Appendix 11.26-A

Wildlife Habitat Objectives for Reclamation Plan

AJAX PROJECT

Environmental Assessment Certificate Application / Environmental Impact Statement for a Comprehensive Study

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Wildlife Habitat Objectives For Reclamation Plan

Prepared for

KGHM
Ajax Mine
Kamloops, BC

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environmental services for sustainable development

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1.0 Foreword

KGHM is preparing documents for submission to the British Columbia Environmental Assessment process with respect to a potential copper mine on the southwest boundary of the city of Kamloops. Aspen Park Consulting was asked to prepare a report outlining wildlife habitat requirements that could be incorporated into the proposed reclamation plan being prepared by VAST Resource Solutions Incorporated.

Plant and wildlife inventories were conducted within the proposed footprint of the mine and surrounding area by Keystone Wildlife Research Ltd. during 2007 and 2008. Terrestrial ecosystem mapping (TEM) was prepared by Keystone in 2007. This work formed much of the basis for the recommended habitat characteristics suggested in the following report.

2.0 Methodology

Characteristics of the existing wildlife habitats were noted during several field trips to the mine area from May through August, 2012 by R. Howie (RP Bio) and D. Jury (RP Bio). Formal, statistically robust surveys of the features were not made. Calculations of the areas occupied by existing features were coarsely-determined from orthophoto information. The objectives were to develop a sense of the types of features and traits of the existing habitats so that they could be used to develop prescriptions for replacement habitats. There would be no intent to duplicate the existing features in a quantitative way. The TEM mapping provided was used to further understand the nature of features across the landscape and there was no attempt made to either duplicate that or visit every location within the footprint of the proposed mine operation. Field surveys were targeted to sites felt to be representative of the existing variety.

Characteristics of other habitats in the Kamloops area have also been examined in order to develop concepts for features that could be created within the Ajax mining footprint. An exclosure plot of various species of bunchgrasses planted during the Afton Mine reclamation process was visited with Rick Tucker (P. Ag.) with the Ministry of Forests, Lands

The combined local knowledge of Howie and Jury was also used when developing habitat prescriptions. Both biologists have lived and worked in the area for over 30 years which enabled them to put the detailed inventory work of 2007-08 into a longer term perspective.

3.0 Wildlife Habitat Objectives

Reclamation of disturbed sites presents many challenges which include the desire to use local, native flora in the vegetation mix. Re-creating plant communities which mirror the pre-disturbance ecosystems is generally not feasible within the post-reclamation monitoring period which typically follows cessation of extraction activities and the increase in the rehabilitation process. Experience in many areas suggests that it is more realistic to determine desirable post-disturbance objectives which are practical and feasible given the challenging substrates typical of end of life mine sites. These prescriptions may in fact utilize many native species in the creation of habitats which are valuable for wildlife but will not duplicate the habitats we see today.

It is also recognized that the time frames necessary for vegetation to reach sustainable conditions are not simply predictable. It will be necessary to implement reclamation in a number of stages enroute to reaching final objectives. This means that the characteristics and species mix of the habitats will change over time as the reclamation program undertakes initiatives, monitors for success and modifies responses in order reach longer term goals. An iterative approach is necessary in order to be effective in the long term. In this period of more rapid climate change scenarios, predictions about which species may survive today could be altered if the general or micro-climate regime changes throughout the reclamation process. Hence the need to remain flexible in terms of species used while trying to meet broad habitat goals.

An additional factor which influences the approach to wildlife habitats is the need to integrate with other end land use goals for mine closure which may conflict with or require concessions in approaches that are wildlife - centric.

The objectives are therefore based upon the philosophy of ecological replacement where the post-mining landscapes may have similar functional characteristics to the pre-mining conditions but not necessarily consist of the same species composition. A mosaic of habitats will be planned that will provide vertical and horizontal heterogeneity. Existing habitats of value that are not clearly identified for disturbance will be identified for possible retention when detailed planning of the site facilities is undertaken. The total area and distribution of the wildlife oriented habitats across the post-disturbance landscape will in part be determined by the practicality of creating them as well as the opportunities presented in the end land use plan for the mine.

4.0 Existing Wildlife Diversity

Keystone Wildlife Research conducted wildlife surveys within and adjacent to the proposed mine operating area. They compiled sightings for 3 species of reptiles, 5 species of amphibians, 18 species of mammals and 136 species of birds. While the majority of species are not currently of conservation concern, there were species in each of the broad taxonomic groupings that are at some level of risk either provincially or under the federal Species at Risk Act (SARA). These are listed in Table __ and include 1 mammal. 2 amphibians,1 reptile, 6 species of birds plus 3 plant species. The Keystone report included *Astragalus lentiginosus var. lentiginosus* as blue – listed but its status has changed and it is now yellow – listed by the BC Conservation Data Centre. Similarly, the sandhill crane has been down-listed to yellow status.

Table 1. Species of conservation concern detected within the proposed Ajax mine operating area.

Taxa	Common Name	Latin Name	BC Status	SARA Status
Mammals	badger	*Taxidea taxus*	Red	Endangered
Amphibians	great basin spadefoot	*Spea intermontana*	Blue	Threatened
	western toad	*Anaxyrus borea*	Blue	Special Concern
Reptiles	northern rubber boa	*Charina bottae*	Yellow	Special Concern
Birds	great blue heron	*Ardea herodius herodius*	Blue	Not Listed
	Lewis's woodpecker	*Melanerpes lewis*	Red	Threatened
	olive-sided flycatcher	*Contopus cooperi*	Blue	Threatened
	sharp-tailed grouse	*Tympanuchus phasianellus columbianus*	Blue	Not Listed
	Swainson's hawk	*Buteo swainsoni*	Red	Not Listed
	barn swallow	*Hirundo rustica*	Blue	Threatened

Plants	Blue Grama	*Bouteloua gracilis*	Red	Not Listed
	Ovalpurse	*Hutchinsia procumbens*	Blue	Not Listed
	Sheathing Pondweed	*Stuckenia vaginata*	Blue	Not Listed

While the SARA legislation does not legally apply over the lands within the operating area, reclamation planning should consider retention or long-term re-establishment of SARA - listed species as part of the overall habitat creation plan.

5.0 Wildlife Habitat Objectives

It is recognized that re-creation of the existing habitats within the proposed disturbance areas is not feasible within a reasonable time frame. Evolution of the new landscape that might resemble the current conditions and species mix will take many decades following the creation of suitable conditions for the natural trajectory of ecosystem changes. The physical characteristics of the existing ecosystems were used to suggest long-term target conditions for reclamation, recognizing that the use of native plant species is desirable but may not always be possible, especially in the early stages of reclamation where growing conditions may not match the requirements of the endemic species.

The medium to long term objectives for habitat creation should provide for the following broad habitat types and special features:

- conifer (Douglas fir) forests with grass/shrub understory
- ponderosa pine forests with grass/shrub understory
- aspen copses with grass/shrub understory
- grasslands with shrub patches
- wetlands with emergent vegetation
- streamside riparian
- pit lake
- shrub gullies and damp depressions
- high rock faces
- scree slopes with large rocks and interstitial spaces
- boulder clusters in grasslands and forests
- course woody debris
- specialized features for species of conservation concern
    - -flat knoll tops with bunchgrass mix for sharp-tailed grouse
    - -snake dens
    - -snags

6.0 Target Wildlife Species

For each of the major habitat types, a list of target wildlife species is provided. This list is the potential group of species that may ultimately occupy the habitat once it reaches more mature conditions. The intention is that the list could be used as part of a monitoring program to determine the progress of colonization over time. The diversity of species using the habitats as well as densities of individuals may be one measure of success of the habitats in providing suitable conditions. Target densities for each species have not been determined. Whether the habitats become "source" or "sink" sites for wildlife populations will remain as an evaluation concept for reclamation monitoring.

7.0 Functional Characteristics of Habitat Types

The following discussion describes the physical and functional nature that may be achieved by the various target habitat types. They are based upon the pre-disturbance characteristics. It is expected that that reaching these conditions will take differing lengths of time for each of the habitats. While the species lists provided for the habitat types are native plants, it is recognized that other species may be substituted if growth and survival of native species cannot be achieved. For this reason, the physical nature of the targets and their functional traits for wildlife should be understood. There is no attempt made in this report to describe the reclamation techniques that will be needed to achieve the desired end result. It is expected that professionals with expertise in soils development and plant adaptations will design the reclamation methodologies necessary to develop the plant communities in a way that will reach the end goals for wildlife. It is anticipated that there will be a variety of intermediate steps required to establish these habitats which may include the seeding of agronomic grasses and forbs.

7.1 Habitat *Df* – Douglas Fir Forests

This habitat is primarily a Douglas fir forest that will ultimately provide mule deer winter range along with other wildlife benefits. Serious winter range values will not occur until the stand matures at 100 years or older and the canopy cover reaches the prescribed conditions It is expected that the best locations for this habitat type will be in places that have not been altered by the placement of waste rock although they may have been disturbed in some way. Soil conditions must be suited to tall tree development. Some sites may have remained undisturbed through the life of the mine. North-facing slopes on the tailings pile may be suitable if lower slope angles can be achieved and suitable soil conditions are present

The target habitat should ultimately consist primarily of a multi-layered, multi-age canopy of conifers (Douglas fir preferred) with a layer of both tall and low shrubs and a ground cover of grasses. The site should ultimately have about 25% of the forest with a low crown closure, 25% with a moderate closure and about 50% in a high closure condition with overlapping branches. Shrubs should consist of berry-producing species such as rose, common juniper, soopolallie and Saskatoon. The forest floor should be 80% covered with grasses and forbs. Evolution of the site to native bunchgrasses such as bluebunch wheatgrass or rough fescue would be ideal but it is expected that an interim cover of agronomic species will be necessary. Large downed wood is a valuable feature component that should be provided early in the reclamation process. Large boulders or boulder clusters are not a typical feature of such sites but occur occasionally under natural circumstances. and are recommended in the formula. Provision of such features will contribute to the site diversity throughout the evolving life of the habitat. It is expected that such sites will be developed at higher elevations and on cooler aspects with some stands on slopes up to 30^0 but flatter sites are desirable. Planting within areas that will accumulate moisture will be highly beneficial.

Moist site targets shown in Table 3 are for areas where water may even reach standing conditions for part of the year. Typical understory plants are black birch, willow and red-osier dogwood with spruce as a potential tree species. These sites are likely going to be fairly flat and perhaps not extensive and could include sedges in the understory.

7.1.1 Target Wildlife Species for Douglas Fir Forests

The following list of species indicates those that might be expected to colonize and breed in this habitat type as it matures. Some species will benefit from earlier seral stages. A wider array of birds will use the forests during migration but not during the breeding season. Primary and secondary cavity nesters will not colonize until the stands reach older age classes and larger diameter stems. Some species will be more likely under sparse canopy closure and others will need special elements to be successful. The presence of standing water is always of benefit to many species, even in small patches. Absence of utilization attributes for each wildlife species under the various seral stages is not meant to imply no use whatsoever. The table is meant to suggest the most common expected use patterns

Table 2. Target wildlife species for Douglas fir forests.

Species	shrub/ seedling	pole-sapling	young	mature	old growth	special elements
Birds						
red-tailed hawk	F			N	N	
American kestrel	F			N	N	snags, cavities
merlin	F		F	N	N	
dusky grouse	F N	F N		F N	F N	
great horned owl	F		F	F N	F N	
northern pygmy owl	F			F N	F N	snags, cavities
northern saw-whet owl	F			N	N	snags, cavities
calliope hummingbird				F N	F N	shrubs, riparian
hairy woodpecker			F	F N	F N	snags
northern flicker	F		F	F N	F N	snags
pileated woodpecker				F N	F N	snags
western wood pewee			F N	F N		
dusky flycatcher			F N	F N	F N	
Cassin's vireo				F N	F N	
common raven	F				F N	cliffs
mountain chickadee			F N	F N	F N	cavities, deciduous
red-breasted nuthatch			F N	F N	F N	cavities
ruby-crowned kinglet				F N	F N	
mountain bluebird	F					snags, cavities
Swainson's thrush				F N	F N	
American robin	F	F	F N	F N		
yellow-rumped warbler	F	F	F N	F N	F N	
Townsend's warbler					F N	
western tanager				F N	F N	
chipping sparrow	F N		F N	F N	F N	
dark-eyed junco	F N		F N	F N	F N	downed material
Cassin's finch						
red crossbill			F N	F N	F N	
pine siskin	F		F N	F N	F N	
evening grosbeak				F N	F N	
Mammals						
mule deer	F	F	F	F	F	downed material deciduous
white-tailed deer	F	F	F	F	F	
porcupine		F R	F R			downed material rock outcrops crevices
red squirrel			F R	F R	F R	snags

northern flying squirrel				F R	F R	snags
yellow-pine chipmunk	F	F	F R	F R	F R	downed material
northern pocket gopher	F R					grassy openings
deer mouse	F R	F R	F R	F R	F R	downed material
common shrew		F R	F R	F R	F R	standing water
long-eared myotis				F R	F R	snags
fringed myotis	F	F	F	F	F	
big brown bat					R	snags
bushy-tailed wood rat	F R	F R	F R	F R		downed material rocky outcrops, crevices
southern red-backed vole			F R	F R	F R	downed material
meadow vole	F R					downed material
snowshoe hare			F R	F R	F R	downed material
coyote	F R	F	F	F	F	
black bear	F R	F R	F R	F R	F R	downed material
marten				F R	F R	downed material, snags
ermine			F R	F R	F R	downed material
long-tailed weasel	F R	F R				downed material, snags
cougar	F	F	F	F	F	
bobcat	F	F	F	F R	F R	downed material
Reptiles						
wt garter snake	F R		F R	F R	F R	rock, wetlands
northern alligator lizard	F R	F R	F R	F R	F R	low crown closure rocky outcrops
rubber boa	F R		F R			talus, rocks

F = feeding N = nesting R = reproduction


Photograph 1. Young to middle age Douglas fir forest on north-facing slope.

Target Habitat Characteristics

Habitat	Slope degrees	Aspect degrees	Species	Stems/ha	Spacing metres	Understory		Large Downed Wood		Boulders		Snags/ha
						% groundcover	plants/ha	dia. cm	pieces/ha	Singles/ha	clusters	
Douglas Fir forest	4 - 30	320 - 90	Douglas Fir	800 - 1200	3 -10			20 - 40	25 - 35	3 - 5	1	3
			common juniper	3-5		.05	5 - 7					
			fescue bunchgrass &/or bb wheatgrass		0.7 – 1	70 +						
			Saskatoon				20					
			rose				200*					
			soopolallie				20					
interim stages			agronomic grasses									
Moist site targets	0 - 5		Engelmann spruce	250**	4 - 5			20-40	25 - 35			1
			black birch				250*					
			red-osier dogwood				200 – 300*					
			willow				150*					

Table 3. Target habitat characteristics for Douglas fir forests.

