ENRICHING MINE RECLAMATION: HIGHLIGHTS OF THE BRENDA MINE BIODIVERSITY ENHANCEMENT PROGRAM

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ABSTRACT

Historically, restoration and reclamation science has focused on returning disturbed sites to some past condition. Finding this difficult, later efforts have focused on restoring habitat elements like vegetative cover, even when the species added are not native. Consistent with Xstrata Copper Canada's corporate focus on biodiversity, this presentation describes a way of responding to these challenges highlighting a biodiversity enhancement project at Xstrata Copper Canada's Brenda Mine, a closed site located near Peachland. Operations at Brenda ceased in 1990, and substantial reclamation was completed by 2000. Seeking a better understanding and protection for long term health, function and viability of the natural environment, a biodiversity assessment and conservation plan for the Brenda site was completed in 2009. This plan identified priorities for enhancement, and also described the species that might benefit from actions on the mine site. Moving to implement these recommendations and establish site monitoring approaches, this presentation reports on planting, site treatments, and direct wildlife enhancement techniques that have been initiated in the first year of this three year project. It also describes planned future actions including monitoring and other site enhancements designed to define benefits and challenges associated with site restoration and management of biodiversity at Brenda Mine.

KEY WORDS: mine, reclamation, Brenda Mine, biodiversity, enhancement, program

INTRODUCTION

In fields like habitat enhancement, scientists evaluate existing sites and routinely develop future-focused management plans to make the site significantly different from its current or historical condition. A future-focused approach also has value for reclamation and restoration. While restoring vegetation cover and managing erosion may become the first priority, opportunities are likely to be lost if planning concentrates exclusively on mimicking the condition prior to mining. Evaluating the potential of the new site, highlights the ways that mining has modified the landscape and created both opportunities for new species and challenges for existing species. Physical changes to mine sites create new options to enhance sites for biodiversity. Reclamation programs can enhance scientific knowledge and provide a legacy of understanding about species and ecosystems in the area. Finally, efforts focused on communicating restoration and enhancement activities provide a chance to change public perceptions about mining, shifting the spotlight from impacts during mine development and operation - to the environment quality and actions that continue after mining activities are complete. Based on the approach adopted by Xstrata

Copper for its closed mine sites, this paper reports efforts to enhance vegetation and biodiversity at Brenda Mine in British Columbia.

BRENDA MINE SITE DESCRIPTION AND HISTORY

Located 35 km west of Kelowna, immediately west of Highway 97C (Coquihalla Connector), the elevation of Brenda Mine ranges from 1250 to 1550 meters above sea level. Biogeoclimatic zones have been described in British Columbia to provide an ecologically-based description of BC's ecosystems (British Columbia Forest Service, 2012). The majority of the site is classified as Thompson Dry Mild Montane Spruce (MSdm2), with small portions described as Thompson Dry Cold Engelmann Spruce-Subalpine Fir (ESSFdc2) and Cascade Dry Cool Interior Douglas fir (IDFdk2). These classifications indicate moderate biodiversity, which may be somewhat enhanced by the proximity of the site to the highly diverse South and Central Okanagan valley. Diversity at Brenda Mine may also increase if climate change results in future expansion of species ranges northward and to higher elevations (Parmesan, 2005). Photo 1 provides a 2007 image highlighting the contrast between surrounding forested areas and the Brenda Mine site. Significant opportunities for biodiversity enhancement have been created by mining.

Photo 1: Brenda Mine site showing original pine dominated forest (dark-shaded regions of photo) and cleared mine site with water features and reclaimed areas (lighter -shaded areas). Pit lake and rock piles are in foreground and tailings impoundment is in background (Photo credit: Xstrata Copper Canada)

Producing approximately 182 million tonnes of copper and molybdenum ore from 1970 to 1990, the Brenda Mine site is now closed. A formal Decommissioning Plan was submitted and approved in 1993 by the Ministry of Energy, Mines and Petroleum Resources. The majority of reclamation and re-vegetation activities were implemented in the 1990s and completed by the year 2000. Reclamation focuses on the end land use objective of wildlife habitat and limited forestry. Seasonal water treatment and management continues at the site.

