KENO HILL PROPERTY

VALLEY TAILINGS REVEGETATION ASSESSMENT

2008

Prepared for:

by:

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Valley Tailings Revegetation Assessment - Elsa Silver Mine

1.0 Background

In order to facilitate future revegetation efforts at the valley tailings impoundment at the former Elsa silver mine, a number of archived reports on earlier tailings revegetation trials were reviewed (the most pertinent of these documents are referenced at the end of this report).

In the summer of 2007, an inventory of the state of natural revegetation occurring on the mill tailings was carried out and the vegetation types were delineated on a current aerial photograph.

2.0 Historical Revegetation Test Programs

A significant series of revegetation tests on seed mixes, fertilizers and land treatments was carried out on the Elsa valley tailings between 1976 and 1984. This experimentation was largely directed by agrologists from Laurentian University in Sudbury, Ontario, with field trials being carried out in Elsa by United Keno Hill Mines Ltd. summer staff.

Limited successes were achieved with some grasses and legumes during these field trials; however long-term survival did not occur. Although the revegetation experimentation ceased with the economic downturn of the early 1980's, notable conclusions were reached.

- The principal contributor to the inhibition of long-term plant growth on much of the tailings is the impenetrable surface that occurs when salts (primarily zinc sulphate) migrate upward through the tailings "slimes" (approximately 50% pass a 200 mesh screen and are therefore classified as 50% clay/silt). These slimes then dry as a rock-hard, white crust, and are totally unsuitable for plant growth. Surface scarification (raking, harrowing or disking) of these areas is therefore essential prior to seeding.

- The slightly acidic nature of the tailings (pH 6 to 7) occurs when the readily soluble zinc sulphate ($ZnSO_4$) generates some free sulphuric acid (H_2SO_4). The resulting pH in the top 2-3 cm is about 6.7 to 6.8, close enough to neutral as to not be a significant impediment to plant growth.

- Phytotoxic concentrations of cadmium, lead, zinc, copper and manganese are found in the rooting zones of most soils on the unvegetated portion of the tailings impoundment. The high levels of extractable ions appear to be a significant impediment to the establishment of vegetation on these areas.

- Plant development on the metalliferous tailings is restricted by very low levels of macronutrients (nitrogen, phosphorous and potassium) and high concentrations of phytotoxic metals. The repetitive application of both slow release nitrogen fertilizers (such as sulphur coated urea) and quick release nitrogen fertilizers is therefore required for quick germination and sustained plant growth. The repetitive application of phosphorous is also required so that all phosphorous is not tied up by metals and some is continually available to the seeded plants.

- Insufficient rainfall during the early growing season (3.5 inches and 1.4 inches during the summers of 1976 and 1977 respectively, and an average of 6.2 inches from July through August for the years 1976 to 1983) was identified to be a significant problem for plant growth during the late 1970's and early 1980's, although it was noted that grasses were growing well on other sites in the area. The application of mulches (wood shavings and/or hay) was met with very little success in retaining surface soil moisture. A thin layer of topsoil was more effective.

- The more successful seeded grass species commercially available at the time included Meadow Foxtail (*Alopecurus pratensis*), Creeping Red Fescue (*Festuca rubra*), Kentucky Bluegrass (*Poa pratensis*), Red Top (*Agrostis gigantea*), Tufted Hairgrass (*Deschampsia caespitosa*) and Ticklegrass (*Agrostis scabra*). The two latter species are grasses indigenous to the Elsa area. The most successful legume was the non-indigenous Bird's-foot Trefoil *(Lotus corniculatus*), although it did not survive longer than 2 growing seasons.

- The use of dormant, unrooted willow and alder cuttings for revegetating the valley tailings is not feasible. Future use of woody species should involve rooted cuttings or seedlings grown in peat pots or nursery beds for 2-3 years prior to planting on the tailings.