*should be planted 5 clumps per 100m^2 and from 5 – 10 plants per clump. Species can be mixed in clumps. Minimum patch size 100m^2.
** 250 is old growth target; 1200 stems per ha when stems are 12-25 cm dbh

7.2 Habitat *At* - Aspen Groves

Trembling aspen is an important tree that favours damper sites with high water tables, springs or other sources of water. Its short-lived characteristics and soft wood leads to centre rot and renders the trees valuable for both primary and secondary cavity nesters. The highest percentage of cavity nesters in fir/aspen forests use aspens for nesting. The open canopy favors an extensive shrub understory with a grassy forb layer. Middle to older age stands result in high levels of wildlife diversity, particularly when cattle browsing is eliminated or strictly limited.

The ultimate goal is to achieve self-sustaining stands of aspens ranging in size from 0.5 to 1.5 hectares each. The stands should ultimately contain older, decaying trees as well as new, suckering growth that is free to reach maturity with minimal interference from domestic ungulates. Should cattle grazing become one of the end land use objectives for the site, some aspen groves should be reserved for wildlife if others are used for cattle-sheltering purposes.

Typically, abundant deadfall characterizes a biologically diverse aspen stand. Such material should be spread early on the reclamation site in order to protect young growth from excessive browsing. Conifers can be used if a ready supply of aspen from salvage is not available to use as deadfall. The prime purpose is to create an impenetrable barrier to grazing livestock in order to allow new plantings to reach adequate heights. Downed material should have varied diameters from 10 - 25 cm diameter. Under natural conditions, scattered boulders can be found in some groves depending upon geological history of the site. The addition of these features using large mine waste rock would be of value. Rocks as large as can be transported are suitable as well as pieces ranging from 1 - 1.5 metres in diameter. Aspen groves should be located in depressed areas, as well as along the bases of dump slopes and along the margins of some wetlands. Creating small areas of standing water within some groves would be an excellent way of enhancing biodiversity.

Photograph 2. Aspen grove with downed wood.

Photograph 3. Target conditions for aspen understory showing prolific shrub understory and unrestrained aspen regeneration.

7.2.1 Target Wildlife Species for Aspen Groves

The following list of species indicates those that might be expected to colonize and breed in this habitat type as it matures at the elevations of the Ajax property Some species will benefit from earlier seral stages and a wider array of birds will use the forests during migration but not during the breeding season. Primary and secondary cavity nesters will not colonize until the stands reach older age classes and larger diameter trees begin to decay and die. Some of the mammals may use the habitat for portions but not all of their life requisites.

Table 4. Target wildlife species for aspen copses

Species	shrub / seedling	pole-sapling	young	mature	old growth	special elements
Birds						
Barrow's goldeneye				N	N	cavities
red-tailed hawk	F			N	N	
Swainson's hawk				N	N	
American kestrel	F			N	N	cavities
ruffed grouse	F N	F N		F N	F N	downed material
sharp-tailed grouse	F			F		
great horned owl	F		F	F n	F N	
northern saw-whet owl	F			N	N	cavities
red-naped sapsucker				F N	F N	
downy woodpecker			F N	F N		snags
hairy woodpecker				F N		
northern flicker	F			F N	F N	snags
western wood pewee			F	F N		
least flycatcher				F N	F N	
warbling vireo			F N	F N	F N	
black-billed magpie	F			F N	F N	
American crow				N	N	
tree swallow	F			N	N	cavities
black-capped chickadee			F N	F N	F N	cavities
house wren			F N	F N	F N	cavities
mountain bluebird	F			N	N	cavities
European starling	F	F	F	N	N	cavities
cedar waxwing	F		F N	F N		
orange-crowned warbler		F	F N	F N	F N	
chipping sparrow	F N	F	F N	F N		
song sparrow				F N	F N	shrubs

Mammals						
mule deer	F		F	F	F	
white-tailed deer	F		F	F	F	
vagrant shrew	F	FR	FR	FR		
deer mouse	F R	F R	F R			downed material
coyote	F	F	F	F	F	
black bear			F	F	F	downed material
long-tailed weasel	F	F	F	F		
Reptiles						
wt garter snake	F R		F R	F R	F R	rock, wetlands

F = feeding N = nesting R = reproduction

Target Habitat Characteristics												
Habitat	Slope degrees	Aspect degrees	Species	Stems/ha	Spacing	Understory		Course Woody Debris		Boulders		Snags/ha
						% groundcover	plants/ha	Dia. cm	pieces/ha	Singles/ha	clusters	
Aspen copse	0 - 15	all	trembling aspen	4000	1 - 3 m			15 - 30	50 - 80	2 - 3		5
			rose				1500					
			red-osier dogwood				1000					
			willow				300 - 400					
			common snowberry				2000					
			pinegrass			70						
						Plant shrubs as a dense mix throughout overstory.						

Table 5. Target habitat characteristics for aspen copses.

7.3 Habitat *Py* – Ponderosa Pine Forests

Ponderosa pine forests currently exist on some warm, south-facing slopes north of Jacko Lake. Possibly, such habitats might be re-created on south or west-facing slopes of the tailings pile where soil depths would be adequate. The long-term goal would see a mature forest with stem densities similar to local natural habitats with a large woody debris component. Boulders in clusters and as single features are recommended as useful additional components recognizing that they are occasionally found under natural conditions. Shrubs are important understory features and should be included in the prescription. Where feasible, gullies should be created to capture moisture and serve as planting locations for shrubs.

A bunchgrass understory is preferred but as with this component throughout the area, the capabilities of attaining viable stands of native bunchgrasses has yet to be determined. In the long term, successful growth and aging of the pine forests will generate snags but in the short term, snags or potential snags should be planted.

Photograph 4. Example of open ponderosa pine forest.

Photograph 5. Example of a boulder cluster.

7.3.1 Target Wildlife Species for Ponderosa Pine Forests

The following list of species indicates those that might be expected to colonize and breed in this habitat type as it matures. Some species will benefit from earlier seral stages and a wider array of birds will use the forests during migration but not during the breeding season. Primary and secondary cavity nesters will not colonize until the stands reach older age classes and larger diameter stems.

Table 6. Target wildlife species for ponderosa pine forests.

Species	shrub/ seedling	pole-sapling	young	mature	old growth	special elements
Birds						
red-tailed hawk	F			F N	F N	
American kestrel	F			F N	F N	snags, cavities
dusky grouse	F N			F N	F N	
great horned owl	F		F	F N	F N	
mourning dove	F			F N	F N	
common nighthawk	F				F N	
calliope hummingbird				F N	F N	shrubs, riparian
Lewis's woodpecker	F			F N	F N	cavities
hairy woodpecker			F	F N	F N	snags
northern flicker	F		F	F N	F N	snags
dusky flycatcher				F N	F N	
Pacific-slope flycatcher				F N	F N	rock ledges, cutbanks
Clark's nutcracker				F	F	
mountain chickadee			F N	F N	F N	cavities, deciduous
white-breasted nuthatch				F N	F N	cavities
pygmy nuthatch				F N	F N	cavities
mountain bluebird	F			F N	F N	snags, cavities
American robin	F	F	F N	F N		
yellow-rumped warbler	F	F	F N	F N	F N	
western tanager				F	F	
chipping sparrow	F N		F N	F N	F N	
dark-eyed junco			F N	F N	F N	downed material
Cassin's finch				F N	F N	
Mammals						
mule deer	F	F	F	F	F	downed material deciduous
white-tailed deer	F	F	F	F	F	
red squirrel			F R	F R	F R	
northern flying squirrel				F R	F R	snags

yellow-pine chipmunk	F	F	F R	F R	F R	downed material
northern pocket gopher	F R					grassy openings
deer mouse	F R	F R	F R	F R	F R	downed material
dusky shrew			F R	F R		
fringed myotis	F	F	F	F	F	
big brown bat					F R	snags
bushy-tailed wood rat	F R			F R		downed material rocky outcrops, crevices
meadow vole	F R					downed material
long-tailed vole				F R		
coyote	F R	F	F	F R	F R	
black bear	F R	F R	F R	F R	F R	downed material
badger	F					
cougar	F	F	F	F	F	
bobcat	F	F	F	F	F R	downed material
Reptiles						
wt garter snake	F R		F R	F R	F R	rock, wetlands
northern alligator lizard	F R	F R	F R	F R	F R	low crown closure talus, rocky outcrops
rubber boa	F R		F R			talus, rocks

F = feeding N = nesting R = reproduction

Target Habitat Characteristics

Habitat	Slope degrees	Aspect degrees	Species	Stems/ha	Spacing	Understory		Course Woody Debris		Boulders		Snags/ha
						groundcover	plants/ha	Dia. cm	pieces/ha	Singles/ha	clusters	
Ponderosa Pine forest	10 -20	160 - 270	ponderosa pine	200-700				20 - 40	15 - 20	3 - 5	1 - 2	3 - 5
			common juniper				3 - 5					
			Saskatoon				25					
			rabbit-brush				1000					
			pasture sage				1500					
			bb wheatgrass		30 – 80 cm	75%, 30-50 cm height	10,000					
			rough fescue		30-80 cm	15% of total	1500					
			rose			low shrubs should be planted densely with patch sizes from 100 – 500m^2. Rose & snowberry should be both mixed and pure stands on damper sites. 2 - 4 patches/ha						
			common snowberry									

Table 7. Target habitat characteristics for ponderosa pine forests.

7.4 Habitat *Gr* - Grasslands

Grasslands are a major component of the existing landscape within the proposed Ajax Mine footprint. The dominant species of bluebunch wheatgrass and rough fescue can be challenging to re-establish on a native soil base and perhaps more so on an impoverished soil base or a mineralized substrate. Portions of the existing grasslands are largely composed of the introduced Kentucky bluegrass which has been mostly accepted as a naturalized component of our grasslands despite its non-native origins. Crested wheatgrass is another common species that has been widely introduced in the area generally. Weed control will likely be an early challenge during the process of re-vegetating both waste rock and tailings sites.

The general target is to have a densely-covered terrain of bunchgrasses with deciduous shrub patches in depressed areas and moisture-accumulating sites. The mature grass bunches in an ungrazed condition should have the top growth hang over and intersect with the top growth of neighbouring plants. Isolated ponderosa pine trees scattered across the landscape would be appropriate. Kentucky bluegrass is an acceptable co-habitant in patches. Aromatic shrubs (*Artemisia sp.*) occupying low density patches of south-facing slopes are also a target association.

Patches of rose and snowberry should be created along linear depressions that are designed to concentrate moisture as well as planted in irregularly shaped polygons consisting of a mixed species assemblage. These patches should vary in size from 100 - 500 m^2. Protection from cattle browsing and loafing is desirable and at least 50% of the patches should have barriers placed to minimize or eliminate cattle access. Large surplus rocks and dead trees would be suitable. Patches of water birch are particularly desirable where sufficient water and soil conditions can be created to enable growth.

Rock outcrops occur naturally in places within the undeveloped mine property. Boulders and boulder clusters are proposed as alternatives to the exposed outcrops. The densities of rocks and clusters noted in Table 9 are not suggested for every hectare of grassland. Of the grasslands created, about 25% should contain single, large boulders and the areas treated in this way should be scattered randomly across the landscape. The boulder clusters of varying size rocks up to 100m^2 should be scattered on about 10% of the area reclaimed as grasslands.

7.4.1 Target Wildlife Species for Grasslands

The future presence of some wildlife species will depend upon the development of supplementary components to the grasslands habitat such as wetlands, ponds and shrub patches and nearby tree copses. For example, Swainson's and red-tailed hawks will forage over the grasslands but nest in adjacent aspen or coniferous groves. A wider array of birds than those in Table 8 will utilize the grasslands during migration or during the winter period but will not remain to nest.

In the table below, the *seral stages* column is a broad reference to initial and intermediate plant communities that may consist of agronomic species necessary to kick start the reclamation process. The mature column represents what could be thought of as the potential natural community (PNC) which should be an appropriate mix of native bunchgrasses depending upon soils, slope, aspect and other factors. This should be the ultimate target community over a defined percentage of the landscape.

Table 8. Target wildlife species for grasslands

Species	shrub patch	seral stages	mature	special elements
Birds				
American wigeon*		N	N	ponds for foraging
Mallard*		N	N	ponds for foraging
green-winged teal*		N	N	ponds for foraging
Swainson's hawk		F	F	trees for nesting
sharp-tailed grouse	F	F	F N	tall, dense bunchgrass clumps for nesting
long-billed curlew		FN	FN	wetlands
Killdeer*		N	N	ponds for foraging
spotted sandpiper*		N	N	ponds for foraging
long-billed curlew		F N	F N	
short-eared owl		F	F N	
horned lark		F N	F N	
cliff swallow		F	F	man-made structures or tall rock faces for nesting; wetlands for foraging
barn swallow		F	F	man-made structures for nesting; wetlands for foraging
spotted towhee	F N			
chipping sparrow	F N	F	F	
clay-colored sparrow	F N	F	F	
vesper sparrow	F	F N	F N	
savannah sparrow		F N		
western meadowlark		F N	F N	

Brewer's blackbird	F N	F	F	
Mammals				
mule deer	F	F	F	
yellow-bellied marmot		F R	F R	rock piles
Badger**		F R	F R	fine-textured soil for dens
montane vole		F R	F R	
northern pocket gopher		F R	F R	fine-textured soil
vagrant shrew	F R	F R	F R	
coyote	F	F	F	
long-tailed weasel	F	F	F	downed material
Reptiles				
wt garter snake	F	F	F	standing water for foraging & within 500 m of potential den sites

F = feeding N = nesting R = reproduction

* these species nest in the dry uplands and will depend upon the successful establishment of ponds within or near to grasslands

** denning only if deep soil conditions are developed & a suitable food supply is present

Photograph 6. Bunchgrass showing desirable height and density.

Photograph 7. Example of rose shrub patches in grasslands.

Photograph 8. Water birch in wet depression.

Habitat	Slope degrees	Aspect degrees	Species	Stems/ha	Spacing	Understory		Course Woody Debris		Boulders	
						Groundcover %	plants/ha	Dia. cm	pieces/ha	Singles/ha	clusters
Grasslands	0-30	0 - 360	bluebunch wheatgrass		40-70 cm	80% when plants are 30-50 cm high	12 – 15,000	30-40	1-2	2-3 but only on 25% of the hectares	1 but only on 10% of the hectares
		300 - 80	rough fescue		40-70 cm	60% on Northerly aspects when plants are mature.	5-6000 on N aspects to replace bb wheatgrass				
		all	Kentucky bluegrass			15					
			Sandberg's bluegrass			1					
		100-220	big sagebrush	800-1200							
		100-220	rabbit-brush	200-300							
		all	prickly rose	Create linear patches along drainages plus irregular polygons of mixed species from 100 - 500m^2, plus isolated plantings @ 2-300 stems/ha. Create at least 1 patch per 2 ha.							
		all	prairie rose								
		all	common snowberry								

Table 9. Target habitat characteristics for grasslands.

