2 – 3 year supply of seed from a variety of species is available for the reclamation program. If additional conifer seed is required, local provenances will be purchased.

All seedlings will be planted with a fertilizer tab or bio-pak and will either have mycorrhizal inoculation through the growth medium at the nursery or at the time of planting. Three general treatment regimes will be used to promote seedling survival:

1. Rip trenches where agronomic seed mixes have been sown to reduce competition. Seedlings will be planted in the bottom of the ripped trenches to take advantage of the improved moisture retention in these microsites. These treatments will be used on flat and gently sloping terrain.
2. Excavators will be used to create plantable microsites in areas where agronomic grasses have been sown on dry, warm aspects and adjacent to roads that cross dumps.

Ripping treatments have been effective in promoting acceptable survival of Engelmann spruce in the Harmer and Harmer II areas of the mine (Figure 6). Engelmann spruce and lodgepole pine seedlings planted between 1986 and 1988 at Fording Coal's Fording River Operations have site indices of approximately 19 meters, which is similar to the productivity of adjacent forest land (Straker et al. 2002). Seedlings were planted on resloped waste rock that was seeded with birdsfoot trefoil (*Lotus corniculatus*) 2 – 4 years after planting. Strong (2000) found similar height growth results at the Coal Valley Mine in western Alberta and he suggests that dense conifer stands may be required to facilitate the development of understory vegetation that is similar to natural stands of similar age.

Trees and shrubs will be planted in stands or patches with densities that vary from 2000 to 4000 stems per hectare[6]. In general, trees will be planted at wider spacing (2000/ha) and small shrubs (e.g., prickly rose) will be planted at narrower spacing (4000/ha). Varying the planting density for various species will create conditions that approximate the spacing found in undisturbed plant communities.

[6] These planting densities require inter-plant spacing from 1.6 – 3.1 meters.

Figure 6. Engelmann spruce seedlings planted on Harmer Ridge in 1983, after ripping for site preparation.

Matching stocktype to the species and site conditions is an important consideration for successful planting programs. In general, PSB 412 1+0 and PSB 415D 1+0 have worked well for many species used at Elkview Coal and Teck-Cominco, Kimberley Operations[7]. The choice of frozen stored or active hot stock is also important because seedling survival is related to their condition at the time of planting. Frozen stored conifer seedlings should be planted as close to snow melt as possible. This allows the seedlings to take advantage of the available moisture and to be physiologically synchronized with the native vegetation. Two or three planting periods may be required depending on the elevation and aspect of the planting sites. Frozen stored conifer stock will be targeted to sites that will be planted before June 10th. Hot stock should be planted in the period from June 20th to July 20th in moist to wet sites and on cool aspects. These stock types have been conditioned at the nursery so that top growth is finished but diameter and root growth are active. The interaction of planting time and stock type (frozen or hot) is not well understood for deciduous species and drought stress and blackout treatments used to condition conifer stock would be detrimental to the deciduous species. Deciduous trees and shrubs will be frozen stored and thawed just prior to planting for all sites. All stock will be kept cool prior to planting and standard stock handling procedures will be strictly enforced to promote the highest levels of seedling survival possible.

[7] John Przeczek, R.P.F., Interior Reforestation Co. Ltd, personal observation.

4.3.3 Vertical and Spatial Diversity

Parmenter and MacMahon (1992) suggest that deliberate inclusion of both horizontal and vertical heterogeneity in vegetation architecture will result in a landscape mosaic that is more conducive to the development of a highly diverse, self-perpetuating faunal community (Figure 7). Within and between habitat diversity also needs to be considered as natural landscapes contain heterogeneous patches of vegetation (Allen 1992). Allen and Friese (1992), while discussing mycorrhizal fungi reproduction and distribution, suggest that habitat heterogeneity may be important since patch size appears to be localized around individual plants and different plants represent different habitats.

Vertical and spatial diversity will be promoted by applying general guidelines for the proportion of each Reclamation Treatment Unit that will be planted to either grass and legume dominated plant communities or tree and shrub dominated plant communities (Table 2). Diversity will also be promoted by planting stands that range from pure coniferous through mixed coniferous-deciduous to pure deciduous. Shrubs will be intermixed with trees, planted adjacent to tree patches, and planted as separate shrub dominated islands. All plantings will be a mix of species.

The key to providing a mosaic of habitats is the inclusion of a diversity of species along with a diversity of patch sizes ranging from 0.1 to upwards of 100 hectares in size. The shape and distribution of the patches will be designed to ensure that diversity is promoted and connectivity to adjacent undisturbed land is accommodated. This will require detailed planning and tracking to ensure that area and variability objectives are met. Elkview's Geographic Information System will be used to ensure that planning and tracking requirements are satisfied.

4.3.4 Riparian areas

Riparian areas contribute significantly to vertebrate richness since many species use them and are often more abundant and reproductively successful there (Bunnell 1995). Riparian habitats are fairly limited in extent at Elkview and where they occur they will be planted with a mix of tree and shrub species. Planting will include upland sites within 5 – 10 meters of the riparian boundary and trees and tall shrubs (e.g., willow, alder) will dominate these plantings.

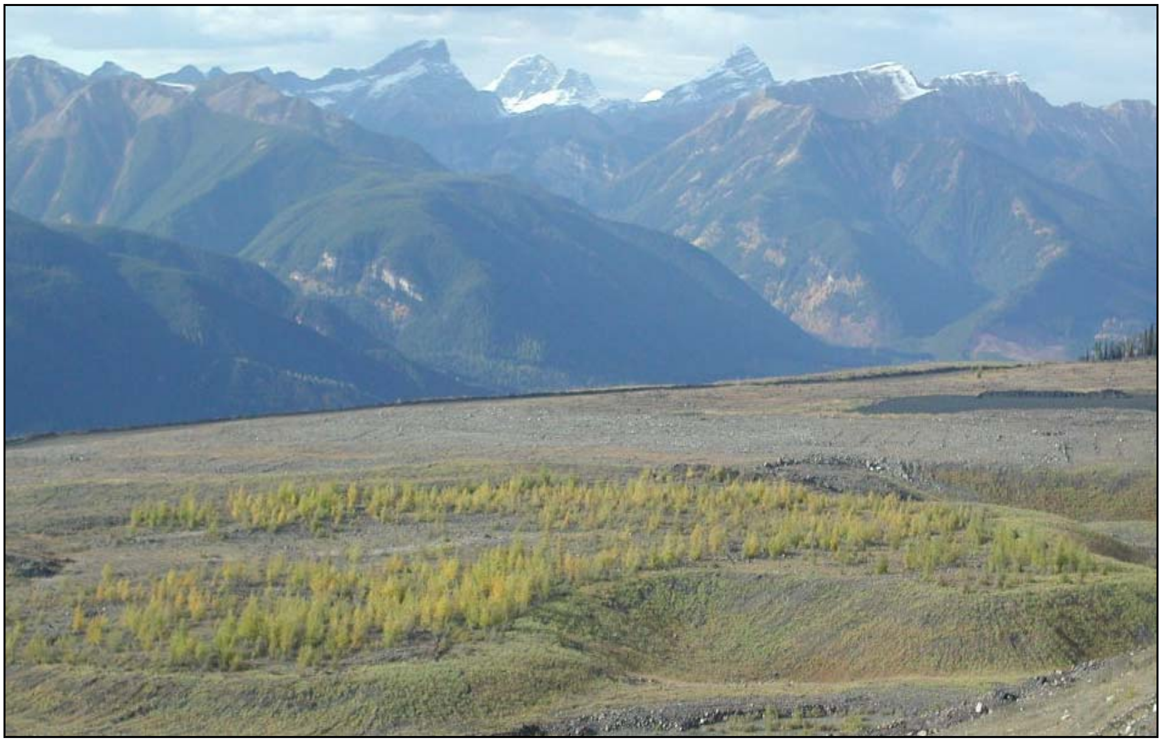

Figure 7. Vertical and spatial diversity created by a large "patch" of cottonwood volunteers on Harmer II.