EVALUATING GENERAL SITE POTENTIAL

Effective biodiversity management requires an expanded view of site potential. The approach used at Brenda Mine considers limiting factors at the site today, as well as those likely to occur in future. A particular strength of this view is that it is not primarily focused on the disturbance that created the changed site. Rather, the approach focuses on the continuum of possibilities beginning today, seeking to highlight the benefits of current site conditions, as well as those that can be developed or will likely occur in the future.

Natural disturbances like wind, insects and fire cause some proportion of each ecosystem to be disturbed. Because human disturbances like road construction, forest harvesting, urban development, agriculture, etc. impact additional areas, the supply of disturbed sites tends to exceed what nature creates. For a variety of reasons, ecologists highly value mature and old growth sites in ecosystems and seek to protect existing sites and rehabilitate disturbed areas to restore what existed prior to disturbance. For example, a number of sensitive species (e.g. Northern Goshawk *Accipiter gentilis* (Cooper and Stevens, 2000), Mountain Caribou *Rangifer tarandus caribou* (Kinley, 1999) and Spotted Owl *Strix occidentalis* (Dupuis, 1998) depend on large patches of undisturbed late seral stage or old growth forest. When natural disturbance reduces the supply of these patches, it takes many decades for old growth forest to develop again.

Biodiversity is also valued; high diversity areas like Okanagan grasslands and coastal Garry Oak ecosystems are endangered (Egan, no date), but management to protect biodiversity is not the only priority. Also, enhancing biodiversity is more complex than seeking to maximize the number of species and individuals supported by a particular site. Across the landscape, managers want a mosaic of sites at different stages of succession. This ensures that the site supports communities and species that thrive in a variety of seral stages.

ENHANCING SCIENTIFIC KNOWLEDGE PROVIDES A LEGACY

Recent activities at Brenda Mine continue to focus on sustaining vegetation cover on tailings/rock pile areas and management/seasonal treatment of water. Five years ago, Xstrata also began implementing Biodiversity Conservation Assessment Plans for both operating and closed sites including Brenda Mine (Madrone Environmental Services Ltd., 2009). The plan identified opportunities for actions to improve biodiversity that were initiated in 2009-2010. These efforts focused on enhancing vegetation structure on open areas, enhancing cavity nest sites for small birds and enhancing the supply of native shrubs and trees in areas dominated by shrubs and grasses. Actions taken included establishing brush piles, planting

additional native shrubs and trees (alder, pine, willow and balsam poplar), as well as erecting bat houses and nest boxes for bluebirds.

Early monitoring results highlighted the success of nest boxes—almost all (19/20) showed signs of prospecting —and nesting occurred in 12 boxes (60%) in the first year. Monitoring results also suggested some improvements to be made to bat box locations. Planting sites in 2009-2010 included upland areas, tailings sites and beach/riparian locations where natural colonization of trees and shrubs was relatively low. The trial planting of native shrub and tree cuttings and nursery tree seedlings had low to moderate success depending on the site (5-30% survival documented after 2 years for cuttings, and in the order of 50% survival for conifer seedlings). Plant mortality was higher in drier sites, where wildlife grazing caused impacts and also near tailings beach sites where erosion moved soil and buried some plants.

In 2011 Xstrata adopted a 3-year program to implement its biodiversity conservation plans at the Brenda Mine site, using the team of Altura Environmental Consulting, Bearfoot Resources Ltd., and Polster Environmental Services Ltd. After considering the previous results and obtaining further direction from Xstrata, the team completed additional planning and enhancement work. This work focused on three priorities.

First, additional efforts focussed on documenting ongoing wildlife use on the Brenda Mine site focusing particularly on rocky sites with limited vegetation. This involved updating species lists and using remote wildlife cameras, video, and experts in wildlife identification. Species identification sheets were also developed to help mine site staff identify possible species. A list has been developed for the site with more than 200 species (mainly mammals, birds and plants) confirmed to date. More effort in the near future is expected to increase the number of species confirmed to occur on the site. Collectively, these activities are designed to document mine site biodiversity and highlight the use wildlife are making of all sites, including those areas with sparse vegetation.