7.5 Habitat *We* - ponds and marshes

Ponds with and without emergent aquatic vegetation are found within the Kamloops region and are very important to enhancing local biodiversity. It is The pH levels are highly variable depending upon a variety of factors such as soil types, water depths, inflow and outflow, evapo-transpiration rates and so forth. It is recognized that the grasslands of the Ajax mine area are subject to high evapo-transpiration rates and maintaining permanent or semi-permanent water bodies will be challenging. Although ephemeral ponds are common grassland features, it is recommended that reclamation efforts attempt to create more permanent water bodies. Maximum biodiversity may be achieved by providing a range of wetland types and it is suggested that the focus be on ponds (75% or more of the surface area as open water) and marshes (25% or more of the total surface area as emergent vegetation). Fens, bogs and swamps are not typical of the pre-disturbance landscape.

Reclamation efforts should focus on the creation of 12 - 15 wetlands ranging in size from 0.3 - 5 ha with sinuous shorelines along which a range of habitat types will be created. We suggest that 6 - 8 ponds be developed and 7 - 8 marshes.

It is recommended that 5 - 6 ponds would have shorelines of grasses and sedges, 4 - 5 would be vegetated with cattails and bulrushes and 3 - 4 would be developed with a mixture of cattails, bulrush, tall shrubs and possibly aspens on the perimeter. Emergent vegetation should include cattails as well as stands of bulrush of several species. Willow and water birch patches should be created along portions of the shorelines as well as being interspersed amongst the cattail habitat. Sections of shoreline should be developed with no emergent aquatic vegetation and left as shallow mud flat type habitats to attract sandpipers and other wading birds. On larger ponds, areas created as potential mud flats should occupy at least 30% of the pond perimeter and occur as a contiguous section as opposed to smaller, fragmented patches. Adjacent upland habitats should vary from shrub/grasslands, cottonwood or aspen stands if feasible and conifers on dry sites. Submerged aquatic vegetation should be added to the ponds. Inoculation with invertebrates using hay bale trapping and transfer methods from nearby natural ponds should also be used. Complexity should be added to the pond margins with a variety of rock clusters and logs to provide hiding spots for amphibians.

Depth contours should vary to enable the development of habitats from dry beach through very shallow water conditions gradually deepening to a maximum of 2-3 metres. The capability to develop these wetlands will be challenging without a consistent supply of water. They risk becoming pan lakes with high evapo-transpiration rates. The possibilities of supplying piped reclamation water should be investigated. The potential to excavate deeper basins in the rock dumps and lining them with tailings material in order to seal the voids should be examined. Particle composition of the tailings fines will determine their ability to retain water. The use of rubber or plastic liners may be necessary if it is not feasible to seal the voids with other methods.

There should be no considerations for stocking fish in these shallow ponds. This would reduce the biodiversity potential and may be biologically difficult or impossible due to the shallow nature, potentially low winter oxygen levels and / or high pH levels. Fish introductions should be limited to the *pit lake* habitat type.

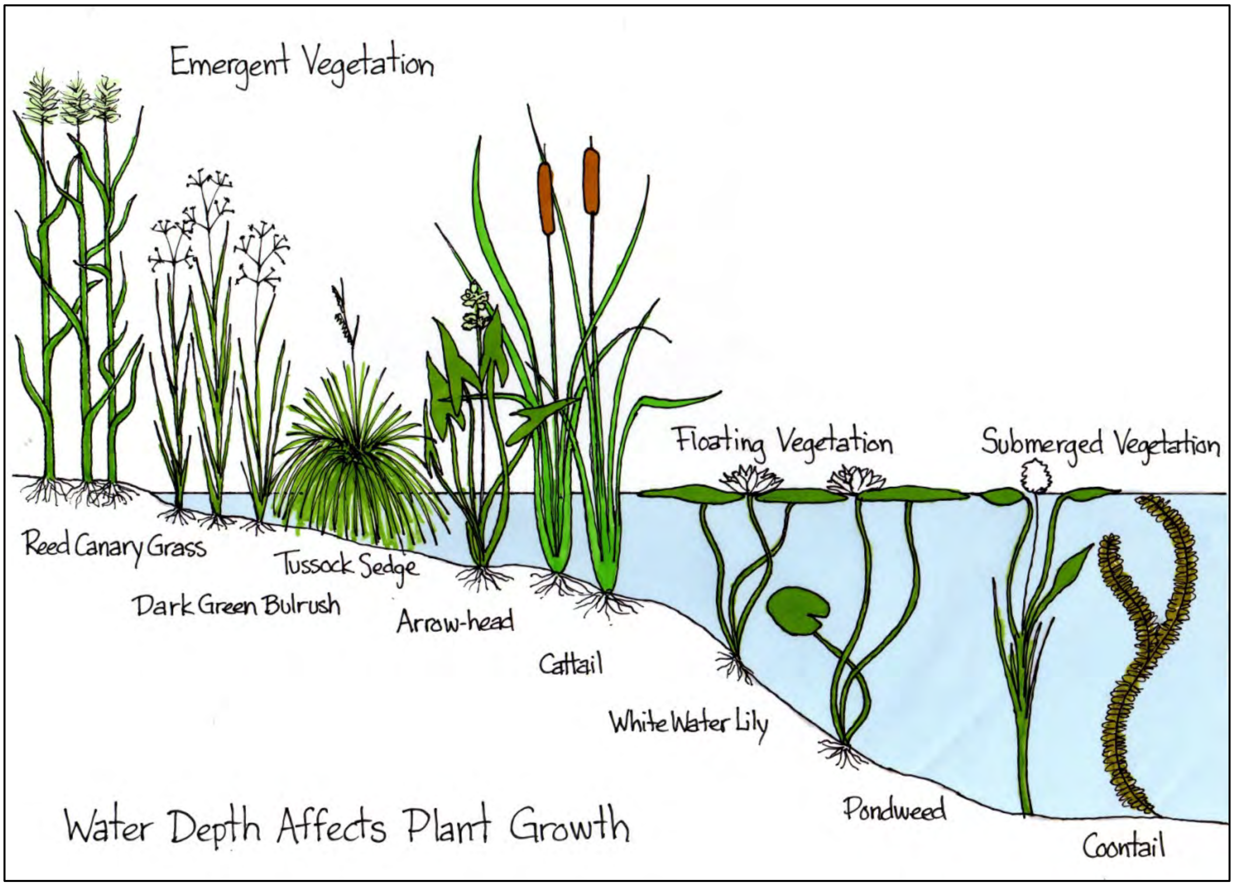

Figure 1. Example of pond margin profile that could be developed for deeper ponds. Species mix will vary to suit local conditions.

7.5.1 Target Wildlife Species for Ponds

If there is success in developing pond ecosystems, the potential list of bird species that could visit the ponds during migration is fairly high and would exceed the number of species that would be present as breeders. Only the potential local breeding species are listed in the table below. For waterfowl, the potential species will depend upon the availability of suitable nesting habitat such as extensive emergent vegetation or upland vegetation with adequate height and ground cover. Cavity nesters will depend upon the proximity of trees old enough to accommodate woodpecker cavities, thus it will be at least several decades after planting before trees such as aspens may be suitable, if growing conditions are ideal. Ponds serve as foraging and rearing sites for cavity-nesters.

In table 10, the following definitions are used for aquatic zones:

shore - substrate is continuously exposed with little vegetation cover; immediately below the riparian zone

littoral - extends from the shoreward boundary to water depths which are the maximum extent of plant rooting which may be no more than 2 metres.

limnetic - beyond the vegetated fringe or littoral zone including deep water areas

Table 10. Target wildlife species for ponds.

Species	Shore	Littoral	Limnetic	Special Elements
Birds				
horned grebe		F N	F	
pied-billed grebe		F N	F	
Canada goose	F	F N	L	
gadwall		F	L	islands, upland grasses for nesting
American wigeon	F	F	L	upland grasses for nesting
mallard	F	F (N)	L	upland grasses for nesting
blue-winged teal	F			upland grasses for nesting
cinnamon teal	F	F N	L	
northern shoveler				upland grasses for nesting
northern pintail	F	F	L	upland soil + some veg. for nesting
green-winged teal	F	F	L	upland grasses for nesting
canvasback		F N	F L	
redhead		F N	L	

ring-necked duck		F N	F L	
lesser scaup		F	F L	upland grasses for nesting
bufflehead		F	F L	
Barrow's goldeneye		F	F L	
spotted sandpiper	F			upland forbs & grasses for nesting
killdeer	F			sparsely vegetated uplands for nesting
Mammals				
muskrat		F R		
Amphibians				
great basin spadefoot		F R	F	upland soils suitable for burrowing
western toad		F R	F	
Pacific chorus frog		F R	F	
long-toed salamander		F R	F	downed material in upland

F = feeding N = nesting R = reproduction L = loafing

Photograph 9. Shallow wetland on tailings substrate.

Photograph 10. Cattail margin of deep pond.

Photograph 11. Margin of tailings pond with cattail and willow plantings. Shallow margins are important foraging sites for shorebirds such as these dowitchers.

Photograph 12. Example of type 2 pond - smaller than 1 ha with cattail and grass margin.

Target Habitat Characteristics									
Habitat	Size ha	Shoreline Gradient[1]	Depth Metres	% Open Water	Riparian Planting	% Shoreline planted	Course Woody Debris pieces	Islands	Boulders
Pond 1	0.3	15:1	0.5	100	grasses, sedges	100	1	0	1
Pond 2	0.5	15:1	0.5	100	grasses cattails	60 40	3	0	2
Pond 3	0.5	15:1	0.5	100	grasses, sedges shrubs	90 10	5	1	2
Pond 4	0.7	15:1	0.7	90	grasses, sedges bulrush shrubs	75 20 5	7	1	0
Pond 5	2.0	15:1	1 - 1.5	80	grasses sedges shrubs trees	50 30 10 10	10	2	5
Pond 6	5.0	15:1	1 - 2	75	grasses cattail sedges/bulrush shrubs trees	30 20 10 20 20	15	3	5
Marsh 1	0.3	15:1	0.3	25	bulrush	100	2	0	0
Marsh 2	0.5	15:1	0.3	15	cattails bulrush	50 50	4	0	0
Marsh 3	0.5	15:1	0.5	25	cattails	100	5	0	0
Marsh 4	0.7	15:1	0.7	20	cattails willow	75 25	5	0	1
Marsh 5	0.7	15:1	0.7	25	cattails bulrush	25 75	10	1	2

Marsh 6	1.0	15:1	1.0	25	cattails bulrush sedge willow	10 50 30 10	10	2	2
Marsh 7	1.5	15:1	1.0	25	bulrush sedge water birch willow	40 20 20 20	10	2	3
Marsh 8	2.5	15:1	1.0	25	cattails bulrush willow water birch aspen	25 25 20 25 5	10	3	4
Marsh 9	3.0	15:1	1.0	20	cattails bulrush willow water birch aspen	50 15 10 10 15	15	3	4

Table 11. Target habitat characteristics for ponds.

[1] this gradient is a general target. Portions of the shoreline of each pond could be steeper but in general, more than 75% of the perimeter should have a gradient close to the suggested ratio which is given as horizontal : vertical.

7.6 Habitat *We2* - Other Wetlands

A variety of "other" wetlands in moisture accumulating sites could be developed in areas where standing water ponds are not feasible or are undesirable. For example, if it is not desirable to have standing water atop the tailings mound due to a risk of creating slope failure problems, the top of the tailings could be contoured with a variety of irregular-shaped depressions in order to accumulate as much moisture as possible. Suitable forbs, cattails, sedges and shrubs could be planted as appropriate to the conditions that emerge from the contouring. Water birch would be a valued shrub for planting if suitable moisture conditions can be maintained to ensure survival. While these damp sites may not function as productively as ponds or marshes in terms of wildlife production, the added vegetation and moisture diversity would contribute to overall wildlife diversity to some degree.

7.7 Habitat *Lp* - Pit Lakes

There appears to be a potential for a lake to develop in the exhausted pit. While these lakes exhibit “steep and deep” characteristics with limited shoals and the potential to stratify and not mix adequately, current research has demonstrated a good potential to create conditions for viable fisheries in waters with basic as opposed to acidic characteristics. A pit lake should be developed that will sustain sport fish such as rainbow trout or brook trout. This will likely require fertilization and vitamin therapy in order to develop essential conditions and turnover cycles. Ducks will loaf on these lakes but breeding is not expected due to the lack of emergent vegetation or surrounding upland vegetation that is accessible. Loons and piscivorous waterfowl may feed if fingerling trout are present. Shoals must be created in order to encourage at least foraging by waterfowl. Lack of essential habitat components will likely mitigate against successful colonization by amphibians.

Table 12. Target wildlife species for pit lakes

Birds	Fish
variety of dabbling-type ducks	rainbow trout
Barrow’s goldeneye	brook trout
common goldeneye	
common merganser	

Photograph 13. Pit lake showing part of pit floor reclaimed with vegetation. This pit supported rainbow trout as a result of reclamation initiatives.

7.8 Habitat *Rf* – Rock Faces

Vertical rock faces are an inevitable end result of the pit excavation. While the faces may be unstable, ledges, cracks, crevices and large rock talus slopes at the foot of the faces may provide habitat for some species of birds that prefer such locations under natural conditions. Most mammals native to the proposed mine elevation in the Kamloops area are not adapted to these habitats although some rodents and smaller mammals may use accessible talus slopes within the pits as supplementary habitats if these sites attract insects and sparse vegetation.

The feasibility of drilling several small adits for bat hibernacula should be examined. Dimensions to be determined. Potholes roughly 1 metre in all dimensions should be created in sheer pit faces. At least 10 such holes should be excavated. The floors of such invasions of the pit face provide nesting and roosting sites for a variety of species.

Table 13. Target wildlife species for rock faces

Species	ledge	Face / overhang	Talus	Crevice
Birds				
red-tailed hawk	N			
golden eagle	N			
peregrine falcon	N			
prairie falcon	N			
violet – green swallow				N
northern rough-winged swallow				N
cliff swallow		N		
barn swallow	N			
common raven	N			
rock wren			N	
Say's phoebe	N			
Mammals				
Myotis bat species				HR

N = nesting HR - hibernation/roosting

7.9 Habitat *Rs* – Rock Slopes

Large boulder slopes resulting from gravitational sorting of end-dumped overburden will occur in various places around the bottom of the waste rock piles and possibly at some elevations upslope on the dump sites depending upon contouring practices. Traditional reclamation practices result in these sites being covered with soil and planted with vegetation. This approach results in a reduction of potential biodiversity on the site by removing the large boulders and interstitial spaces that will be colonized by a variety of wildlife species much as happens in naturally-occurring talus slopes below eroding cliff faces.

Species such as yellow-bellied marmots, tree frogs, wood rats, white-footed mice, chipmunks, weasels, snakes and a variety of invertebrates will colonize the lower, unreclaimed rock slopes, particularly where they are close to natural habitats forming an ecotone between them. Ground – foraging birds such as sparrows will hunt the rocks for seeds and insects. Large rock habitats are less likely to be occupied when they are separated from natural habitats by long distances of bare waste rock with no vegetation to provide shelter and a food supply for the potential colonizing species. It is therefore important that large rock habitats located on middle and upper slopes of the dump sites be linked to the lower, natural habitats by vegetated corridors if it is not possible to vegetate the entire rock slope from top to bottom. If road beds are built using large rock material, reclamation procedures should leave sections of rock exposed along the road bed margins to create an ecotone between the rocks and the reclamation vegetation.