4.3.5 Additional Habitat Elements

Habitat elements including standing dead trees, brush piles, and rock piles create unique habitats that are used by specific vertebrate species (Thomas 1979, Bunnell et al. 1995, 1999). Most of the information available on the importance of these habitat elements has been generated in the context of their response to timber harvesting activities in temperate forests. There is no information regarding the optimal number of distribution of many of these habitat elements in reclaimed environments or their relative importance. However, they can be created relatively easily during reclamation activities and will add to the diversity of potential wildlife habitats (Figure 8). The planned intent is to create them at a variety of densities and distributions and then to monitor wildlife use and apply the findings to modify prescriptions as information becomes available.

4.3.5.1 Standing Dead Trees

Standing dead trees will be placed in some locations to provide perching habitat for birds. Trees used for this purpose tend to be solid and would be equivalent to a "hard" snag which is of limited value to primary cavity nesters that generally excavate trees that have heart rot (Bunnell et al. 1995). Nesting sites for cavity nesters need to be relatively close to foraging sites (Bunnell et al. 1999) and these would only exist in undisturbed forests adjacent to the property. In some cases the snags will be placed with their root system up to provide a larger nesting platform. This approach has been tested at one location on the reclaimed Bodie Dump and has been used successfully at the Quintette Mine[8]. It is possible to substitute nesting boxes for cavities or to create cavity habitat but they are not components of this plan.

Figure 8. Diverse Wildlife Habitat Area on Harmer Ridge showing a conifer "patch" with a standing dead tree and coarse woody debris piles.

4.3.5.2 Brush Piles (modified from Westar 1983)

For some wildlife species, brush cover can supply many of the habitat components that would be supplied by a cover of woody vegetation (Warrick 1976). They can be used to encourage use by upland birds (Yoakum et al. 1980), as well as other species such as White Crowned Sparrows (Yoakum et al. 1980), rabbits (Shomon et al. 1966), porcupines (Taylor, 1933 cited in Maser et al. 1979), and fishers (Couler, 1966 cited in Maser et al. 1979), as well as being useful cover for a variety of other small mammals. Slash and brush piles can also be used as hiding cover for large ungulates (Thomas, 1979).

Brush piles also serve as germinating sites for a number of trees and shrubs (Yoakum et al. 1980). They have the advantage of being inexpensive and they quickly established hiding cover when compared to revegetating sites with trees and shrubs. They will serve in the interim period between the initial reclamation stages and the stages where good tree and shrub cover is attained.

4.3.5.3 Rock Piles (modified from Westar 1983)

"Observations of natural systems indicate that large rocks may well serve as perching sites for a number of birds, especially gallinaceous birds, raptors and grassland passerine. American Kestrels, Blue Grouse, Water Pipits and Horned Larks have used rock piles placed on high elevation reclaimed sites. Rock piles may also provide cover for rodents and arthropods, especially during periods of drought, where microsite protection may be important. Small piles

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8 Kim Bittman, Manager, Environmental Programs, TeckCominco, personnal communication, 2003.

of rock will be left on the reclaimed sites to provide this habitat component. Relatively large rocks of irregular shape will be used to provide interstitial spaces to serve as hiding cover" (Westar 1983). Large boulders and rocks should be retained for later distribution since they can provide cover for insects and small mammals and perching habitat for birds (Michalski et al 1987). Rock piles will be placed during resloping and site preparation for planting trees and shrubs (Figure 9).

Figure 9. Rock and woody debris pile on a reclaimed section of the Bodie waste dump.

4.3.5.4 Piles of Fine Spoil Material

Ad hoc observations made on the Bodie dump in 2002 indicate that piles of fine spoil material may provide microsites that promote increased survival of conifer seedlings on dry south-facing sites (RTU's H-1, H-3, L-1, and L-3). The improved survival and good to excellent seedling vigour on plants adjacent to this habitat element may be due to it providing shelter from desiccating winds in winter or sun and wind during the growing season in addition to providing a good rooting medium. These types of microsites will be created during resloping activities or when excavators are used for site preparation prior to planting trees and shrubs (Figure 10).

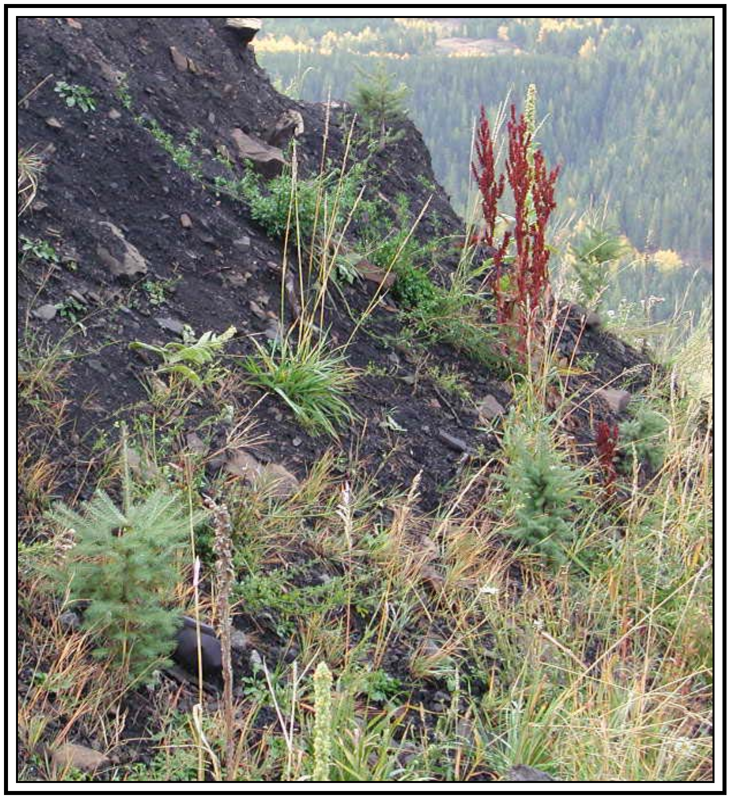

Figure 10. Engelmann spruce seedlings in their second growing season growing in association with a pile of fine spoil material on the Bodie reclaim.

4.3.5.5 Downed Wood (modified from Westar 1983)

Elton (in Maser et al. 1979) estimated that systems with no dead or downed woody material lost more than 20% of its fauna. Downed wood is important to many vertebrate and invertebrate species as well as in nutrient cycling and mycorrhizal colonization of new areas (Harvey et al. 1976, Bunnell et al. 1995). Maser et al. (1979) and Bunnell et al. (1995, 1999) outlined several other important features associated with logs. In an experimental reclaimed site on Harmer, Westar Mining found increased tree survival on spruce outplanted on the leeward side of logs (Environmental Services, Westar Mining, unpublished data). In addition, logs have been used in reclamation of bauxite spoils in Australia to encourage arthropod decolonisation (Major et al. 1982). Generally speaking, the larger the log the more useful it is (Maser et al. 1979, Bunnell et al. 1999).