- In order to retain soil moisture and keep seeded plants away from upwardly migrating salts from the tailings, a soil cap will likely be required. The cap should include a thin layer of granular material and layer of soil material. The granular material would act as a capillary break and allow the plants to grow in the soil capping unaffected by salts from the tailings. The granular material could be waste rock from an open pit mine or coarse gravel. The soil material could be overburden with 30-40% mineral fines.

3.0 Current Status of Tailings Vegetation

A summary assessment of the existing vegetation on the tailings was carried out in early August 2007. The vegetation observed primarily consists of locally occurring indigenous species that have naturally colonized the tailings since the Elsa concentrator ceased production nearly two decades previously.

The following vegetation types were observed on the valley tailings during the 2007 assessment (the approximate extent of each vegetation type is delineated on the accompanying aerial photograph):

A) Willow Regeneration

This is a relatively dry willow-dominated vegetation type with an approximately 40% vegetative cover.

Observed plant species include:

Salix glauca	grey-leaf willow
Salix spp.	willow
Populus balsamifera	balsam poplar

Equisetum arvense	common horsetail
Carex sp.	sedge
Calamagrostis canadensis	bluejoint
Deschampsia caespitosa	tufted hairgrass
Hordeum jubatum	foxtail barley
Epilobium angustifolium	fireweed
Lupinus arcticus	arctic lupine
Platanthera hyperborea	northern green orchid
Erigeron sp.	fleabane
Parnassia palustris	grass-of-Parnassus
Taraxacum officinale	common dandelion

B) Bluejoint Meadow

This small isolated meadow has a vegetative cover of about 70%.

Observed plant species include:

Calamagrostis canadensis	bluejoint
Picea glauca	white spruce
Populus balsamifera	balsam poplar
Betula papyrifera	paper birch
Betula glandulosa	dwarf birch
Agrostis scabra	ticklegrass
Equisetum arvense	common horsetail
Stellaria sp.	chickweed

C) Undisturbed Closed Black Spruce

These largely undisturbed patches of black spruce forest have a nearly 100% vegetative cover.

Observed plant species include:

Picea mariana	black spruce
Betula glandulosa	dwarf birch
Salix glauca	grey-leaf willow
Ledum groenlandicum	Labrador tea
Potentilla fruticosa	shrubby cinquefoil
Arctostaphylos rubra	bearberry
Carex sp.	sedge
Vaccinium vitis-idaea	lingonberry
Equisetum arvense	common horsetail

D) Barren

These barren areas are void of vegetation. Some of these areas are higher dry ground while other areas are seasonally flooded.

E) Water Sedge

These wetland areas are dominated by nearly pure stands of water sedge with an approximately 95% vegetative cover.

Observed plant species include:

Carex aquatilis	water sedge
Equisetum fluviatile	water horsetail
Calamagrostis canadensis	bluejoint
Rumex arcticus	arctic dock
Hordeum jubatum	foxtail barley
Deschampsia caespitosa	tufted hairgrass

F) Balsam Poplar Regeneration

This vegetation type occurs on disturbed elevated areas. The vegetative cover is about 40%.

Observed plant species include:

Populus balsamifera	balsam poplar
Salix glauca	grey-leaf willow
Salix alaxensis	felt-leaf willow
Betula papyrifera	paper birch
Epilobium angustifolium	fireweed
Taraxacum officianale	common dandelion
Hordeum jubatum	foxtail barley
Calamagrostis canadensis	bluejoint
Parnassia palustris	grass-of-Parnassus
Achillea millefolium	common yarrow
Achillea sibirica	Siberian yarrow
Agropyron sp.	wheatgrass
Agrostis scabra	ticklegrass

G) Undisturbed Open Black Spruce

This small area of relatively undisturbed open black spruce with aspen has a vegetative cover of about 50%.