If waste rock slopes are anticipated being adjacent to forested habitats which will remain intact, the large rocks should be allowed to roll downslope against the forest margin in order to create an ecotone which becomes integral with the forest as opposed to creating a wide, barren leave strip between the forest and the lower waste piles. Animals and plants will colonize faster under those circumstances.

It is recommended that the lower 3 vertical metres of the waste rock slopes above the toe remain unreclaimed along at least 50% of the perimeter. 50% of the unreclaimed margin should be diversified with shrub planting (photograph 14). If the remaining 50% of the lowest perimeter of the rock dumps is reclaimed with soil and grass, 75% of that margin should be diversified with shrub planting or aspen groves if adjacent soil and moisture conditions are suitable.

Table 14. Target wildlife species for ecotone areas of rock slopes

Mammals	Reptiles & Amphibians
yellow-bellied marmot	w.t. garter snake
yellow pine chipmunk	rubber boa
deer mouse	pacific chorus frog (if water is near)
ermine	

Photograph 14. Mine rock dumps with shrubby toe interface.

7.10 Habitat *Ri* – Riparian Zones

Streamside riparian habitat is extremely important for the proper functioning of the aquatic ecosystem, maintenance of fish populations and the provision of habitat for a wide variety of birds and other wildlife that contribute to the overall biodiversity of the area. Any relocations of Peterson Creek will require compensation initiatives to be undertaken immediately following the relocation and details for that process will be determined by the HADD determination and authorization process under the federal Fisheries Act. For this reason, detailed prescriptions for creekside habitats were not prepared for this report.

However, there may be sections of the creek and associated wetlands which can be improved but may not be dealt with under the authorization for relocation. The reclamation program should anticipate enhancing any sections of the creek which, after analysis, are deemed to be in need of improvement or have greater potential than under current conditions.

7.10.1 Target Wildlife Species for Riparian Zones

Table 15 lists the potential wildlife species that could be found nesting or foraging in the riparian areas along Peterson Creek when in a healthy and mature condition. It assumes the potential for mature black cottonwood growth in areas that may be in need of restoration following changes due to mining requirements. As with other lists, it is not considered exhaustive and reflects resident species or those present for the nesting season. Many additional migrant bird species may temporarily use the riparian zone while passing through the general area. The creek environment includes quiet water areas created by beaver dams.

Table 15. Target wildlife species for riparian zones

Species	shrub/ seedling	pole-sapling	young	mature	old growth	special elements
Birds						
Barrow's goldeneye					N	snags, cavities
mallard	F					beaver pond
green-winged teal	F					beaver pond
American kestrel	F			N	N	snags, cavities
red-tailed hawk	F			N	N	
ruffed grouse	F	F N	F N	F N	F N	
sharp-tailed grouse	F	F	F	F	F	
great horned owl	F		F N	F N	F N	old diurnal raptor nests
Vaux's swift				N	N	
rufous hummingbird	F N					shrubs
calliope hummingbird	F N					shrubs
downy woodpecker			F N	F N	F N	snags
hairy woodpecker			F N	F N	F N	snags
northern flicker	F		F	F N	F N	snags
willow flycatcher	F N					pond, willows
eastern kingbird	F N					tall shrubs
black-billed magpie	F				F N	
tree swallow	F	F	F N	F N	F N	Snags, cavities
house wren	F	F	F	F N	F N	cavities
American robin	F	F	F N	F N		
European starling	F	F	F	F N	F N	cavities
yellow warbler	F N					tall shrubs, pond
yellow-rumped warbler	F	F	F	F	F	
spotted towhee			F N	F N		shrubby understory

song sparrow	F		F N	F N	F N	shrubby understory
Bullock's oriole			F N	F N	F N	
Mammals						
mule deer	F		F	F	F	
bats sp.	F	F	F	F HR	F HR	snags, cavities
coyote	F	F	F			
beaver		F R	F R	F R		
deer mouse				F R	F R	
vagrant shrew	F R	F R	F R	F R	F R	
meadow jumping mouse		F R	F R	F R	F R	grassy patches, shrubs
western jumping mouse			F R	F R	F R	grassy patches, shrubs
black bear	F	F	F	F	F	
long-tailed weasel	F	F	F	F	F	
ermine	F	F	F	F	F	
Reptiles						
wt garter snake	F	F	F	F	F	

F = feeding N = nesting R = reproduction H R = hibernation/roosting

8.0 Habitats to Benefit Species of Conservation Concern

In addition to some of the broader habitat reclamation initiatives, it may be possible to undertake specific, detailed initiatives which would benefit species of conservation concern known to inhabit the pre-disturbed property or the general Kamloops area. Some species may simply benefit from the created habitats with no special efforts.

8.1 Badger

Badger use of the post-reclamation lands is most likely to be in areas where rodent populations provide a food source and depths of fine-textured soils enable burrowing. Layers of rock or gravel inhibit badger burrowing. Perhaps such habitats will remain in the areas between the waste rock piles where soil was not removed and can be suitably rehabilitated. If yellow-bellied marmots colonize the base of the rock dumps and if the interstitial spaces where they choose to den are large enough, badgers may make attempts to raid the dens. If pocket gophers colonize newly-created grasslands on deeper soils badgers will make attempts to dig them out.

Natural badger dens in the Thompson region are normally excavated in deeper, fine-textured soils generally with less than 35% course fragments (Hoodicoff 2003). It is not clear that there will be opportunities to retain or create soil conditions that will be suitable for use by badgers during the post-mining era. Soil depths on reclaimed waste rock dumps will likely be shallow for the most part. If soil pockets with depths approaching 1.5 metres or more are created within 500 metres of rocky sites colonized by marmots, perhaps badgers will excavate natural dens.

Artificial dens have been successfully created for European badgers but these animals are more social than the American badgers which are solitary in their denning habits. Recovery plans for our native badgers have not traditionally discussed the creation of artificial dens. This may be because they have been shown not to work under natural conditions, but “badger houses” have been used in captive situations to raise badgers for future release. It is recommended that if a prey base can be established on the reclamation landscape, artificial den structures be created in an effort to attract badgers,

The details of the actual den structure have yet to be developed, but the general site conditions should have the following attributes.

- location should have unobstructed vision of the local landscape
- vegetation within 25 metres of the den should consist of low plants such as Kentucky bluegrass and forbs less than 20 cm in height

- 1-2 patches of low shrubs should be located within 50 metres of the den
- the site should be within 500 metres of a substantial prey base
- a nursery den as well as 2 alternate den structures should be provided
- low to mid-slope heights are preferred over the bottom of depressions unless the low point in the landscape is very open and quite extensive (> 300m wide)

8.2 Great Basin Spadefoot

Spadefoots may breed in shallow pond habitats that are created through the reclamation process. They are capable of developing from eggs to emerging juveniles in one season. They will not burrow into course rock such that they will only survive in areas that have deeper, fine-textured soils within acceptable commuting distances of ponds. The general prescription for developing ponds earlier in this document should be suitable. Spadefoots have been known to survive in water with pH ranging from 7.2 – 10.4 (Buseck et al 2005). Potential breeding ponds should abut pockets of soil created within 200 metres, with depths to 1.5 metres and a bunchgrass cover as opposed to sod grasses that will allow toads to access bare dirt for burrowing and hibernation.

10% of the created ponds should not have plants attractive to waterfowl added to the shoreline in order to discourage waterfowl use which could lead to increased predation on spadefoot eggs or tadpoles. Small rocks, sticks, twigs and other small woody debris should be thrown into the ponds to provide attachment sites for eggs until aquatic vegetation develops.

Adult foraging habitat is an important third component but its parameters are not well understood. Foraging occurs on upland sites that are capable of sustaining invertebrates such as earthworms, crickets, spiders, beetles, flies and other invertebrates. It should likely consist of bunchgrasses or relatively open grass sites with limited sod-forming grasses. Soil depths do not need to be as deep as potential hibernating sites but a minimum of 15 cm is likely necessary to allow animals to burrow as required to adapt to seasonal temperatures, to avoid dessication and other circumstances during the non-hibernation period. The presence of shrubs such as rose, big sagebrush and rabbit-brush is acceptable if not desirable. Ensuring that extensive stands of cheatgrass do not develop is an important management consideration to benefit spadefoots as well as a variety of other species and vegetation community values.

Natural colonization of scattered vacant ponds and dispersal between habitats is not well-documented. Although long distance travels of up to 5 km in search of water have been suggested (Hovingh et al. 1985), it is more likely that typical home ranges are within several hundred metres of natal ponds (Linsdale 1938; Bragg 1965). Adult and newly-emerged toadlets must have the ability to travel between breeding ponds, foraging sites and hibernation sites. These habitat types should not be fragmented by physical impediments and preferably not roads once reclamation is completed. Recovery efforts should consider transplant experiments in order to kick-start development of local populations.

8.3 Western Toad

Western toads may attempt to breed in reclamation ponds where water depths need not be adequate to allow for overwintering of tadpoles. Adjacent upland conditions must have advanced sufficiently to provide shelter and food resources with adequate overwintering locations for maturing and adult individuals. Toads have been shown to use terrestrial habitat between 600 and 2000 metres from breeding ponds (Browne and Paszkowski 2010). The ability find hibernation sites below frost line may be more limiting than the type of wetland available for breeding. Typical wintering sites include mammal burrows, cavities under rocks and roots and burrows in stream banks. Given the possible travel distances recorded for this species, it is likely that voids in waste rock dump sites as well as the undisturbed forested areas and tree patches surrounding the disturbed mine site could provide suitable hibernacula for toads that successfully breed in ponds created during the reclamation process.

The key reclamation challenge in the short term may be the creation of suitable breeding ponds. Techniques for creating pond habitats noted elsewhere in this report will likely be suitable as toad breeding sites. Sandy-bottom ponds may be preferred but natural ponds supporting toads often have muddy margins. Warmer temperatures are preferred but this should be easily-achieved in the reclamation ponds. Course and small woody debris should be added to ponds in order to create habitat complexity which will aid in developing a food source for tadpoles. Emergent vegetation is acceptable within the ponds but floating vegetation may not be typical. A sedge margin is suitable but areas that are clear of vegetation may facilitate emergence. Depths may vary but the pond must retain water for the length of the breeding and development season which may vary with temperature. April through September is likely an adequate period.

8.4 Northern Rubber Boa

Boas were found along the northern margin of the Property, but it is not clear that they were well-distributed across the entire area. They may be more concentrated in the open forests in the northwest portions of the property than in the open grasslands. They occupy a wide variety of habitat types across their range but tend to favor areas with significant amounts of course woody debris that provides suitable cover. Prey includes newborn rodents, insects and occasionally bats and small birds. Re-occupation of reclaimed lands will depend largely upon the evolution of a suitable prey base.

Winter hibernacula tend to be in rocky areas where temperatures remain above freezing and are fairly stable for the cooler periods. Adequate humidity is likely important but precise conditions are unclear.

8.5 Great Blue Heron

Herons have not traditionally nested in the Knutsford area and it is not expected that post-mining conditions will be suitable for that function. If any ponds develop an amphibian prey base, herons may forage during migration. Attempts to develop habitats suitable for heron nesting are not recommended.

8.6 Swainson's Hawk

This buteo is a tree nester and opportunities for them to re-nest on the altered landscape are not foreseen for several decades after reclamation begins. This will depend upon planting survival and subsequent growth rates of aspens. Swainson's hawks prefer open grassland areas with scattered trees or small clumps of trees and shrubs. They will use both conifers and aspens up to 22 metres in height and have been known to use artificial nest platforms. The presence of small mammals in the reclamation grasslands will be key to the use of these areas by Swainson's hawks. Grasshopper populations could assist in meeting dietary requirements but relying upon adequate levels of this insect is clearly not a solution to the long-term colonization by this raptor. It is not known whether they will nest on tree stems planted upside down with the roots exposed as an aerial mass.

It is recommended that 10 artificial nest structures be placed once the grassland community has developed and rodents are observed to have colonized the reclaimed areas. Artificial nest structures should be placed near any large tracts of native grassland that will remain undisturbed if there are no suitable nest trees nearby that will remain throughout the life of the mine. These structures should be placed early in the reclamation process. There are many designs available for attaching to poles dug into the substrate. The plan in Figure 2 is provided as a sample for guidance even though it was designed for Ferruginous Hawks.

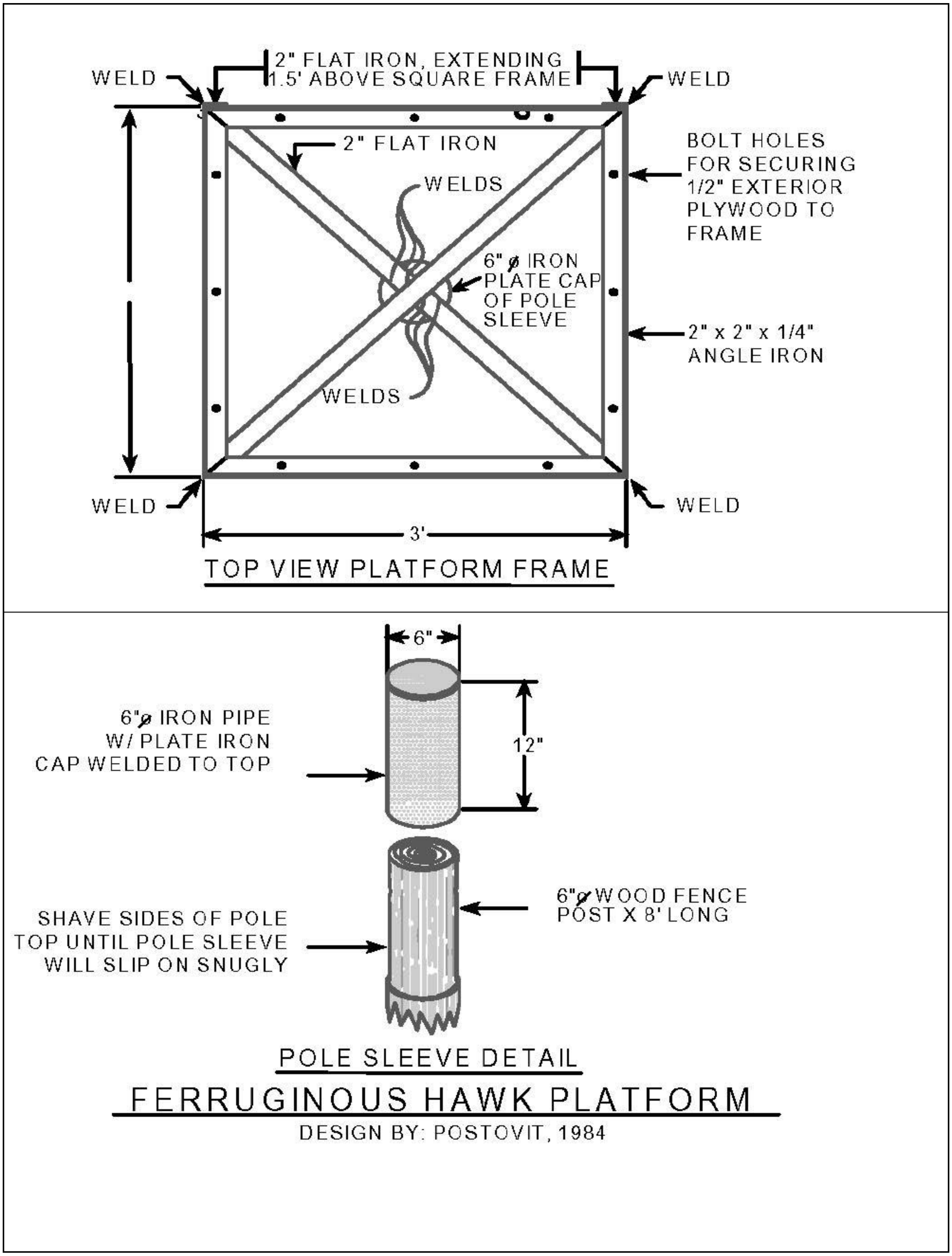

Figure 2. Raptor nesting platform from Sec. 7 *Handbook of Western Reclamation Techniques*.