Because of their mycorrhizal colonization properties, their wildlife value and increased tree survival associated with log created microsites, logs will be placed on the reclaimed sites in those areas that will be planted into tree and shrub islands. Log placement will be along the contour of the hill (rather than up and down a slope) to collect moisture, organic matter, nutrients and fines on the upslope side of the log (Ausmus, 1977 in Maser et al. 1979).

Wildlife use of logs increases as the log decomposes. However, handling of well-decomposed logs is difficult and much of the material will break-up or be lost. The downed wood placed during reclamation activities will be relatively sound. It will decay over time as decomposers re-establish and moisture content of the downed wood increases. Monitoring will be required to assess the effectiveness and longevity of downed woody microsites.

4.3.6 "Special" Areas (modified from Westar 1983)

4.3.6.1 Highwalls and Footwalls

Several types of areas created in the mining process are regarded as being economically "unreclaimable" in the traditional sense. Highwalls and footwalls that are not backfilled are not capable of being revegetated. However, these areas can be made useful in terms of wildlife habitat. Steele and Grant (1983) reported that man-made cliffs contributed significantly to bird populations on reclaimed sites in Colorado and New Mexico. Cliffs near water (within 0.5 km) are used more than cliffs further from water (Maser, Rodick and Thomas, 1979). These areas will be seeded several years after operations have ceased to take advantage of the *in situ* weathering of materials which will allow for the establishment of a sparse vegetative cover. Highwalls will provide good escape cover for Rocky Mountain bighorn sheep *(Ovis canadensis)*[9].

4.3.6.2 Talus

Talus slopes are natural landscape features of the Elkview mine area. While it is recognized that large areas of talus is not an acceptable reclamation goal, several small areas of steep, large diameter rubble will be left in order to satisfy the habitat requirements of some species. The pika is an obligate talus species and the Golden Mantled Ground Squirrel and Neotoma Wood Rat are seldom found in any other habitat type at the Elkview mine. These species have colonized two reclaimed slide areas on the property that satisfy the habitat component of large, loose rubble. Areas that will be left as steep, non-vegetated talus for pikas will have to be deep to satisfy the thermal requirements described by Krear (1965) in Maser et al. (1979).

5. Reclamation Treatment Unit Regimes

RTU regimes include a basic set of treatments that will be applied wherever a significant area of a specific RTU occurs in the landscape. Variations in RTU treatment regimes will be required to account for availability of seed mixes, planting stock (trees and shrubs), or additional habitat structures. Each RTU is defined by its general management intent, specific objectives (Table 2), and, in some cases, unique management issues. Management intent is framed with a focus on the featured species (elk and mule deer). However, the mosaic of habitats over the mine site should be considered when evaluating the overall plan objective for providing a wide range of wildlife habitat diversity. There are also a number of common features among the RTU's where similar treatments are applied (e.g., seeding and fertilization) and these were detailed in previous sections of the text.

Tree and shrub seedling requirements will vary among RTU's and from year to year. Table 3 provides an estimate of seedling requirements and areas for grass-legume plant community establishment for a conceptual hectare of each RTU.

5.1 RTU: H-1 - High Elevation, Steep Slopes, Warm and Neutral Aspects

5.1.1 Management Intent

The focus of treatments in this RTU is to provide quick initial erosion control and to produce forage for elk and mule deer in summer and fall. The target plant communities will consist of 95 - 100% agronomic grasses-legumes and 0 - 5% native trees and shrubs. Additional habitat elements will not be created in this RTU.

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[9] Dave Ryder, Senior Environmental Coordinator, Elkview Coal Corp., personal communication, 2003.

5.1.2 Unique Management Issues

This RTU will be left with slopes that have modified crest angles of 26° with average slopes of approximately 34°. Steep slopes, poor soils and dry site conditions will limit the potential for establishing trees and shrubs on these sites. Snow loads on adjacent RTU's may limit ungulate movement and the potential for these areas as to be accessed for winter range.

5.1.3 Specific Treatments

5.1.3.1 Grass and Legume Plant Communities

- modify slopes by reducing crest angles to approximately 26° and pushing down slope at 37°; spread available soil material to ameliorate harsh growing conditions where possible.
- aerially seed agronomics in the fall following resloping.
- fertilize the following spring, maintenance fertilizer applications as required.

5.1.3.2 Trees and Shrubs

The steepness of these slopes will make it difficult for planters to work safely and efficiently which, in combination with the dry site conditions, will limit the opportunity to establish trees and shrubs. However, benches associated with former roads and the toe slopes adjacent to them will provide opportunities for site preparation and planting appropriate microsites.

- site prepare benches (ripper or excavator as appropriate).
- cluster plant to take advantage of appropriate microsites at densities appropriate for each species.
- spring plant with frozen stored stock prior to June 10th.

5.2 RTU: H-2 - High Elevation, Moderate and Steep Slopes, Cool and Neutral Aspects

5.2.1 Management Intent

The focus of this RTU is to provide a mix of conifer-deciduous forests for hiding and thermal cover intermixed with forage areas dominated by grasses and legumes. The target plant communities will consist of 25 - 45% agronomic grasses-legumes, 5% native grasses and legumes, and 50 - 70% native trees and shrubs. Conifers will dominate the tree species planted in this RTU.

5.2.2 Unique Management Issues

Deep snow loads and late snowmelt will influence tree and shrub planting programs on these sites. Agronomic grass-legume communities will be promoted on the steepest slopes due to the difficulty associated with planting them with trees and shrubs.

5.2.3 Specific Treatments

5.2.3.1 Grass and Legume Plant Communities

- modify slopes by reducing resloping to approximately 26°. Approximately 10% of this RTU will be left with slopes that have modified crest angles of approximately 26° with average slopes of approximately 34°; spread available soil material to ameliorate harsh growing conditions where possible.

- priority for agronomic seed mixes will be given to steeper slopes.
- aerially seed agronomics in the fall immediately following resloping. Application with hydroseeders or hand-held cyclone seeders may be considered in some situations to avoid areas designated for tree and shrub planting.
- fertilize the following spring, maintenance fertilizer applications as required.
- native grass-legume species islands will be limited to the more gentle slopes.

5.2.3.2 Trees and Shrubs

- avoid steep slopes when establishing trees and shrubs.
- mechanically site prepare by ripping or with excavators, or use herbicides, as required to reduce potential competition from grasses and forbs.
- planting should take advantage of the best microsites and seedlings will be planted at densities appropriate for each species.
- summer plant conifer hot stock between June 20th – July 15th, spring plant frozen stored deciduous stock prior to June 10th.

5.2.3.3 Additional Habitat Elements

- avoid locating additional habitat elements on steep slopes.
- standing dead trees in clusters of 3 – 5, rock piles, brush piles and downed wood will be incorporated randomly where operationally feasible depending on the availability of appropriate materials.

Table 2. Reclamation treatment unit description and objectives.