Observed plant species include:

Picea mariana	black spruce
Populus tremuloides	trembling aspen
Populus balsamifera	balsam poplar
Salix sp.	willow
Lupinus arcticus	arctic lupine
Arctostaphylos uva-ursi	kinnikinick
Calamagrostis purpurascens	purple reed grass
Geocaulon lividum	toadflax
Rosa acicularis	prickly rose
Poa glauca	glaucous bluegrass
Empetrum nigrum	crowberry
Shepherdia canadensis	soapberry
Potentilla fruticosa	shrubby cinquefoil
Erigeron sp.	fleabane

H) Water Horsetail

These wetland areas are dominated by water sedge and nearly pure stands of water horsetail. The vegetative cover is approximately 90%.

Observed plant species include:

Equisetum fluviatile	water horsetail
Carex aquatilis	water sedge
Calamagrostis canadensis	bluejoint
Eriophorum angustifolium	cottongrass
Salix alaxensis	felt-leaf willo*w*
Betula glandulosa	dwarf birch
Platanthera hyperborea	northern green orchid
Geum sp.	avens

I) Water

Only aquatic vascular plant species occur in these flooded areas.

Observed plant species include:

Potamogeton sp.	pondweeed
Hippuris vulgaris	mare'stail
Myriophyllum sibiricum	water-milfoil

4.0 Summary and Recommendations

Of the ha of current tailings impoundment, approximately ha remain almost void of vegetation (see areas delineated as Barren on attached air photo). These barren zones include sections of both the east and west tailings areas. In order to resume efforts to revegetate these areas, while benefiting from the insight gained from the earlier field trials, the following steps are recommended:

- Soils samples were collected from nine test pits on the tailings impoundment in 2007. These test pits include six sites from the non-vegetated, barren areas of the impoundment and from three nearby sites where revegetation is naturally occurring. At each site samples were collected from the depths of cm (?). Each of these soil samples should be analysed for texture, total metals, extractable ions, organic content, available nutrients, cation exchange capacity, carbon-nitrogen ratio and pH (the laboratory selected should first be consulted for procedures and protocols).

  The results of these analyses should help characterize the current state of the impounded tailings. The results may also shed some light on why there is no vegetative growth on the barren areas of the tailings, Vegetation Type D (Barren) on the air photo, compared to the areas where natural revegetation is occurring, particularly Vegetation Type A (Willow Regeneration).

- A field survey of the unvegetated area of the tailings should include (at a minimum) a series of transects with in-situ measurements of soil pH and moisture content at rooting depths (2-10 cm) and an examination of the current surface penetrability.

- If the character of the unvegetated tailings has not altered significantly since the field trials of the early 1980's, experimentation with soil caps should commence. This could include the establishment of test plots with differing thicknesses granular material and soil, followed by applications fertilizers and seed mixes.

References

Blundon, D. J. 1977. 1977 Preliminary Report on Revegetation of U.K.H.M Ltd., Tailings, Elsa, Yukon. Report submitted by Department of Biology, Laurentian University, Sudbury, Ontario.

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*2006 aerial photograph obtained from Geodesy Remote Sensing Inc., Calgary Alberta. Flown 13,14 September 2006.

Projection - UTM Zone 8 NAD83
NTS 105M/13
Vegetation identified by Stu Withers, S.P.Withers Consulting, Whitehorse, Yukon.

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0 50 100 200 300 m

Legend

- Test Pit Est 1995
- Test Pit Est 2007
- Public Road
- Exploration Roads
- Trails
- Cutlines
- Contours
- Water Course (actual and potential)
- Swampy area
- Pipe

Valley Tailings Vegetation Type

- A - Willow Regeneration
- B - Bluejoint Meadow
- C - Undisturbed Closed Black Spruce
- D - Barren
- E - Water Sedge
- F - Balsam Poplar Regeneration
- G - Undisturbed Open Black Spruce
- H - Water Horsetail
- I - Water

ALEXCO RESOURCE CORP.

VALLEY TAILINGS VEGETATION STUDY

VALLEY TAILINGS VEGETATION TYPES

Drawn By: HD	Date: December 2007	**FIGURE**
Checked by: DC/SW	File: D:\Projects\AllProjects\ALEX-05-01\gis\mxd\UKHM\VegetationStudies\ValleyTailingsVeg2007\ValleyTailingsVeg.mxd	