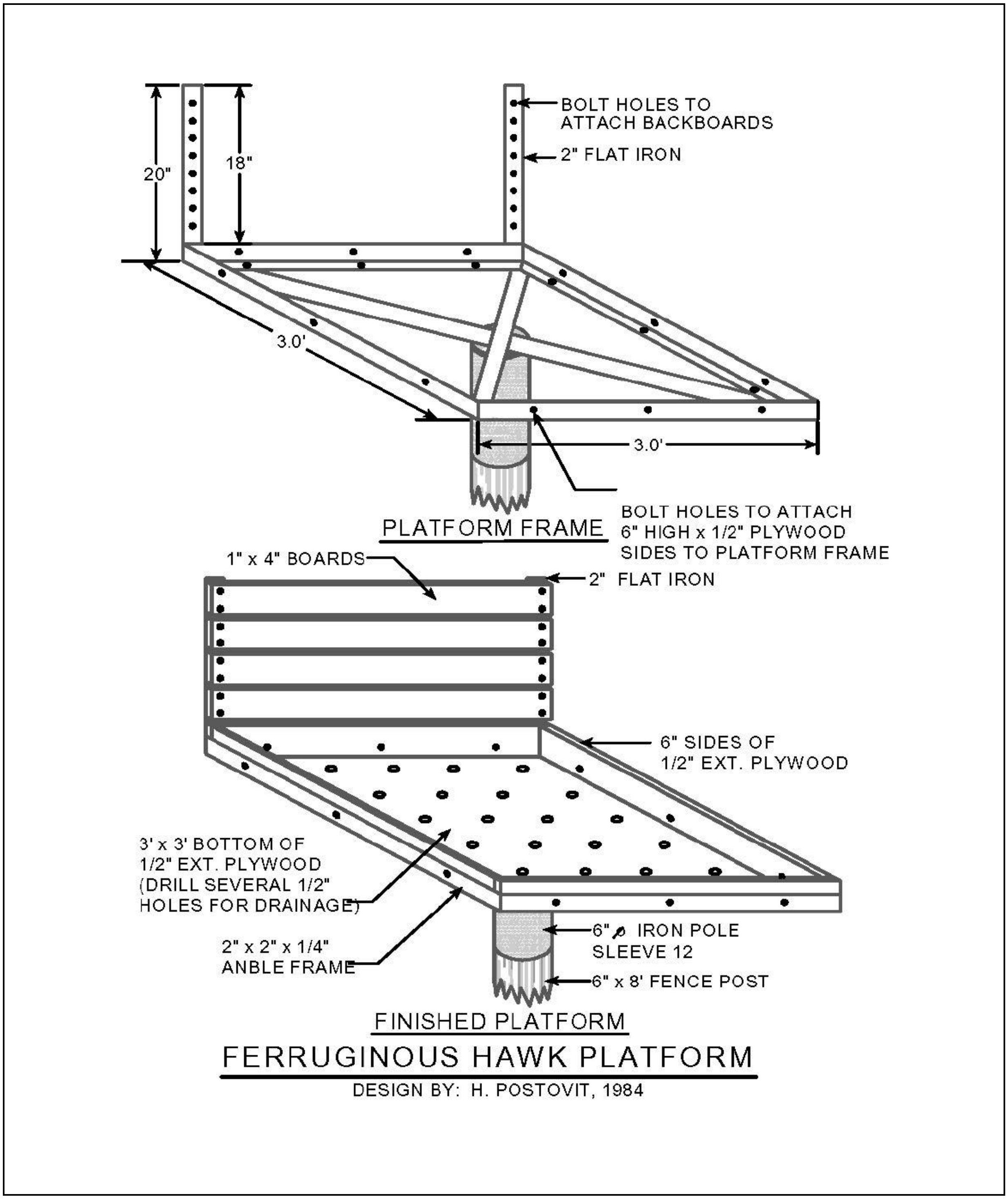

Figure 3. Oblique details for raptor nesting platform from Sec. 7 *Handbook of Western Reclamation Techniques*.

8.7 Peregrine Falcon

Peregrines nest on high, steep cliffs in the Kamloops area and migrate through the Property area. They have not traditionally nested in that area due to the lack of cliff faces and no concentrated prey base. It is possible that falcons could choose to nest on the steep pit faces if micro-site conditions were favorable. This will depend upon the availability of a ledge with sufficient exposure height that the falcons feel comfortable. Short face heights with intervening slopes of crumbling rock may be insufficient compared to vertical face heights of perhaps 20 metres or more. The availability of those conditions may well depend upon the response of the rock to weathering and the face heights left after mining. Specific initiatives to create nesting sites are not recommended at this time.

8.8 Sharp-tailed Grouse

An excellent and extensive habitat model and life requisite description for sharp-tailed grouse was prepared by Teske & Ohanjanian and modified by Keystone. It is provided in Appendix 1. Ultimately, it is anticipated that shrub/grassland habitats created on the waste rock areas could provide suitable feeding and security requisites while existing riparian zones along Peterson Creek and nearby areas will provide wintering attributes. Reclamation aspen groves should also provide feeding and security requisites once they reach appropriate growth stages. Any retained grassland areas should remain suitable for this species.

Potential lek locations will need to be specifically created in hopes that they will be used, as the final contours of the waste rock piles have not been determined. Ten flatter areas or gentle hummocks raised slightly above the surrounding land surface and potential lek areas ranging from 400 - 1000m^2 should be created on the top of the waste rock piles. These hummocks could consist largely of till for the basic construction material but the final planting medium should be a fine-textured soil that will be exposed between the sparsely-planted bunchgrasses. The hummocks should be shaped more or less like the surrounding drumlins with the long axes oriented in a NW-SE direction. They may be as narrow as 50 m across the narrow axis. The hummocks should be seeded with bunchgrass plants to create an area of low grass cover suitable for lekking purposes (photo). Bare dirt between bunchgrasses would be appropriate if it does not become overgrown with weeds. While native bluebunch wheatgrass is a preferred planting, Dura hard fescue would be acceptable on these lek sites as it tends not to grow as tall as the native species. Spacing of bunches should generally vary from 0.5 – .75 m with some bare areas up to 4 m^2 being desired. The lek areas are to be spaced widely across the final waste rock landscape and not clustered. Developing shrub patch habitats within 1-200 metres of lek sites is desirable.

Locating perches suitable for raptors should be avoided within 300 m of the lek sites unless the perches are well below the top of the lek surface so that raptors cannot spot grouse from the perch.

Photograph 15. Sharp-tailed grouse lek site showing acceptable spacing of bunchgrasses. Birds will use areas with lower bunch densities as well.

8.9 Long-billed Curlew

Curlews have been seen periodically in the general area of the mine properties in the distant past (G. Little pers com) but the lack of recent sightings corresponds to declines noted elsewhere in the Knutsford area by R. Howie. Reasons for the decreases are not clear and may not be related to local nesting conditions.

Short-growth grasses with damp depressions and/or shallow wetlands would benefit curlews. Mixed grass and herbaceous cover is suitable and even sparse shrublands with a grassy substrate are acceptable. Generally, grass less than 30 cm tall is preferred. Re-colonization of the site by insects will be a critical component leading to the presence of curlews. The interspersion of short grass habitats with grazed pastures, agricultural fields and grazed mixed grass/shrub communities would be suitable across the landscape. In other areas near Kamloops, curlews and sharp-tailed grouse occupy the same landscapes and mixed grass mosaics.

Nesting often occurs where grass is short (7 - 20 cm) but this can vary. Brood-raising requires similar areas for cover. The home range requirements will vary depending upon how productive the habitats become, but could range from 15 - 30+ hectares per pair or more.

8.10 Lewis's Woodpecker

Lewis's woodpeckers will not excavate their own cavities in harder stems placed as future cavity-bearing snags as they traditionally are secondary occupants. They may excavate sites in trees that are quite soft and rotting, but those are not expected to occur on the mine property for many decades. Early occupancy of the Property by nesting Lewis's woodpeckers will require the placing of snags with pre-existing cavities of the size created by northern flickers. This will require the salvage of any existing cavities on the Property prior to logging for mining purposes. If none are available within the property, it may be possible to obtain some from local areas designated for commercial timber harvest.

Lewis's woodpeckers are known to use nest boxes so these should be attached to harder snags that are placed on the Property. This woodpecker presence will also require the existence of a substantial prey base of larger insects although they will fly up to 2 km from nest sites to forage. Berry-bearing shrubs are also an important component of their food supply. Opportunities for colonization might be best on sites destined to be reclaimed to ponderosa pine habitat once there is a reasonable growth of grass cover and the shrub component. The nest boxes should meet the following criteria.

- floor dimensions 17.5 x 17.5 cm
- depth 40-45 cm
- hole above floor 32 cm
- hole dia 7.5 cm
- placement height 3-7 – 6 m

The front face with the hole should be constructed of a slab of ponderosa pine with the bark intact, or pine bark should be glued to the front face of the box. The back of the box should be longer than the preferred box depth to facilitate attachment to a pole mounted in the ground. A ventilation slot should be left below the roof overhang.

Photograph 16. Lewis woodpecker nest box design.

8.11 Olive-sided Flycatcher

This flycatcher tends to nest at higher elevations in more mature forests with bare snag tops, wetlands or other openings and near the margins of logging cutblocks. It is not expected that conditions for this species can be created specifically by reclamation initiatives. Past occurrences on the property have likely been of migratory birds not seeking nesting opportunities although in 2012, there were significantly more records of this species than normal in low elevation grasslands/aspen grove habitats during the early nesting season. It is not known if any remained to nest at these lower elevations. It is possible that once grown and mature, the aspen grove habitats created by the reclamation process could provide nesting opportunities, but elevations of the proposed mine site are below the typical habitats used by this flycatcher.

8.12 Barn Swallow

Barn swallows have limited nesting opportunities on the pre-mining landscape within the Ajax operating area. Rock faces created by the original TECK operation provide the best potential. This swallow may nest on buildings developed as part of the mining operation. This will be a relatively short term opportunity that will be lost once all of the buildings are decommissioned and removed. Nesting has been observed on the existing pit walls and this may occur again once operations cease. Other opportunities to create nesting habitat are limited apart from leaving some buildings but this is an unlikely option. From a mitigation perspective, barn and cliff swallows that nest on mine structures should be tolerated as much as possible and not disturbed during the nesting cycle. To do so would be an offence under the Migratory Birds Convention Act. If nests are found to be creating problems from droppings, structures can be built under the nests to prevent droppings from falling on work areas or becoming a nuisance for workers and mine operations.

9.0 Special Habitats

9.1 Snake Hibernacula

Snakes require suitable den sites in order to successfully overwinter at local latitudes. Artificial hibernacula have been constructed in various areas with some success in use by snakes that find the dens on their own or after being transplanted for a variety of reasons. Figure 4 is provided only as a general guide for what could be created to provide opportunities for snakes that may attempt to recolonize the reclamation areas.

The general principal is to construct a pit to depths below frost line but above the water table and to fill it with broken rubble within which snakes will hibernate. Modifications to the design could include plastic or corrugated pipes that lead from the ground surface to deeper portions of the excavation. As well, it may be advisable to create a sump area below the lowest rubble where water could be directed via pipes in order to create humid conditions. Suitable benches above the sump would be needed to enable snakes to hibernate away from the wetted sump area. The top should be covered with earth and large boulders scattered near the entrance holes to provide basking surfaces and shelter. Further design details should be discussed during the reclamation stage.

Dens should be located along south-facing slopes in native soils (Figure 5) in areas of maximum potential solar radiation but not at extreme valley bottom sites where cold air could pool. Below the foot of the rock dump sites would seem to be acceptable for example. This would put them in proximity to wetland habitats such as Peterson Creek or other wetlands which may be advantageous in attracting snakes. Hibernacula constructed on the rock dump or tailing slopes or should be within 200 metres of any wetlands or ponds that are successfully created, but the tops of the dumps may be too high in elevation to be used. Such sites should be avoided. Few snakes are expected to be long distances out in dry grasslands, with the wetlands more likely to serve as an attractant to species like garter snakes. Detailed site locations have not been established.

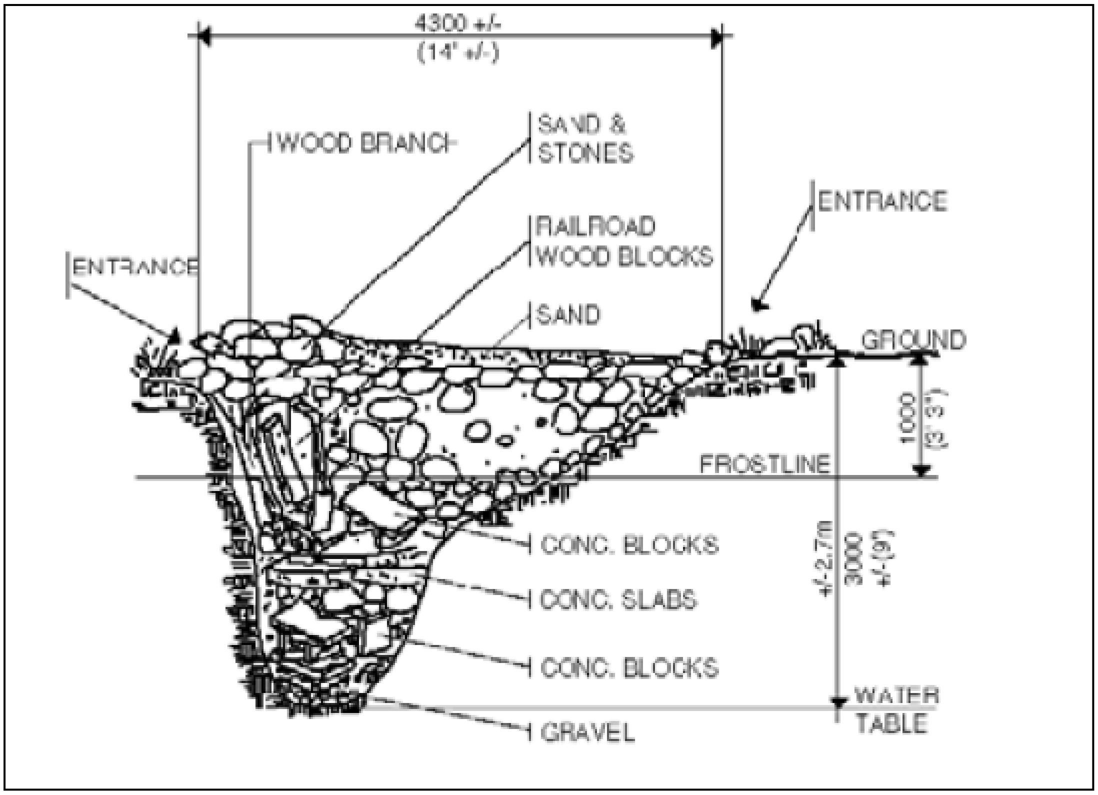

Figure 4. Sample snake hibernaculum.