<table>
<tr><th rowspan="3">RTU</th><th rowspan="3">Description</th><th colspan="6">Spatial Diversity Objectives (% of RTU)</th><th rowspan="3">Additional Structural Elements</th><th colspan="3">Productivity Objectives (kg/ha)</th></tr>
<tr><th colspan="3">Tree and Shrub Dominated</th><th colspan="3">Grass and Forb Dominated</th><th rowspan="2">Elev. (m)</th><th rowspan="2">Target*</th><th rowspan="2">Min.**</th></tr>
<tr><th>Tree</th><th>Shrub</th><th>Total</th><th>Agronomic</th><th>Native</th><th>Total</th></tr>
<tr><td rowspan="2">H – 1</td><td rowspan="2">High Elevation, Steep Slopes, Warm and Neutral Aspects</td><td rowspan="2">0 – 5</td><td rowspan="2">0 – 5</td><td rowspan="2">0 – 5</td><td rowspan="2">95 – 100</td><td rowspan="2">0</td><td rowspan="2">95 – 100</td><td rowspan="2">No</td><td>> 1850</td><td>500</td><td>250</td></tr>
<tr><td>1650-1850</td><td>A – 2000
N – 1000</td><td>A – 1000
N – 500</td></tr>
<tr><td rowspan="2">H – 2</td><td rowspan="2">High Elevation, Moderate and Steep Slopes, Cool and Neutral Aspects</td><td rowspan="2">40 – 55</td><td rowspan="2">10 – 30</td><td rowspan="2">50 – 70</td><td rowspan="2">25 – 45</td><td rowspan="2">5</td><td rowspan="2">30 – 50</td><td rowspan="2">Yes</td><td>> 1850</td><td>500</td><td>250</td></tr>
<tr><td>1650-1850</td><td>A – 2000
N – 1000</td><td>A – 1000
N – 500</td></tr>
<tr><td rowspan="2">H – 3</td><td rowspan="2">High Elevation, Moderate Slopes, Warm Aspects</td><td rowspan="2">5 – 10</td><td rowspan="2">5 – 10</td><td rowspan="2">10 – 20</td><td rowspan="2">75 – 85</td><td rowspan="2">5</td><td rowspan="2">80 – 90</td><td rowspan="2">Yes</td><td>> 1850</td><td>500</td><td>250</td></tr>
<tr><td>1650-1850</td><td>A – 2000
N – 1000</td><td>A – 1000
N – 500</td></tr>
<tr><td rowspan="2">H - 4</td><td rowspan="2">High Elevation, Flat – Rolling Complex Terrain, Variable Aspects</td><td rowspan="2">15 – 20</td><td rowspan="2">15 – 20</td><td rowspan="2">30 – 40</td><td rowspan="2">50 – 60</td><td rowspan="2">10</td><td rowspan="2">60 – 70</td><td rowspan="2">Yes</td><td>> 1850</td><td>500</td><td>250</td></tr>
<tr><td>1650-1850</td><td>A – 2000
N – 1000</td><td>A – 1000
N – 500</td></tr>
<tr><td>L – 1</td><td>Low Elevation, Steep Slopes, Warm and Neutral Aspects</td><td>0 – 5</td><td>0 – 5</td><td>0 – 5</td><td>95 – 100</td><td>0</td><td>95 – 100</td><td>No</td><td rowspan="4">< 1650</td><td rowspan="4">A – 3000
N - 1500</td><td rowspan="4">A – 1500
N – 500</td></tr>
<tr><td>L – 2</td><td>Low Elevation, Moderate and Steep Slopes, Cool and Neutral Aspects</td><td>40 – 55</td><td>10 – 30</td><td>50 – 70</td><td>25 – 45</td><td>5</td><td>30 – 50</td><td>Yes</td></tr>
<tr><td>L – 3</td><td>Low Elevation, Moderate Slopes, Warm Aspects</td><td>5 – 10</td><td>5 – 10</td><td>10 – 20</td><td>75 – 85</td><td>5</td><td>80 – 90</td><td>Yes</td></tr>
<tr><td>L - 4</td><td>Low Elevation, Flat – Rolling Complex Terrain, Variable Aspects</td><td>15 - 20</td><td>15 - 20</td><td>30 - 40</td><td>50 - 60</td><td>10</td><td>60 - 70</td><td>Yes</td></tr>
<tr><td>SU - 1</td><td>Steep, Untreated</td><td colspan="10">Includes highwalls footwalls, rock, and talus. These areas will be seeded after they have been left to weather for a few years and should be considered non-productive.</td></tr>
</table>

Notes:

* Target productivity represents the average above ground dry weight productivity that will be achieved over the area in each RTU averaged on a property-wide basis five years after the cessation of fertilizer treatments.

Numbers preceded by an A are for agronomic legume dominated swards (>50% ground cover of legumes).

Numbers preceded by an N are for non-agronomic and native swards (≥50% ground cover of agronomic grasses or native species).

** No area larger than 2 hectares will have average above ground dry weight biomass levels below this minimum.

Table 3. Tree and shrub seedling requirements for a conceptual hectare, by treatment unit.

RTU	Assumptions	Area in Grass-Legume (ha)		Seedling Requirements (#/ha)		
		Agron.	Native[1]	Trees	Shrubs	Total
H-1 & L-1	5% of the area will be planted 25% of the seedlings will be coniferous trees at 2000/ha 25% of the seedlings will be deciduous trees at 2000/ha 50% of the seedlings will be shrubs at 3000/ha	0.95	0.0	50	75	125
H-2 & L-2	60% of the area will be planted 60% of the seedlings will be coniferous trees at 2000/ha 20% of the seedlings will be deciduous trees at 2000/ha trees will be planted at 2000/ha 20% of the seedlings will be shrubs at 3000/ha planting will be concentrated on moderate slopes	0.35	0.05	960	360	1320
H-3 & L-3	20% of the area will be planted 20% of the seedlings will be coniferous trees at 2000/ha 20% of the seedlings will be deciduous trees at 2000/ha trees will be planted at 2000/ha 60% of the seedlings will be shrubs at 3000/ha planting will be concentrated on moderate slopes	0.75	0.05	160	360	520
H-4 & L-4	40% of the area will be planted 25% of the seedlings will be coniferous trees at 2000/ha 25% of the seedlings will be deciduous trees at 2000/ha 50% of the seedlings will be shrubs at 3000/ha	0.5	0.1	400	600	1000
SU-1	No planting required	0.0	0.0	0	0	0

5.3 RTU: H-3 - High Elevation, Moderate Slopes, Warm Aspects

5.3.1 Management Intent

The focus of this RTU is to provide grass and legume dominated forage areas for ungulate late spring, summer, and fall range intermixed with shrub patches and minor areas with conifer-deciduous trees. The target plant communities will consist of 75 - 85% agronomic grasses-legumes, 5% native grasses and legumes, and 10 - 20% native trees and shrubs with shrubs being the dominant component.

5.3.2 Unique Management Issues

Dry site conditions and heavy use by deer and elk will limit the potential for establishing trees and shrubs on these sites.

1 These areas are specific to islands that will be created within agronomic communities to encourage the dispersal of native plant seed over the mine site. Additional native seed will be applied where tree and shrub seedling have been established.

5.3.3 Specific Treatments

5.3.3.1 Grass and Legume Plant Communities

- modify slopes by resloping to approximately 26°; spread available soil material to ameliorate harsh growing conditions.
- aerially seed agronomics in the fall following resloping.
- fertilize the following spring, maintenance fertilizer applications as required.

5.3.3.2 Trees and Shrubs

- planting should be concentrated in protected sites around additional habitat elements, in localized areas that shift to neutral aspects, or in concave slope positions (e.g., toe slopes).
- Mechanically site prepare all areas by ripping or with excavators, or apply herbicides, to reduce competition from grasses and forbs.
- cluster plant to take advantage of the best microsites and seedlings will be planted at densities appropriate for each species.
- spring plant frozen stored coniferous and deciduous stock as quickly as possible after snowmelt.