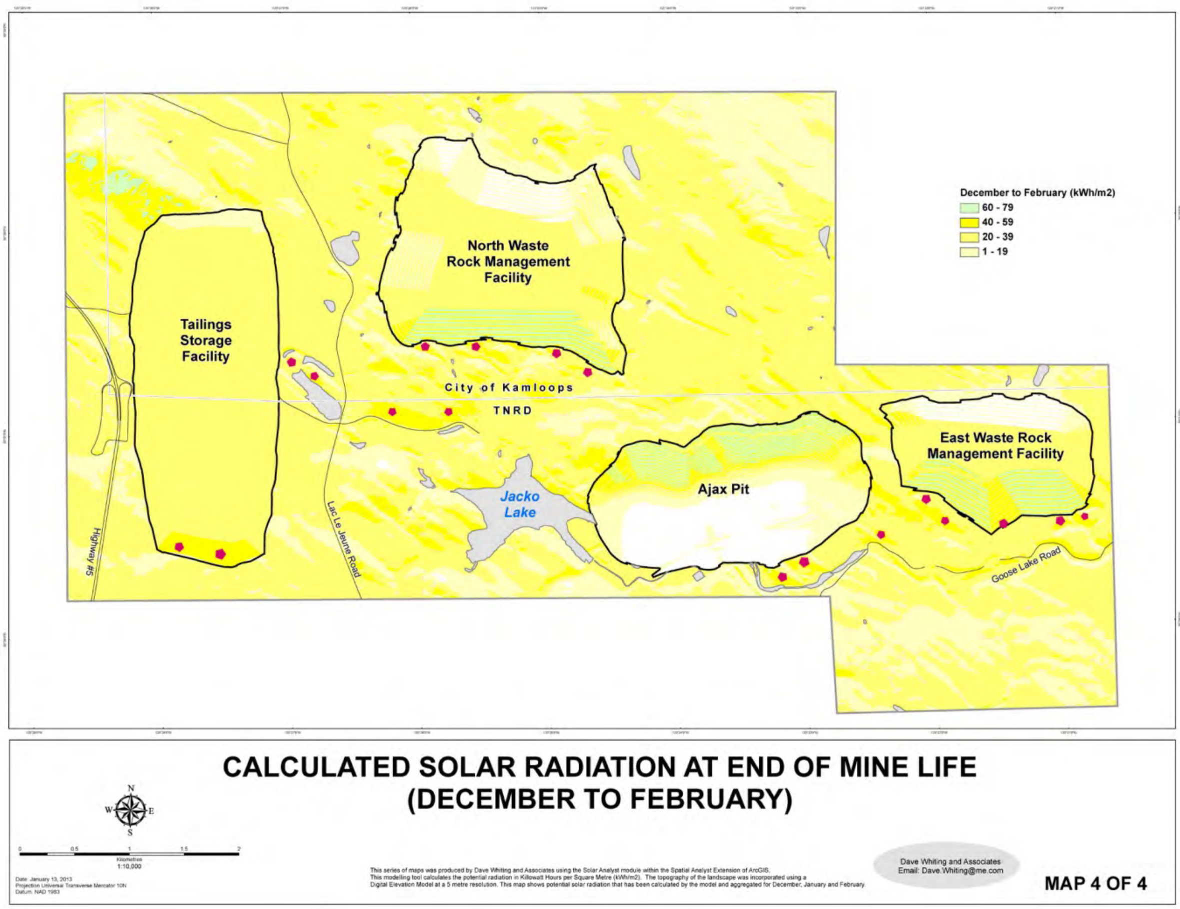

Figure 5. Sample locations for artificial snake hibernacula shown as red dots on solar radiation map created by Dave Whiting & Associates (2012).

9.2 Bird Nest Boxes

There is a wide range of species that will use artificial nest boxes and depending upon the nature of the reclamation habitats under development, an extensive program could be established to bolster biodiversity on the site during the early stages of habitat evolution. Mine sites such as TECK - Highland Valley Copper have created a highly successful nest box program that provides cavities for species such as mountain bluebirds and tree swallows utilizing reclaimed mine sites. Additional birds such as Barrow's goldeneye and bufflehead can also be attracted to nest boxes if suitable supportive wetlands are created during the reclamation process. There are a host of designs easily available but a sample design (Figure 6) is provided for small passerines such as bluebirds and swallows. Wrens would even use a box of this design. Boxes for woodpeckers and other species can supplement habitat conditions in evolving forested reclamation habitats as well as open grassland sites. Annual maintenance of nest boxes is a commitment that must be made for the program to be successful but for a nominal cost, it may be possible to contract with local NGO organizations to undertake this work.

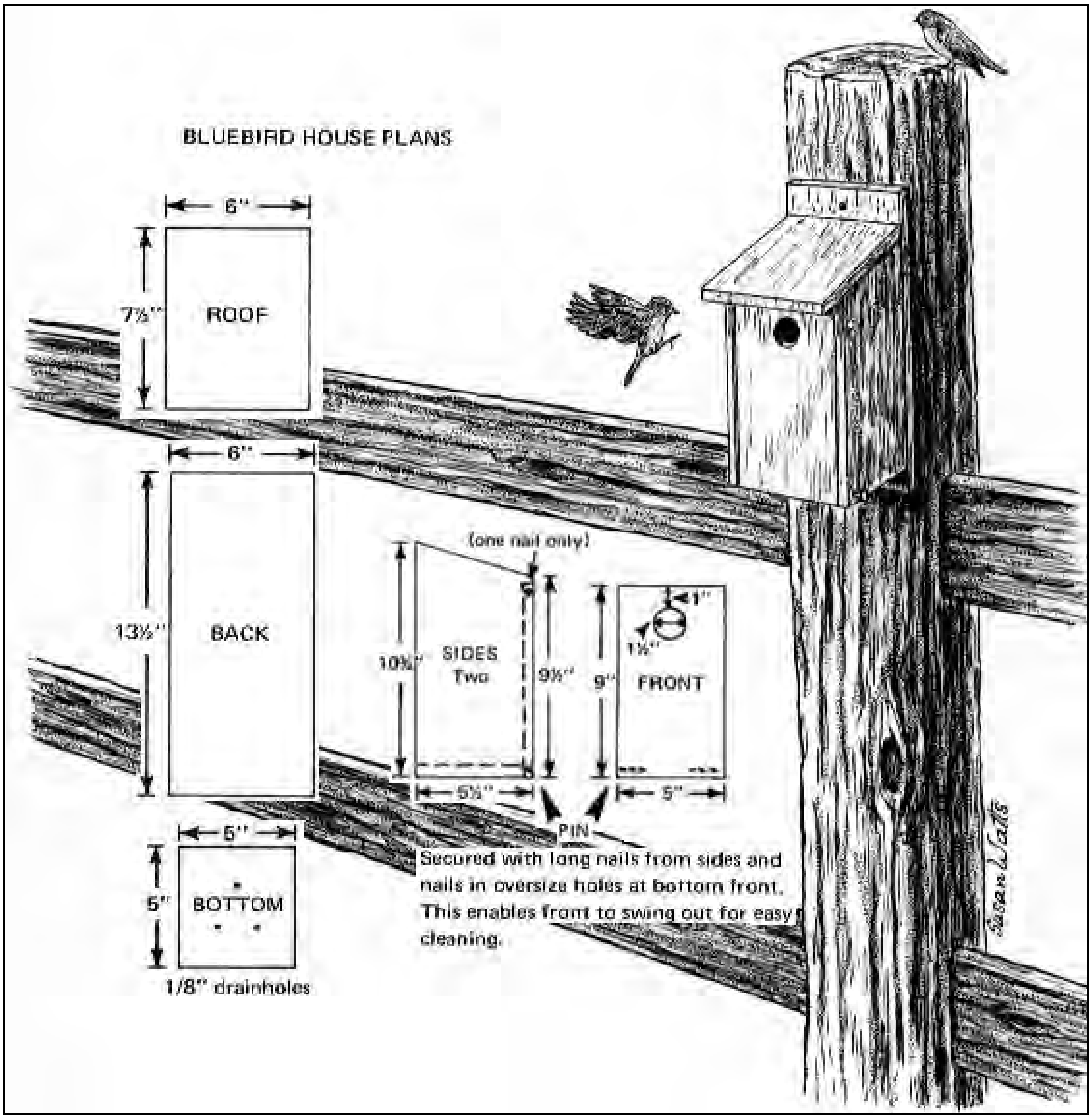

Figure 6. Nest box design suitable for passerines such as swallows, bluebirds and house wrens. (Ohio Dept. of Natural Resources)

9.3 Small Mammal Nest Boxes

Mammals such as red and flying squirrels will utilize nest boxes and these could be placed within developing forested sites in order to provide suitable cavities. Figure 7 illustrates a box suitable for squirrels.

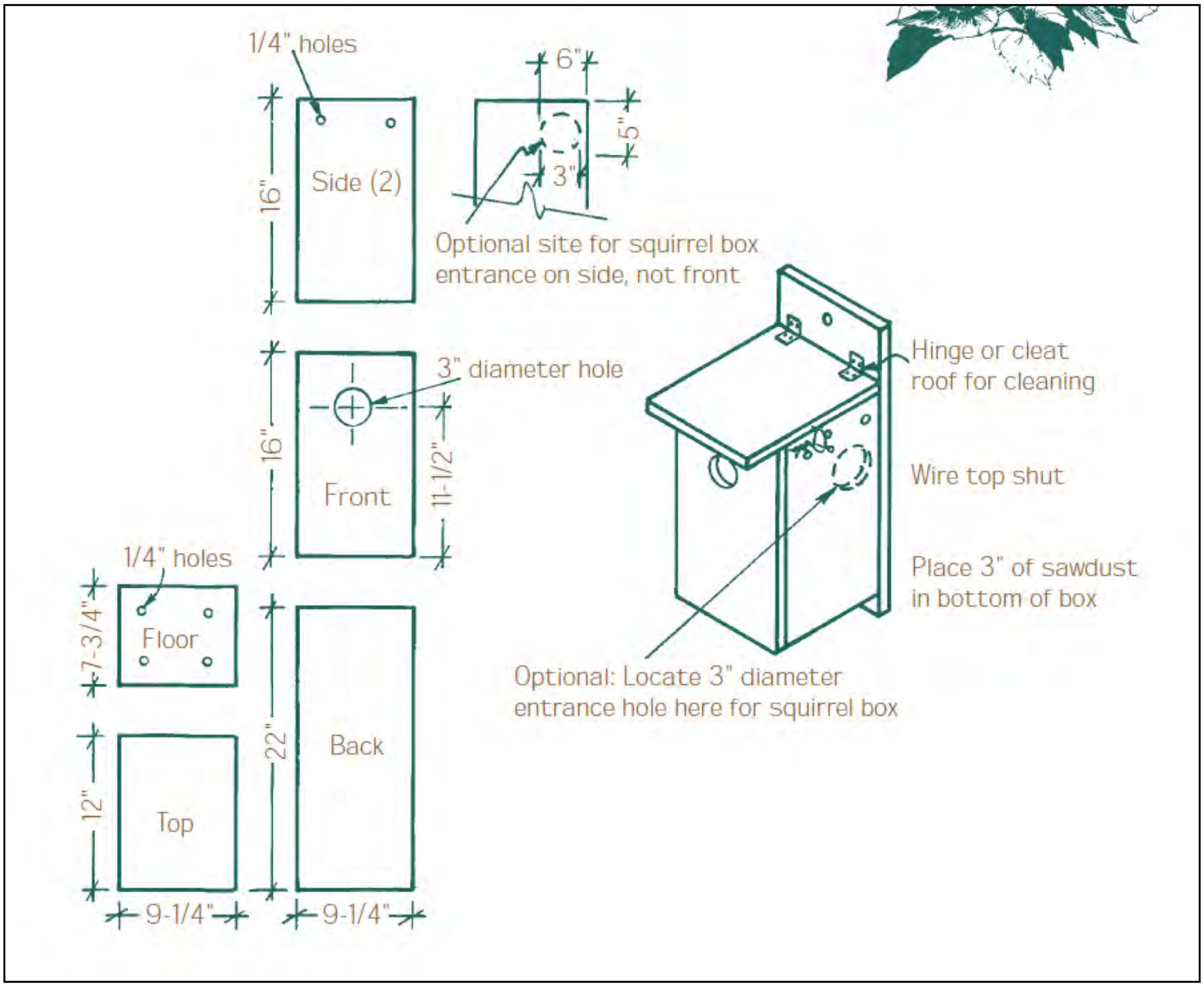

Figure 7. Small mammal nest box design (Windstar Wildlife Institute).

10.0 Indicator Species for the Initial Decade of Colonization

The following list of species are those that could occur as foraging, nesting or reproducing species during the early stages of mine reclamation. The list includes possible passage migrants. To a large degree it suggests potential but the speed with which the reclamation habitats respond over time will largely determine the likelihood of colonization by many species. The concomitant development of suitable adjacent wetlands will influence the presence of nesting waterfowl and amphibians around the margins. It is assumed that by 10 years, forest habitats will not be more advanced than early in the pole/sapling stage with a grassy understory. Some will colonize as permanent residents while others will occur as temporary occupants such as migratory birds or summer breeding birds with changes as the habitats age. The occurrence of a large percentage of these species actually obtaining functional value from the sites could serve as one indicator of a successful initial trajectory of the reclamation program. Simple presence for a short term may not imply that the conditions necessary for beneficial occupancy have been met.

Table 16. Potential wildlife that could beneficially utilize proposed Ajax reclamation sites within the first 10 years.*

Birds				Mammals				Amphibians				Reptiles		
Conifer Forest	Aspen	Grassland	Pond	Conifer Forest	Aspen	Grassland	Pond	Conifer Forest	Aspen	Grassland	Pond	Conifer forest	aspen	Grassland
RTHA - F	RTHA - F	SACR - F	PBGR - FN	SOCI - FR	SOVA- FR	SOVA - FR	MYLU- F		AMMA-F		AMMA - R	ELCO - FR	THEL - FR	
AMKE - F	AMKE - F	AMWI - N	HOGR - FN	MIPE - FR	MIPE - FR	MIMO - FR	MYYU - F			SPIN - F	SPIN - R	CHBO -FR		
MERL - F	RUGR- FN	MALL - N	CAGO - FN	PEMA - FR	PEMA - FR	THTA - FR	ONZI - FR	ANBO - F		ANBO - F	ANBO - R	THEL - FR		
DUGR - FN	STGR - F	NOPI - N	AMWI - F	THTA - FR	THTA - FR	MAFL - FR					PSRE - R			
GHOW - F	GHOW - F	GWTE - N	MALL - F	TAAM - F	CALA - F	CALA - F								
NOFL - F	NOFL - F	NOSL - N	BWTE - F	CALA - F	LYRU - F	LYRU - F								
CORA - F	BBMA - F	LESC - N	CITE - F	URAM - F	MUFR - F	MUFR - F								
MOCH - F	MOBL - F	NOHA - F	NOSL - F	LYRU - F	URAM - F	URAM - F								
RCKI - F	CEWA - F	SWHA - F	REDH - F	ODHE - F	ODHE - F	ODHE - F								
MOBL - F	OCWA - F	RTHA - F	RNDU - F											
AMRO - F	YRWA - F	RLHA - F	LESC - F											
YRWA - F	CHSP- FN	AMKE - F	BUFF - F	Various species of bats could forage throughout but need special features for roosting or hibernacula.										
CHSP - FN	VESP - FN	STGR - F (N?)	BAGO - F											
DEJU - FN		LBCU - FN	COGO - F											
VESP - FN		KILL - N	AMCO -FN											
PISI - F		SPSA - N	KILL - F											
		WIPH - N	SPSA - F											
		SEOW - F	LESA - F											
		NOSH - F	COSN - F											
		CORA - F	WIPH - F											
		HOLA - FN												
		MOBL - F												

		AMRO - F												
		EUST - F												
		AMPI - F												
		ATSP - F												
		CHSP - FN												
		VESP - FN												
		SAVS - FN												
		LALO - F												
		SNBU - F												
		WEME - F												
		GCRF - F												

F = feeding N = nesting R = reproduction

* see Appendix 2 for common names to accompany codes used in the table.

11.0 Mitigation Practices

During the course of mine development and ultimately the operations, it should be possible to retain some species of wildlife for varying lengths of time, depending upon whether their habitat is likely to be removed, or whether some species actually colonize the mine site during its operations. Tolerance of their presence and the adoption of practices to allow them to remain are recommended, so long as the health and safety of the mine personnel and the wildlife is not threatened.

11.1 New Colonization

Examples of this phenomenon could be the establishment of nesting colonies of cliff swallows or single nests of barn swallows. Both species are attracted to sheltered spaces on or inside buildings, so long as there is a food source nearby. Cliff swallows have been observed foraging at least 5 km from nest sites on active mine buildings (R. Howie, pers obs). Disturbance of nests of migratory birds during the nesting season is prohibited under the Migratory Birds Convention Act.

During the course of progressive reclamation of some areas while the mine remains active elsewhere on the property, the successful development of early grass/forb communities will likely attract populations of rodents which in turn will attract predators such as coyotes. The growth of forage will attract deer and possibly black bear and a variety of birds. All of these species will acclimate to the presence of humans and mine activity in the absence of aggressive actions to deter or frighten them. So long as strict avoidance of feeding and proper management of putrescible waste is practiced, many of these animals will live successfully within the Property without becoming nuisance wildlife which will lead to their destruction. Tolerance of their presence is recommended where there is no hazard to wildlife, workers and general mine operations.

The erection of electrical transmission lines to service the mine operation will provide structures that could attract raptors to nest or perch. These should be monitored and appropriate aversion responses undertaken in the way of supplementary designs or devices to deter perching or nesting at hazardous locations. Nesting platforms may be advisable in order to control locations where raptors could nest rather than waiting for the birds to make the choice of location. Various designs can be found through literature or on-line searches as this is an issue along transmission corridors with a long history of responses by a variety of agencies.

11.2 Wildlife Relocation

Prior to the removal of habitats for species of management concern such as spadefoot toads, western toads, sharp-tailed grouse or other species, discussions should be held with the appropriate management agencies to determine whether animal capture and translocation is warranted. During the reclamation process, the reverse actions should also be discussed. It may be desirable to hasten the colonization of some ponds by spadefoots for example, through translocation of adults into the reclamation ponds. Once suitable reclamation habitat exists, and if local populations are healthy, capture and movement of sharp-tailed grouse onto reclaimed habitats may be warranted as an experiment to hasten re-colonization and the development of biodiversity.

11.3 Selective Exclusion

If wildlife enter the active mining operation and become threatened by industrial hazards such as heavy equipment traffic and so forth, exclusion fencing should be erected to eliminate the hazard to both wildlife and operations staff. Passages may be needed to allow for traditional animal movement patterns if these become evident. Other forms of animal control may be needed to prevent utilization of mine sites that could be hazardous to both workers and wildlife. Prompt response to perceived hazards should be part of the operation protocol before wildlife dies or is injured.

11.4 Interim Wildlife Habitat

The development of the various habitat types described earlier in this report can take many years to evolve. In the interim, it is possible to provide substitute habitats that can benefit some species of wildlife. Brush piles, erected tree snags, artificial nesting structures, nest boxes for smaller species and temporary water source enhancements are a few techniques that should be considered and implemented as appropriate.

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Appendix 1

Taxonomic Equivalents for Plant Species Names

The following are the scientific names for the species referred to by their common names in the preceding report.

Common Name	Scientific Name
Black Cottonwood	*Populus balsamifera ssp. trichocarpa*
Trembling Aspen	*Populus tremuloides*
Water Birch	*Betula occidentalis*
Ponderosa Pine	*Pinus ponderosa*
Lodgepole Pine	*Pinus contorta var. latifolia*
Engelmann Spruce	*Picea engelmannii*
Douglas Fir	*Pseudotsuga menzeisii*
Saskatoon	*Amelanchier alnifolia*
Black Hawthorne	*Crataegus douglasii*
Columbia hawthorne	*Crataegus Columbiana*
Choke Cherry	*Prunus virginiana*
Prickly Rose	*Rosa acicularis*
Nootka Rose	*Rosa nutkana*
Prairie Rose	*Rosa woodsii*
Big Sagebrush	*Artemisia tridentata*
Common Rabbit Brush	*Chrysothamnus nauseosus*
Douglas Maple	*Acer glabrum*
Pacific Willow	*Salix lucida ssp. lasiandra*
Bebb's Willow	*Salix bebbiana*
Scouler's Willow	*Salix scouleriana*
Red-osier Dogwood	*Cornus stolonifera*
Common Snowberry	*Symphoricarpos albus*
Kinnikinnick	*Arctostaphylos uva-ursi*
Common Juniper	*Juniperus communi*s
Rocky Mountain Juniper	*Juniperus scopulorum*

Appendix 2

Common Names to Accompany Codes in Table 16

The codes used in the table in order to save space are commonly used acronyms for the various species within major groups of animals. The codes are listed in alphabetical order as opposed to taxonomic sequence in order to simplify the task of finding a code for those not familiar with them when perusing Table 16. Most of the codes were taken from Cannings and Harcombe (1990) and updated where taxonomy has changed from the original manuscript.

Birds		Birds		Mammals	
Code	Common Name	Code	Common Name	Code	Common Name
SACR	Sandhill Crane	MALL	mallard		
AMCO	American coot	MERL	merlin	CALA	coyote
AMKE	American kestrel	MOBL	mountain bluebird	LYRU	bobcat
AMPI	American pipit	MOCH	mountain chickadee	MAFL	yellow-bellied marmot
AMRO	American robin				
		NOFL	northern flicker	MIPE	meadow vole
ATSP	American tree sparrow	NOHA	northern harrier	MIMO	montane vole
AMWI	American wigeon	NOPI	northern pintail	MUFR	long-tailed weasel
BAGO	Barrow's goldeneye	NOSH	northern shrike	MYLU	little brown myotis
BBMA	black-billed magpie	NOSL	northern shoveler	MYYU	Yuma myotis
BUFF	bufflehead	OCWA	orange-crowned warbler	ODHE	mule deer
BWTE	blue-winged teal	PBGR	pied-billed grebe	ONZI	muskrat
CAGO	Canada goose	PISI	pine siskin	PEMA	deer mouse
CEWA	cedar waxwing	RCKI	ruby-crowned kinglet	SOCI	common shrew
CHSP	chipping sparrow	REDH	redhead	SOVA	vagrant shrew
CITE	cinnamon teal	RNDU	ring-necked duck	TAAM	yellow-pine chipmunk
COGO	common goldeneye	RLHA	rough-legged hawk	THTA	northern pocket gopher
CORA	common raven	RTHA	red-tailed hawk	URAM	black bear
COSN	common snipe	RUGR	ruffed grouse		
DEJU	dark-eyed junco	SAVS	savannah sparrow		
DUGR	dusky grouse	SEOW	short-eared owl		
EUST	European starling	SPSA	spotted sandpiper		
GCRF	gray-crowned rosy finch	SNBU	snow bunting		
GHOW	great horned owl	STGR	sharp-tailed grouse		
GWTE	green-winged teal	SWHA	Swainson's hawk		

HOGR	horned grebe	VESP	vesper sparrow
HOLA	horned lark	WEME	western meadowlark
KILL	killdeer	WIPH	Wilson's phalarope
LALO	Lapland longspur	YRWA	yellow-rumped warbler
LESA	least sandpiper		
LESC	lesser scaup		

Amphibians		**Reptiles**	
Code	Common Name	Code	Common Name
ANBO	western toad	CHBO	rubber boa
AMMA	long-toed salamander	ELCO	northern alligator lizard
PSRE	Pacific chorus frog	THEL	western terrestrial garter snake
SPIN	spadefoot toad		

Appendix 3

Habitat Models

Columbian Sharp-tailed Grouse

This species account is based upon one originally prepared by Irene Teske, B.Sc., R.P.Bio. and Penny Ohanjanian, M.Sc., R.P.Bio., for the Premier Diorite Project. It has been edited and updated for the Abacus study area by Keystone Wildlife. Edited/added text is indicated by Arial font.

Species Data

Common Name:	Columbian Sharp-Tailed Grouse
Scientific Name:	(*Tympanuchus phasianellus columbianus*)
Species Code:	B-STGR-CO
Provincial Status:	Blue-listed (BC CDC 2010)
COSEWIC Status:	not listed (BC CDC 2010)
Identified Wildlife Status:	Identified (June 2006)

Project data

Area:	Abacus TEM Mapping Area
Project Map Scale:	TEM, 1:20,000
Ecoprovince:	Southern Interior
Ecoregion:	Thompson-Okanagan Plateau
Ecosection:	Thompson Basin (THB)
Biogeoclimatic Zones:	BGxh2, BGxw1, PPxh2, IDFxh2

1.0 Distribution

There are seven sub-species of Sharp-Tailed Grouse in North America. The Columbian Sharp-Tailed Grouse (CSTG) was originally found in the Great Basin and Columbia Plateau, from interior central and southern BC, Washington, Oregon, Idaho, and northwestern Montana to California, Wyoming and Nevada, east to Utah and southwestern Colorado (NRCS 2007; Tesky 1994). It is now extirpated from California (Hoffman and Thomas 2007), and currently occupies less than 5% of its original range (Utah DWR 2002).

1.2 Provincial Range

The Columbian subspecies occurs '*from near Vanderhoof south to Merritt, east to the Cariboo Mountains, and west to the Coast Ranges'* (BCMWLAP 2004). It has been extirpated from the Okanagan. CSTG occupy the Bunchgrass, Interior Douglas-fir, Montane Spruce, Ponderosa Pine, Sub-boreal Pine and Spruce and Sub-boreal Spruce BEC zones (BC CDC 2010). Within BC, about 42 sub-populations (lek groups and isolated leks) are known (D. Jury, pers. comm., cited in BC CDC 2008b).

1.3 Distribution on the Study Area

CSTG were not observed during breeding bird surveys of the study area, but this species was not targeted during surveys in order to avoid potential disturbance of lekking and nesting areas during the spring breeding period. Known lek sites are located on private land within the TEM-mapped area (D. Jury, pers. comm.; Howie 2005) and additional lek sites may also be present. Hunting CSTG within Region 3 is currently permitted only in MU-3-31 (northwest of Clinton).

1.4 Elevation Range: 275–1190 m in British Columbia (BC MWLAP 2004). In Utah, elevation ranges up to 2438 m have been reported (Utah DWR 2002).

2. Ecology and Habitat Requirements

The Sharp-Tailed Grouse is a prairie game bird. The Columbian subspecies of Sharp-tailed Grouse is associated with native grasslands and perennial bunchgrasses, including bluebunch wheatgrass and rough fescue, which are in excellent condition. Deciduous trees and shrubs are also considered essential habitat features (Ritcey 1995). Declines in CSTG populations across the subspecies' range have been associated with diminished quality and quantity of native grassland habitat, especially with conversion of native grassland and shrub-steppe to cropland, overgrazing, and forest encroachment onto grasslands (Schroeder *et al.* 2000; NRCS 2007; McDonald and Reese 1998).

High-suitability habitat for sharptails consists of a mosaic of grassland growing season range interspersed with shrubby riparian wintering habitat (USDA 1999). In the BC southern interior, sharp-tails are associated with climax grasslands with little to no sagebrush in the BG, PP and IDF (Leupin 2003). Sharp-tails in Utah (Evans 1968 cited in Tirhi and Hayes 1997) and Idaho (Marks and Marks 1987 cited in Tirhi and Hayes 1997) preferred slopes <60%, and Ritcey (1995) also states that the subspecies prefers gentle slopes.

CSTG do not migrate, but may make short-distance movements between winter and summer habitats when snowfall dictates. Home range size is influenced by topography, availability of food and cover, and season (Tirhi and Hayes 1997). Year-round home ranges in BC have been documented as averaging 4.9 km^2 (Van Rossum 1992 as cited in BCMWLAP 2004). Two male birds in the Kamloops area had home ranges of 2.1 and 3.8 km^2 (Leupin 2000 cited in Leupin 2003). Near Kamloops, radio-marked males remained within 600 m of the lek (Leupin 2000 cited in Leupin 2003), and radio-marked birds of both sexes remained within 2.8 km of the lek of capture (Leupin 2003). In Washington State, CSTG moved up to 14 km between breeding habitat and winter habitat (Schroeder 1994 cited in Tirhi and Hayes 1997).

CSTG feed mainly before sunrise and after sunset (USDA 1999). Approximately 90% of the diet is made up of vegetative matter (primarily forbs, fruits, buds and grasses), with insects forming the remaining 10% (USDA 1999; Hoffman and Thomas 2007). The diet of chicks is primarily insects (BCMWLAP 2004). Important food plants for grassland populations include snowberry (*Symphoricarpos alba*), rose (*Rosa* sp.), buttercup (*Ranunculus* spp.), salsify, choke cherry (*Prunus virginiana*), prickly lettuce and dandelion (*Taraxacum officinale*), and during the winter, buds and browse from water birch (*Betula occidentalis*), trembling aspen (*Populus tremuloides*), saskatoon (*Amelanchier alnifolia*), and choke cherry (BCMWLAP 2004; Hoffman and Thomas 2007; Jones 1966).