5.3.3.3 Additional Habitat Elements

- standing dead trees in clusters of 3 – 5, rock piles, brush piles and downed wood will be incorporated randomly where operationally feasible depending on the availability of appropriate materials.

5.4 RTU: H-4 - High Elevation, Flat to Rolling Complex Terrain, Variable Aspects

5.4.1 Management Intent

The objective for this RTU is to provide a mosaic of grass and legume dominated forage areas for ungulate summer and fall range intermixed with tree and shrub patches that take advantage the varied terrain. The target plant communities will consist of 50 - 60% agronomic grasses and legumes, 10 % native grasses and legumes, and 30 - 40% native trees and shrubs with a relatively even split between the tree and shrub components.

5.4.2 Unique Management Issues

Complex terrain will make it difficult to optimize the use of microsites for tree and shrub planting.

5.4.3 Specific Treatments

5.4.3.1 Grass and Legume Plant Communities

- modify slopes by resloping to approximately 26° where required. Free-dump areas will require some surface modification and may require the addition of soil material where coarse materials are dominant.
- seed agronomics in the fall following resloping.
- fertilize the following spring, maintenance fertilizer applications as required.

5.4.3.2 Trees and Shrubs

- planting should be concentrated on cool and neutral aspects, moisture receiving sites, and in protected locations around additional habitat elements.
- mechanically site prepare by ripping or with excavators, or use herbicides, as required to reduce potential competition from grasses and forbs.
- plant to take advantage of the best microsites and seedlings will be planted at densities appropriate for each species.
- spring plant frozen stored coniferous and deciduous as quickly as possible after snowmelt and summer plant conifers on areas that retain snow for extended periods.

5.4.3.3 Additional Habitat Elements

- standing dead trees in clusters of 3 – 5, rock piles, brush piles and downed wood will be incorporated randomly where operationally feasible depending on the availability of appropriate materials.

5.5 RTU: L-1 - Low Elevation, Steep Slopes, Warm and Neutral Aspects

5.5.1 Management Intent

The focus of treatments in this RTU is to provide quick initial erosion control and to provide forage for elk and mule deer winter range. The target plant communities will consist of 95 - 100% agronomic grasses-legumes and 0 - 5% native trees and shrubs. Additional habitat elements will not be created in this RTU.

5.5.2 Unique Management Issues

This RTU will be left with slopes that have modified crest angles of 26° and average slopes of approximately 34°. Steep slopes, poor soils and dry site conditions will limit the potential for establishing trees and shrubs on these sites.

5.5.3 Specific Treatments

5.5.3.1 Grass and Legume Plant Communities

- modify slopes by reducing crest angles to approximately 26° and pushing down slope at 37°; spread available soil material to ameliorate harsh growing conditions where possible.
- aerially seed agronomics in the fall following resloping.
- fertilize the following spring, maintenance fertilizer applications as required.

5.5.3.2 Trees and Shrubs

The steepness of these slopes will make it difficult for planters to work safely and efficiently which, in combination with the dry site conditions, will limit the opportunity to establish trees and shrubs. However, benches associated with former roads and the toe slopes adjacent to them will provide opportunities for site preparation and planting appropriate microsites.

- mechanically site prepare benches (ripper or excavator as appropriate).
- cluster plant to take advantage of appropriate microsites at densities appropriate for each species.
- spring plant with frozen stored as close to snowmelt as possible.

5.6 RTU: L-2 - Low Elevation, Moderate and Steep Slopes, Cool and Neutral Aspects

5.6.1 Management Intent

The focus of this RTU is to provide a mix of conifer-deciduous forests for hiding and thermal cover intermixed with forage areas dominated by grasses and legumes. The target plant communities will consist of 25 - 45% agronomic grasses-legumes, 5% native grasses and legumes, and 50 - 70% native trees and shrubs. Deciduous species will dominate the trees planted in this RTU.

5.6.2 Unique Management Issues

Agronomic grass-legume communities will be promoted on the steepest slopes first due to the difficulty associated with planting them with trees and shrubs.

5.6.3 Specific Treatments

5.6.3.1 Grass and Legume Plant Communities

- modify slopes by resloping to approximately 26°. Approximately 10% of this RTU will be left with slopes that have modified crest and toe angles with average slopes of approximately 34°; spread available soil material to ameliorate harsh growing conditions.
- priority for agronomic seed mixes will be given to steeper slopes.
- aerially seed agronomics in the fall immediately following resloping. Application with hydroseeders or hand-held cyclone seeders may be considered in some situations to avoid areas designated for tree and shrub planting.
- fertilize the following spring, maintenance fertilizer applications as required.
- native grass-legume species islands should be created on more gentle slopes.

5.6.3.2 Trees and Shrubs

- avoid steep slopes when establishing trees and shrubs.
- mechanically site prepare by ripping or with excavators, or use herbicides, as required to reduce potential competition from grasses and forbs.
- planting should take advantage of the best microsites and seedlings will be planted at densities appropriate for each species.
- spring plant frozen stored stock prior to June 10th.

5.6.3.3 Additional Habitat Elements

- avoid locating additional habitat elements on steep slopes.
- standing dead trees in clusters of 3 – 5, rock piles, brush piles and downed wood will be incorporated randomly where operationally feasible depending on the availability of appropriate materials.

5.7 RTU: L-3 - Low Elevation, Moderate Slopes, Warm Aspects

5.7.1 Management Intent

The focus of this RTU is to provide grass and legume dominated forage areas for ungulate winter range intermixed with shrub patches and minor areas with coniferous and deciduous trees. The target plant communities will consist of 75 - 85% agronomic grasses-legumes, 5% native grasses and legumes, and 10 - 20% native trees and shrubs with shrubs being the dominant component.

5.7.2 Unique Management Issues

Dry site conditions and heavy use by deer and elk will limit the potential for establishing trees and shrubs on these sites.

5.7.3 Specific Treatments

5.7.3.1 Grass and Legume Plant Communities

- modify slopes by resloping to approximately 26°; spread available soil material to ameliorate harsh growing conditions.
- aerially seed agronomics in the fall following resloping.
- fertilize the following spring, maintenance fertilizer applications as required.

5.7.3.2 Trees and Shrubs

- planting should be concentrated in protected sites around additional habitat elements, in localized areas with shifts to neutral aspects, or in concave slope positions (e.g., toe slopes).
- mechanically site prepare by ripping or with excavators, or use herbicides, as required to reduce potential competition from grasses and forbs.
- cluster plant to take advantage of the best microsites and seedlings will be planted at densities appropriate for each species.
- spring plant frozen stored coniferous and deciduous stock as quickly as possible after snowmelt.

5.7.3.3 Additional Habitat Elements

- standing dead trees in clusters of 3 – 5, rock piles, brush piles and downed wood will be incorporated randomly where operationally feasible depending on the availability of appropriate materials.

5.8 RTU: L-4 - Low Elevation, Flat to Rolling Complex Terrain, Variable Aspects

5.8.1 Management Intent

The objective for this RTU is to provide a mosaic of grass and legume dominated forage areas for ungulate spring, summer and fall range intermixed with tree and shrub patches that take advantage the varied terrain. The target plant communities will consist of 50 –6 0% agronomic grasses and legumes, 10% native grasses and legumes, and 30 - 40% native trees and shrubs with a relatively even split between the tree and shrub components.

5.8.2 Unique Management Issues

Complex terrain will make it difficult to optimize the use of microsites for tree and shrub planting.

5.8.3 Specific Treatments

5.8.3.1 Grass and Legume Plant Communities

- modify slopes by resloping to approximately 26° where required. Free-dump areas will require some surface modification and may require the addition of topsoil where coarse materials are dominant.
- seed agronomics in the fall following resloping, avoid areas designated for tree and shrub planting.
- fertilize the following spring, maintenance fertilizer applications as required.

5.8.3.2 Trees and Shrubs

- planting should be concentrated on cool and neutral aspects, moisture receiving sites, and in protected locations around additional habitat elements.
- mechanically site prepare by ripping or with excavators, or use herbicides, as required to reduce potential competition from grasses and forbs.
- plant to take advantage of the best microsites and seedlings will be planted at densities appropriate for each species.
- spring plant frozen stored coniferous and deciduous stock as quickly as possible after snowmelt.

5.8.3.3 Additional Habitat Elements

- standing dead trees in clusters of 3 – 5, rock piles, brush piles and downed wood will be incorporated randomly where operationally feasible depending on the availability of appropriate materials.

5.9 RTU: SU-1 – Steep, Untreated

5.9.1 Management Intent

This RTU includes highwalls, footwalls, rock, talus and orphan dumps greater than 100 meters high. These areas will not be treated or they will receive one aerial application of an appropriate grass-legume mix after they have been left to weather for a few years when operations cease. They should be considered non-productive from a vegetation establishment perspective.

6. Reclamation Schedule

A 30-year mine plan was developed for the Elkview property in 2001 that included a reclamation schedule that identified areas for treatment over the life of the plan. The main focus of the plan is to ensure that reclamation liabilities are dealt with as they are incurred and to ensure that at the end of the plan, there are minimal liabilities left outstanding. An important aspect of this schedule includes dealing with the backlog of disturbed lands left from the previous owners.

After careful assessment of the areas available for reclamation, it was decided that a phased approach would be most effective. Based on equipment availability, 100 hectares was determined to be an acceptable and attainable area to treat annually. The mine plan was examined and suitable areas were delineated for reclamation treatments and the resulting schedule, provided in Appendix 5, shows the proposed areas of reclamation activity over the next 30 years. The first 10 years of the schedule is shown in detail and the remainder is shown in five-year increments.

Mine plans change frequently and the schedule is based on the current mine plan. Detailed reclamation schedules will be developed annually and submitted as part of the annual reclamation report.

7. Results Based Standards and General Operational Monitoring Program

This section outlines a set of results-based standards and additional criteria that will be used to assess reclamation success at Elkview. It also describes the philosophy and general approach that will be used while developing and implementing research studies and the operational monitoring program.

7.1 Results Based Standards

Elkview Coal Corporation believes that there is a need to develop clear, measurable and objective criteria that can be used to set specific results based standards for assessing reclamation success. There are additional criteria that can be used to support the results obtained when assessing results based standards but they cannot be used to define standards because they are subjective or there is not enough information currently available. Table 4 provides a summary of the results based criteria and specific indicators that Elkview will use to assess reclamation success.

Table 4. Results based criteria and indicators of reclamation success at Elkview Coal Corporation.

Criteria		Indicators of Success
Geological Stability		Progressive annual dump resloping No significant dump failures
Minimize and Control Surface Erosion		No active rills > 30 cm deep and 30 cm wide 3 years after resloping treatments have been completed Provincial air quality standards (fugitive dust) Provincial water quality standards (TSS)
Vegetation	Productivity	Productivity targets specified in Table 2 for grass and legume swards
	Spatial Diversity	Spatial (area based) objectives outlined in Table 2 Variety in patch size distribution
	Species Diversity	Establishment of native species islands as outlined in Table 2 Successful establishment and acceptable growth of native trees and shrub species as outlined in Table 2

7.2 Additional Reclamation Success Criteria

Table 5 provides a summary of the additional criteria that will be used to support findings that result from assessing Elkview's results based standards. The additional criteria have a strong focus on ecological processes and wildlife habitat connectivity and use. These criteria are either subjective or there have not been enough studies completed to allow for assigning specific values that would indicate if important thresholds exist and whether they have been reached or exceeded. It is also possible that some of the criteria could have localized values assigned as additional information becomes available.

Table 5. Additional criteria and indicators of reclamation success at Elkview Coal Corporation.

Criteria	Indicators of Success
Spatial Diversity	Connectivity with adjacent undisturbed land is promoted
Vegetation	Foliar nutrient and trace element content Species richness and diversity Native species are expanding from original planting and seeding locations
Ecological Functioning	Soil profile development is occurring Soil organic matter and nutrients are aggrading Mycorrhizal fungi colonization % is increasing
Wildlife Use	Continued presence and migration of deer and elk Re-establishment and ongoing use by a variety of wildlife species

Naeth et al. (1991) recommends the establishment of benchmark sites to permit the comparison of soil physical properties disturbed through reclamation activities. They state that these sites should have detailed characterization and be monitored over long periods because undisturbed soil reference sites are imperative in all reclamation research and monitoring. A series of soil reference sites will be established to ensure that there is good representation of each RTU and that the soil chemical and physical properties are characterized. These sites will be reassessed at 10 year intervals.

There are a number of direct measures that can be used to assess whether biogeochemical cycling has been re-established effectively. Zak (1992) suggests that monitoring microbial activity at the functional level may be an effective way to monitor short and long-term reclamation success. He also indicates that measures of mycorrhizal species abundance, change over time, and richness can also assist in determining reclamation success. Allen and Friese (1992) suggest that spore counts of arbuscular mycorrhizal fungi are a good indicator of reclamation success since mycorrhizal reproduction indicates active association with plants. Elkview will use mycorrhizal colonization as a measure of ecosystem process at the functional level. This will be combined with changes in soil chemical and physical characteristics over time to indicate that functional processes at the soil level are developing.

The use of the post reclamation landscape by a variety of wildlife species will be a critical measure of reclamation success. Mule deer and elk will continue to be monitored through aerial flights as recommended by Gibson and Sheets (1997). Additional species, including birds, mice, voles and shrews will be monitored.

7.3 Generalized Monitoring Program

The success of the reclamation program at Elkview depends on the persistence of diverse wildlife habitats. A holistic approach to monitoring that assesses a range of ecological parameters will be required to evaluate program success (Wade and Chambers 1992). The monitoring program at Elkview is designed to yield results that will help to evaluate three basic questions:

1. Have results based standards been achieved?
2. Have overall reclamation objectives been achieved? and,
3. Are reclamation treatments appropriate or are adjustments required?

The reclaimed landscape will go through a series of relatively rapid successional stages and there is a need to be confident that a positive trend has established. Ecological processes are dynamic and results that are apparent after five years will likely have changed after 20 years. Also, it is not clear whether the results of short-term assessments will be good predictors of long-term ecological outcomes. The monitoring program will be designed to describe the changes, relate measured variables to environmental conditions, attempt to establish important ecological relationships and recommend maintaining, modifying or stopping specific reclamation treatments. Wherever possible statistical tests will be used to assess whether important thresholds have been achieved or exceeded. However, a significant hypothesis test may not be a good indicator of the broader applicability of a treatment (Black et al 2001).

Adaptive management approaches (Walters 1986, Nyberg 1998) will be incorporated into all reclamation treatment design, research and monitoring programs. One program objective, and a basic adaptive management principle, is to use monitoring results to test all of the assumptions used in developing reclamation plan concepts. The most significant of these will be the factors used in defining RTU's. For example, Smyth and Paton (2000, p. 22) found that "aspect, coarse fragments and mesoslope position were the main determinants of the sampled environmental variables".