In late fall and winter, a short migration may occur to nearby deciduous riparian areas with well-developed shrub communities, which are critical components of winter habitat (Hoffman and Thomas 2007). This may occur in response to snow; one radio-collared grouse in northern Montana remained in native grassland habitat until a storm left 7 to 10 cm of snow on the ground, at which time (January) it moved to shrubby wintering habitat (Wood 1992). Sharp-tailed Grouse winter in mainly in shrublands, feeding on choke cherry, saskatoon, rose (*Rosa spp.*) and other shrubs (Marks and Marks 1987, 1988), and roosting on the ground or under deep snow (Hoffman and Thomas 2007; USDA 1999). Wintering habitat is critical, especially during heavy snowfall years. During mild winters, birds may remain on summer grassland habitat (NRCS 2007).

Sharptails aggregate into larger flocks on the wintering grounds (USDA 1999). Flocks documented in BC have ranged from 7-72 birds (Leupin 2003). There is some evidence that individual birds may return to traditional wintering areas (Hoffman and Thomas 2007).

In early spring (March to late June), males congregate on traditional dancing grounds (leks) in the open, where they perform displays of foot-stomping with wings outstretched, tails raised and heads lowered (Hoffman and Thomas 2007). Males display for 2-3 hours on leks every morning, beginning from 30 to 60 minutes before sunrise (NRCS 2007). The number of males on a single lek ranges from two to 35, with the more dominant males occupying favoured positions at the centre of the lek (NRCS 2007). Young and/or subordinate males may occupy smaller satellite leks on the periphery of the main lek (Schroeder *et al.* 2000). Females visit the lek to choose a mate. Most females visit leks in mid to late-April in BC (D. Jury, pers. comm. cited in Leupin 2003). Although the older central males are chosen by most of the females, yearling males are often successful at breeding (Bergerud 1988).

Males (and occasionally females) return to leks in the fall, possibly to establish hierarchies for the following breeding season or to allow juvenile birds to learn the location of the lek (Leupin 2003; Hoffman and Thomas 2007). Males generally remain within 2 km (often within 400 m) of the lek during the growing season (Hoffman and Thomas 2007). Male grouse and females that have not nested successfully spend the remainder of the growing season singly or in small groups (USDA 1999; Tirhi and Hayes 1997).

Males on leks appear to be tolerant of some forms of disturbance but are displaced by predators and by human presence (Leupin 2003). Nesting females in particular are susceptible to disturbance (BC CDC 2008b). Females also avoid disturbed leks, which can affect overall reproductive success (Baydeck and Hein 1987, cited in BC CDC 2008b). Some sources state that physical, mechanical, and/or audible disturbances within a 2 km radius of leks can disturb courtship displays, breeding, nesting, and brood-rearing (NRCS 2007). Some anthropogenic disturbance, such as road traffic at a distance greater than 1 km, is unlikely to cause changes in habitat use, especially if security cover is present (D. Jury, pers. comm.).

Eggs are laid in shallow depressions on the ground under cover of a shrub or large bunchgrass in native grassland habitat (Hoffman and Thomas 2007). Nests are usually within 5 km of the dancing grounds. In the Kamloops area, nests were located within 2400 m of the lek (Leupin 2003). Individual females may return to the same general nesting area in successive years (Hoffman and Thomas 2007).

In the southern interior of BC, clutches were found from May 5, with hatching to June 11, though nesting activity is known to be delayed during cold springs (Leupin 2003). One brood is raised per year, though most hens will re-nest if the first clutch is lost (BCMWLAP 2004; Hoffman and Thomas 2007; Ritcey 1995). Eleven eggs form the average clutch in BC (Leupin 2001 cited in Leupin 2003), which is incubated for 23 days before hatching (USDA 1999).

Chicks are precocial and only the female takes care of the brood, which depends on cover and cryptic coloration for protection. The young can fly at ten days of age (USDA 1999). The chicks are vulnerable to inclement weather, starvation and predators (Bergerud 1988 cited in Tirhi and Hayes 1997), so survival rates can be quite variable (BCMWLAP 2004). However, juvenile mortality rates in BC are unknown (Leupin 2003). Mortality of adult birds may be highest during spring and fall dancing periods and during periods of severe winter weather (Leupin 2003). Annual survival of sharptails in Washington State has been reported as 53% (Schroeder 1994 cited in Tirhi and Hayes 1997).

3.0 Habitat Use - Life Requisites

The life requisite that will be rated for CSTG is "Living" in the growing season and in winter. For CSTG, "living" is satisfied by the presence of suitable feeding, and security/reproductive habitat as described in detail below.

3.1 Feeding and Security Habitat

Winter

Winter habitat is typically riparian or upland shrubs, including saskatoon, rose, hawthorn (*Crataegus douglasii*) and choke cherry (Hoffman and Thomas 2007). Wintering areas must provide thermal as well as forage values for this species. Suitable wintering habitat may include structural stages 2-7 (BC MWLAP 2004). Near Kamloops, wintering CSTG used shrub/tree habitats with trembling aspen, black cottonwood (*Populus balsamifera*), and Douglas-fir (*Pseudotsuga menziesii*) in the canopy, and water birch, choke cherry, common snowberry, saskatoon, red-osier dogwood (*Cornus stolonifera*) and prickly rose (*Rosa acicularis*) in the shrub layer (Leupin 2003). Open grassland habitats are still used when snow depths are minimal. Marshes and sedge fens may be used for snow roosting (Ritcey 1995).

Growing Season

Growing season habitat normally consists of structural stages 2 and 3 (BCMWLAP 2004). During the late summer and fall, sharptails may forage in grainfields where such crops are available (USDA 1999; Leupin 2003). Females with broods may use shrubby areas and aspen copses as brood-rearing areas, and tend to nest adjacent to suitable rearing habitat (Hoffman and Thomas 2007). Plant species present in the study area that have been associated with sharp-tail habitat are summarized in Table 1.

Table 1. Plants associated with CSTG habitat (from NRCS 2007; Hoffman and Thomas 2007).

Common Name	**Scientific Name**
bluebunch wheatgrass	*Pseudoroegneria spicata*
brome grasses	*Bromus* spp.
soopolallie	*Shepherdia canadensis*
bluegrass	*Poa* spp.
choke cherry	*Prunus virginiana*
clover	*Trifolium repens*
yarrow	*Achillea millefolium*
dandelion	*Taraxacum officinale*
salsify	*Tragopogon dubius*
gromwell	*Lithospermum* spp.
hawkweed	*Hieracium* spp.
saskatoon	*Amelanchier alnifolia*
willow	*Salix* spp.
juniper	*Juniperus* spp.
lamb's-quarters	*Chenopodium album*
rose	*Rosa* spp.
big sage	*Artemisia tridentata*
snowberry	*Symphoricarpos alba*
wheatgrass	*Elymus* spp.
thistle	*Cirsium* spp.
water birch	*Betula occidentalis*
arrowleaf balsamroot	*Balsamorhiza sagittata*
buckwheat	*Eriogonum* spp.
hawksbeard	*Crepis* spp.
lupine	*Lupinus* spp.
knotweed	*Polygonum* spp.
sedge	*Carex* spp.
prickly lettuce	*Lactuca serriola*
alfalfa	*Medicago sativa*
Idaho fescue	*Fescue idahoensis*

3.2 Reproducing-Eggs

Lek habitat consists of flat, bare or short-grass areas, often located on a ridge or hilltop (USDA 1999; Hoffman and Thomas 2007). Leks may be re-used for many years (>40 in BC; Leupin

2003), but the actual location may shift slightly from year to year, forming 'lek complexes' (Schroeder *et al.* 2000). New leks may be established occasionally by adult males (Tirhi and Hayes 1997). Leks must be secluded and well away from disturbance (BCMWLAP 2004). Size of CSTG leks ranges from 20 to >400 m^2 (Hoffman and Thomas 2007).

Suitable nesting habitat is considered a limiting factor for CSTG (Leupin 2003). Campbell *et al.* (1990) described nest sites as either in open grassland or under sparse canopies of lodgepole pine, ponderosa pine, Douglas-fir or trembling aspen. Nests located near Kamloops were found in dense grasses (bunchgrass, rough fescue, Kentucky bluegrass), averaging 36 cm in height (Leupin 2003). Another species of security value is arrowleaf balsamroot Balsamorhiza *sagittata*), which is often found in association with rough fescue (*Festuca spp.*) or bluebunch wheatgrass (*Pseudoroegneria spicata*). Adults and broods are vulnerable to aerial and mammalian predators. Grass cover >25 cm seems to be characteristic of successful nesting habitat (BC MWLAP 2004). Nests are located in denser cover than the surrounding area (NRCS 2007). In Minnesota, nests are typically located in grass or adjacent to brush or stumps (USDA 1999). Heavy livestock grazing may reduce nesting cover below optimum (Ritcey 1995).

Habitat used by females with broods may differ from that used by nonbreeding adults (Tirhi and Hayes 1997). Brood-rearing habitat in the southern interior consisted of swales and seepage areas with shrubs and dense herb cover 60 cm in height, as well as aspen copses (Leupin 2003). Nesting and brood-rearing habitat on native grassland on the Tobacco Plains, Montana, was characterized by dense grass cover with an average effective height of >20 cm (Wood 1992). In Wyoming, CSTG broods used sagebrush-snowberry and mountain shrub habitat more than expected, and used edges of large openings rather than the centers (Klott and Lindzey 1990).

3.3 Seasons of Use

CSTG habitat will be rated for two seasons: the Growing season (May to October), and the Winter season, as the habitats required in these two seasons are markedly different. Table 2 summarizes the life requisites required for each month of the year.

Table 2. Seasons and life requisites for Columbian Sharp-Tailed Grouse.

Month	Season	Life Requisites
Jan	Winter	Feeding/Security-thermal (Living)
Feb	Winter	Feeding/Security-thermal (Living)
March	Winter	Courtship, Feeding/Security-thermal (Living)
April	Winter	Courtship, Feeding/Security-thermal (Living)
May	Growing	Courtship, Feeding/Security (Living)
June	Growing	Reproducing-eggs (Living)

Month	Season	Life Requisites
July	Growing	Reproducing-eggs (Living)
Aug	Growing	Feeding/Security-thermal (Living)
Sept	Growing	Feeding/Security-thermal (Living)
Oct	Growing	Feeding/Security-thermal (Living)
Nov	Winter	Feeding/Security-thermal (Living)
Dec	Winter	Feeding/Security-thermal (Living)

*Seasons defined for Southern Interior Mountains Ecoprovinces per the Chart of Seasons by Ecoprovince
(RIC 1998, Appendix B).

3.4 Habitat Use and Ecosystem Attributes

Table 3 outlines how each life requisite relates to specific ecosystem attributes (e.g. site series/ecosystem unit, plant species, canopy closure, age structure, slope, aspect, terrain characteristics).

Table 3. Terrestrial Ecosystem Mapping (TEM) Relationships for each Life Requisite for Columbian Sharp-tailed Grouse.

Growing season Living/Reproducing-eggs	Native grasslands with perennial bunch grasses (fescue and/or bluebunch wheatgrass) in excellent condition (Structural Stage 2). • High profile vegetation (height 30 cm plus is excellent, 20 cm is minimal) remaining as residual from previous year. Shrubby areas with high diversity of vegetation and abundant insects for brood-rearing.
Winter Living	• Shrub and deciduous habitat, with abundant saskatoon, rose, choke cherry, structural stages 3-7; native grassland during low-snow periods

4.0 Ratings

There is an intermediate level of knowledge on the habitat requirements of CSTG in British Columbia and thus, a 4-class rating scheme will be used. Ratings will be provided for Living in the growing season (BSTGRCO_G) and Living in the winter (BSTGRCO_W).

4.1 Provincial Benchmark

No provincial benchmark has been defined. According to the Kamloops MOE Regional Wildlife Biologist, habitat within the study area should be rated up to High (D. Jury, pers. comm. June 20, 2008).

4.2 Ratings Assumptions

Ratings assumptions are summarized in Tables 4 and 5 below. Growing season ratings have been based primarily on habitat suitability for Reproducing-eggs habitat (nesting and brood-rearing) rather than lek habitat (Hoffman and Thomas 2007).

Table 4. Assumptions for Living during the growing season.

Variable	Value	Maximum Rating	Comments
BEC subzone	BG, IDF, PP	H	
Ecosystem Unit	Bunchgrass grasslands, riparian aspen, riparian cottonwood, riparian water birch, riparian mixed forest, water birch ecosystems	H	Nesting habitat, nonbreeding adult living habitat
	Sagebrush/rabbit-brush grasslands, non-bunchgrass grasslands	M	
	Dry open forest	L	
	shrub wetlands, herb wetlands	L	Provide abundant insects for chicks, but not listed in literature as important habitats
	Water bodies, coniferous forest, mine, reclaimed mine, cutbank, urban, rural, road, cultivated field, rock/talus outcrop, exposed soil	N	Although CSTG may use alfalfa fields for feeding and nesting (Hoffman and Thomas 2007; Utah DWR 2002), most reclaimed alfalfa-seeded polygons in the study area do not currently provide sufficiently dense cover. Cultivated grain fields are not present in the study area.
Structural stage	1	N	
	2-4	H	Nesting/brood-rearing habitat
	5-7	M	

Winter

Variable	Value	Maximum Rating	Comments
BEC subzone	BG, IDF, PP	H	
Ecosystem Unit	riparian aspen, riparian cottonwood, riparian water birch, riparian mixed forest, subhygric mixed forest, water birch ecosystems	H	
	shrub wetlands, sage/rabbit-brush grasslands	M	
	herb grasslands	L	low snow periods
	coniferous forest, herb wetlands	L	
	Water bodies, mine, reclaimed mine, cutbank, urban, rural, road, cultivated field, rock/talus outcrop, exposed soil	N	
Structural stage	1	N	
	2	L	low snow periods
	3-4	H	
	5-7	M	

4.3 Ratings Adjustments

Columbian Sharp-Tailed Grouse appear to be somewhat tolerant of some anthropogenic disturbances, such as noise from vehicles and equipment. However, residential areas are associated with the presence of dogs and cats, which may result in nest disturbance and in mortality of eggs, chicks and adults. CSTG habitat within 2 km of urban and rural developments should be downgraded by one class for both winter and growing season suitability (D. Jury, pers. comm.). Growing season habitat within 2 km of known lek points, originally rated M or L, should be increased by one class.

4.4 CONFOUNDING FACTORS AND RELIABILITY QUALIFIER

Suitability of Sharp-Tailed Grouse habitat is strongly influenced by the amount of cover (i.e. grassland vegetation height), a variable that is not available within the TEM database and is dependent on the level of grazing within the study area. The current high degree of mortality of ponderosa pine due to pine beetle may increase open grassland habitat for CTST within the study area in the near future.

The biology of the Columbian subspecies is not particularly well known (Hoffman and Thomas 2007), and relatively little information is available specific to British Columbia. This model has been prepared using BC (Kamloops area) information where available, supplemented with data from other areas of the subspecies' range (i.e. USA). It is unknown whether information from the US is directly applicable to the Abacus study area. Limited verification of ratings has been done in the field. This model is assessed as having moderate reliability.

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