The monitoring program will assess six basic criteria: geological stability of reclaimed dumps, successful control of surface erosion, spatial diversity, vegetation productivity and diversity, ecological functioning, and wildlife use. Specific measurable objectives have been developed for some parameters and others will be assessed through determining whether they are in a stable or increasing state. Monitoring will follow standard approaches where possible (e.g., Habitat Monitoring Committee 1996, Luttmerding et al. 1990).

Table 6 provides an overview of the timing of operational monitoring assessments that will be required to evaluate the reclamation program at Elkview Coal. Additional research may be required where specific problems that require detailed study are identified. Time "0" in Table 6 will be set at either the date of resloping or the date when fertilization on a specific site ends. It is important to differentiate these points in time since results based vegetation productivity standards will be assessed from the time when fertilization ends.

A detailed monitoring program with monitoring protocols will be developed during 2003 and 2004. The final monitoring program will also identify current research needs at Elkview.

Table 6. Monitoring indicators and timing.

Criteria	Indicator	Years from Revegetation or Cessation of Fertilization					
		0[2]	3	5	10	15	20
Soils	Profile Development		✓		✓		✓
	Organic Matter Content % (top 10 cm)		✓		✓		✓
	Nutrients, Metals	✓	✓		✓		✓
	Soil Organisms (mycorrhizal fungi)		✓		✓		✓
Grasses and Forbs	Species Composition		✓	✓	✓	✓	✓
	Native Species Ingress			✓	✓	✓	✓
	Above Ground Biomass (grass, forb)		✓	✓	✓	✓	✓
	Below Ground Biomass (total)		✓	✓	✓	✓	✓
	Nutrients, Metals		✓	✓	✓	✓	✓
	Mycorrhizal Relationships			✓	✓	✓	✓
Trees and Shrubs	Survival	1st, 2nd, 3rd and 5th years after planting[3]					
	Growth			✓	✓	✓	✓
	Mycorrhizal Relationships			✓	✓		✓
Wildlife	Ungulates (elk, mule deer)	annual flights and fecal nitrogen analysis					
	Small Mammals			✓	✓		✓
	Birds			✓	✓		✓

8. Outstanding Issues

Reclamation science is relatively young and this plan incorporates a number of ideas, concepts, and treatments that are not proven at Elkview Coal. Ecological systems are complex and specific measures of success are difficult to set, particularly where threshold values may be important. A combination of clear objective measures (e.g., biomass productivity) and more general subjective trend-based criteria (e.g., mycorrhizal colonization, soil profile development) have been proposed as measures that will be used to assess reclamation success. As more information becomes available it may be necessary to revise the objective criteria, set objective criteria for some that are currently subjective and add additional subjective criteria. The operational monitoring and research programs are designed to provide some of the information and to clearly indicate where additional information is required.

Specific ideas, concepts, and treatments that are addressed in this plan that currently require additional operational experience and testing include:

1. Low Elevation Ungulate Winter Range (RTU's L-1 and L-3)

   Elkview Coal has limited experience revegetating these RTU's. It is unclear if the proposed mosaic of grass-forb and tree-shrub dominated plant communities will be sufficient to promote the range of ungulate use that was present before disturbance. Successful establishment of trees and shrubs has been inconsistent on these sites and needs improvement.

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2 These assessments will be completed on specific sites to obtain a representative sample of each RTU.

3 Spring and late growing season assessments will be completed in the 1st – 3rd growing seasons to allow differentiation of mortality associated with growing season problems vs. winter desiccation.

2. Native Plant Ingress

   The use of native plant species islands as seed sources to encourage establishment throughout reclaimed landscapes has become a relatively common technique in British Columbia over the past decade. However, there is insufficient data to assess how effective the approach will be or what the appropriate size and distribution of the islands should be.

3. Additional Habitat Elements

   The majority of our knowledge regarding the importance of standing dead trees, brush piles, rock piles, and downed wood comes from research conducted in temperate forests. Their relative importance and functioning has not been established in reclaimed mine landscapes but they have been used at Elkview, Quintette Coal and the Sullivan Mine.

4. Reclamation Treatment Units

   The criteria used for delineating RTU's may not fully integrate the ecological factors that significantly influence plant community establishment and succession at Elkview. This will be one of the most important assumptions that requires testing through the operational monitoring program.

9. Conclusions

Elkview Coal Corporation believes that reclamation efforts that are focused on ecological factors that directly affect biogeochemical cycles and ecological diversity will provide for a mosaic of self-sustaining plant communities. Targeting diversity at all levels of detail including plant species composition, spatial arrangements of plantings and introduction of a range of habitat elements will ensure that an effective mosaic results. Implementation of the plan will ensure that end land use and reclamation objectives are achieved, reclamation activities are progressive, and that the reclamation program remains flexible and responsive to new ideas and information.

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Appendix 1
Wildlife Species That May Repopulate Reclaimed Land At Elkview Coal

(from Westar 1983)

TARGET SPECIES GROUP "A": Reproduce on the ground, in short grass high elevation grasslands with little or no shrub component.

Birds	Mammals
Water Pipit	Deer Mouse
Horned Lark	Meadow Vole
	Jumping Mouse
	Columbia Ground Squirrel
	Yellow Badger

TARGET SPECIES GROUP "B": Reproduce on the ground, in grassland vegetation with tall and legume grass species.

Birds	Mammals
Northern Harrier	Deer Mouse
Short Eared Owl	Meadow Vole
Vesper Sparrow	Jumping Mouse

TARGET SPECIES GROUP "C": Reproduce on the ground in grassland vegetation with scattered shrub component.

Birds	Mammals
Horned Lark	Deer Mouse
Savannah Sparrow	Meadow Vole
Vesper Sparrow	Jumping Mouse
	Columbia Ground Squirrel
	Yellow Badger

TARGET SPECIES GROUP "D": Reproduce on the ground in grassland/tall shrub association.

Birds	Mammals
Blue Grouse	Deer Mouse
Ruffed Grouse	Meadow Vole
Hermit Thrush	Jumping Mouse
Veery	Long tailed Weasel
Townsends Solitaire	Short tailed Weasel
Wilson's Warbler	Least Weasel
Orange-crowned Warbler	Columbia Ground Squirrel
Nashville Warbler	Yellow Badger
	Coyote
	White tail Deer
	Mule Deer
	Rocky Mountain Elk

TARGET SPECIES GROUP "E": Reproduce in shrubs or deciduous trees.

Birds
Calliope Hummingbird
Great Horned Owl
Mourning Dove
Cedar Waxwing
Willow Flycatcher
Dusky Flycatcher
Least Flycatcher
Eastern Kingbird
Common Crow
American Robin
Swainsons Thrush
Red eyed Vireo
Warbling Vireo
Solitary Vireo
American Redstart
MacGillvarys Warbler
Red-winged Blackbird
Brown-headed Cowbird
Lazuli Bunting
American Goldfinch
Chipping Sparrow
Brewers Sparrow
White-crowned Sparrow
Fox Sparrow
Song Sparrow

Mammals

TARGET SPECIES GROUP "F": Reproduce on the ground, in coniferous vegetation.

Birds
Blue Grouse
Ruffed Grouse
Spruce Grouse
Hermit Thrush
Dark eyed Junco

Mammals
Deer Mouse
Red-backed Vole
Long-tailed Vole
White tail Deer
Mule Deer
Rocky Mountain Elk
Moose
Lynx
Coyote

<u>TARGET SPECIES GROUP "G":</u> Reproduce in coniferous vegetation.

<u>Birds</u>
Goshawk
Sharpshinned Hawk
Coopers Hawk
Merlin
Long-eared Owl
Great Horned Owl
Rufous Hummingbird
Hammond's Flycatcher
Western Wood Peewee
Gray Jay
Steller's Jay
Clark's Nutcracker
Common Crow
Varied Thrush
American Robin
Ruby-crowned Kinglet
Golden-crowned Kinglet
Evening Grosbeak
Cassins Finch
Pine Grosbeak
Pine Siskin

<u>Mammals</u>
Red Squirrel
Pine Martin

<u>TARGET SPECIES GROUP "H":</u> Primary Cavity Nesters (make their own excavations in snags placed on reclaimed site)

<u>Birds</u>
Common Flicker
Pileated Woodpecker
Yellow bellied Sapsucker
Hairy Woodpecker
Downy Woodpecker
White breasted Nuthatch
Red breasted Nuthatch

<u>Mammals</u>

TARGET SPECIES GROUP "I": secondary Cavity Nesters (reproduce in holes made in snag by another species in a natural cavity or in an artificial nest box)

Birds
Wood Duck
Barrows Goldeneye
Bufflehead
Hooded Merganser
Common Merganser
American Kestrel
Pygmy Owl
Barred Owl
Saw Whet Owl
Boreal Owl
Vaux's Swift
Violet-green Swallow
Tree Swallow
Black-capped Chickadee
Mountain Chickadee
Boreal Chickadee
Brown Creeper
House Wren
Mountain Bluebird
Starling
House Sparrow

Mammals
Myotis spp.
Northern Flying Squirrel
Pine Martin

TARGET SPECIES GROUP "J": Utilize cliffs (highwalls, cut faces) or outcrops.

Birds
Peregrine Falcon
Black Swift
Barn Swallow
Cliff Swallow
Common Raven
Rock Wren
Gray-crowned Rosy Finch

Mammals
Bushy Tailed Wood Rat
Golden Mantled Ground Squirrel
Hoary Marmot
Cougar
Mountain Goat
Bighorn Sheep

TARGET SPECIES GROUP "K": Utilize talus (large diameter-sized overburden dumps).

Birds
Grey-crowned Rosy Finch

Mammals
Bushy Tailed Wood Rat
Golden Mantled Ground Squirrel
Pika

Appendix 2
Primary Seed Mixes Used at Elkview Coal Corporation

Low Mix 1: Low Elevation – Gentle to Moderate Slopes, Cool and Neutral Aspects

Species	% by Weight	% by Composition
alfalfa -creeping	5	3
birdsfoot trefoil	5	6
bluegrass, Canada	1	7
bluegrass, Kentucky	1	6
brome, smooth	10	4
clover, alsike	2	4
clover, white Dutch	2	5
fescue, creeping red	5	9
fescue, hard	5	8
fescue, sheeps	4	8
foxtail, coated meadow	15	9
orchardgrass	7	13
rye, perennial	10	7
wheat, crested	8	4
wheatgrass slender	20	9
TOTAL	100	100

Low Mix 2: Low Elevation – Steep Slopes, Warm and Neutral Aspects

Species	% by Weight	% by Composition
alfalfa -creeping	20	16
bluegrass, Canada	1	9
bluegrass, Kentucky	1	8
brome, smooth	20	10
fescue, hard	5	10
fescue, sheeps	4	10
foxtail, coated meadow	13	11
orchardgrass	3	7
wheat, crested	18	11
wheatgrass slender	15	9
TOTAL	100	100

Low Mix 3: Low Elevation - Native Mix – TO BE DETERMINED

Species	% by Weight	% by Composition

High Mix 1: High Elevation – Gentle to Moderate Slopes, Cool and Neutral Aspects

Species	% by Weight	% by Composition
alfalfa -creeping	8	6
bluegrass, Canada	1	8
brome, smooth	18	8
clover, alsike	4	9
fescue, creeping red	3	6
fescue, hard	5	10
fescue, sheeps	4	9
foxtail, coated creeping	10	8
orchardgrass	4	9
rye, perennial	12	10
wheat, crested	15	9
wheatgrass streambank	16	8
TOTAL	100	100

High Mix 2: High Elevation – Steep Slopes, Warm and Neutral Aspects

Species	% by Weight	% by Composition
alfalfa -creeping	20	18
bluegrass, Canada	1	10
brome, smooth	20	11
fescue, hard	2	5
fescue, tall	10	9
rye, perennial	20	20
timothy	2	10
wheat, crested	25	17
TOTAL	100	100

High Mix 3: High Elevation - Native Mix

Species	% by Weight	% by Composition
bluegrass, alpine	3	6
brome, mountain	24	6
fescue, Idaho	2	3
wheatgrass, northern	24	13
Fescue, rough	11	7
Rocky Mtn Fescue	24	55
American Vetch V. villosa	9	1
Alpine timothy	3	10
TOTAL	100	100

Appendix 3
Tree and Shrub Species for Reclamation Programs at Elkview Coal

Scientific Name	Common Name	Reclamation Treatment Unit								
		Riparian	H-1	H-2	H-3	H-4	L-1	L-2	L-3	L-4
Plant species currently used in the reclamation program at Elkview Coal										
Alnus sinuata	mountain alder	✓		✓		✓		✓		
Amelanchier alnifolia	saskatoon				✓	✓			✓	✓
Cornus stolonifera	red osier dogwood	✓		✓		✓		✓		✓
Elaeagnus comutata	wolfwillow		✓	✓	✓	✓	✓	✓	✓	✓
Picea engelmanni	Engelmann spruce	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pinus contorta	lodgepole pine		✓	✓	✓	✓	✓	✓	✓	✓
Populus trichocarpa	black cottonwood	✓	✓	✓	✓	✓	✓	✓	✓	✓
Populus tremuloides	trembling aspen			✓		✓	✓	✓	✓	✓
Prunus virginiana	chokecherry						✓	✓	✓	✓
Rosa acicularis	wild rose	✓	✓	✓	✓	✓	✓	✓	✓	✓
Salix sp.	upland willow		✓	✓	✓	✓	✓	✓	✓	✓
Plant species with potential for use in the reclamation program at Elkview Coal										
Acer douglasii	Douglas maple			✓		✓		✓	✓	✓
Arctostaphylos uva-ursi	kinnikinnik				✓	✓			✓	✓
Betula papyrifera	paper birch	✓		✓		✓		✓	✓	✓
Ceanothus velutinus	sticky laurel							✓	✓	✓
Ceanothus sanguineus	red stem ceanothus							✓	✓	✓
Dryas integrifolia	entire-leaved avens				✓	✓		✓	✓	✓
Juniperis communis	common juniper				✓	✓		✓	✓	✓
Larix occidentalis	western larch	✓	✓	✓	✓	✓	✓	✓	✓	✓
Potentilla fruticosa	shrubby cinquefoil						✓	✓	✓	✓
Salix sp.	riparian willow	✓								
Sambucus racemosa	elderberry	✓		✓		✓		✓		✓
Shepherdia canadensis	buffaloberry		✓	✓	✓	✓		✓		✓
Symphoricarpos albus	snowberry							✓	✓	✓
Sorbus sitchensis	mountain ash	✓		✓		✓		✓		

Appendix 4
Slope Classification, July 2002

Appendix 5
30 Year Reclamation Schedule