Photo 2: Cedar Waxwing *Bombycilla cedrorum* is one of more than 200 species confirmed to occur on the Brenda Mine site (Photo credit: Dave Polster)

Second, on areas with limited vegetation throughout the mine site, wildlife enhancement techniques were used building on the 2009-2010 work. Examining short term (0-30 years), medium term (31-60 years) and long term (60+ years) time scales, the supply of local habitat elements was re-examined focusing on results of earlier enhancement efforts. Building on the documented use of nest boxes, more boxes were added; the site now has 31 small boxes in various locations and also 7 larger boxes (1 for American Kestrel *Falco sparverius* and 6 for cavity nesting ducks). 10 artificial wildlife trees were installed to provide both perching sites and pre-drilled (more natural) cavities as an alternative to nest boxes. Noting no sign of bat use (boxes had been located in cooler areas exposed to wind), the three bat boxes were moved to warmer sites. Boxes are being monitored for use and a bat expert will evaluate the site to provide further recommendations this year. Although the site is too high for many of the bat species native to the Okanagan, there appears to be potential for several species (Nagorsen and Brigham, 1993). Also, the abundant supply of insects (supported by local wetlands and open areas) indicates there is a suitable, seasonally abundant food resource for bats. Since brush piles established in 2009/10 received limited wildlife use (mainly deer and coyote), a plan to enhance existing brush piles was developed. Fine material will be added to existing piles and additional brush piles will be added in other locations. Collectively, nest boxes, bat boxes, brush piles and artificial wildlife trees are focused on improving short term wildlife tree values and vertical structure in areas of sparse or open vegetation.

Photo 3: The addition of artificial wildlife trees and brush piles in open areas of the mine site (e.g. on tailings) helps to address short term requirements for wildlife trees and cover. (Photo credit: Alan Peatt)

Third, vegetation planting continues at Brenda Mine to diversify vegetation in tailings areas and on rocky sites, but new site treatments were adopted together with fencing of treatment patches to exclude wildlife browsing. These focused on moving native pioneering vegetation (Willow *Salix spp.*, Balsam Poplar *Populus balsamifera*, and Sitka Alder *Alnus viridis ssp. Sinuate*) further into rocky areas and meadows, while also seeking to enhance vertical structure and wildlife trees available in these more open areas over the medium to long term. In part, this effort is designed to increase connectivity across open habitats providing cover for wildlife and encouraging wildlife use of these open habitats more frequently. To encourage greater survival in planting, the soil was disturbed using an excavator to create mounds of soil and loosen the upper layers. This provides a variety of planting spots with different slopes and aspects.

Photo 4: A 20 meter by 20 meter rough and loose soil treatment is implemented to improve plant survival. (Photo credit: Alan Peatt)

Photo 5: Early summer (2012) leaf emergence of live-staked balsam poplar and willow in the one of the rough and loose patches. (Photo credit: Alan Peatt)

Mounding the soil helps capture moisture and reduce soil erosion. The looser soil texture in upper layers facilitates root penetration. To date, seven 400 m^2 patches have been established in a variety of sites, both in the rocky soils of the waste rock piles and in finer textured soils associated with the tailings area. Willow and Balsam Poplar live staking was completed in 2012 and planting of alder was completed in spring 2012 using plants germinated from seed collected on the mine site last year. With the moist soil and cooler weather this spring/early summer, plant germination and survival appears high. First year vegetation survival data will be collected in late summer, 2012.

SUMMARIZING BIODIVERSITY ENHANCEMENT AT BRENDA MINE

Prior to development, the mine site resembled the undeveloped area. Mine development and water management efforts on the site have increased the supply of wetlands and lakes. Several amphibians have been identified in association with the wetlands (e.g. Western Toad *Anaxyrus boreas* and Columbia Spotted Frog *Rana luteiventris*) (Churchhill et al., 2008). Both species are considered sensitive to habitat change, including road building and road use (Gardner et al., 2007; Jochimsen, 2004). The Western Toad is listed by the Federal Species at Risk Act (SARA) as a species of *Special Concern* (COSEWIC, 2002). The presence of sensitive amphibians on the Brenda Mine site is an indicator that the site is supporting excellent water quality and habitat for wildlife. Monitoring of Western Toad populations is planned to continue at three year intervals as part of Xstrata's biodiversity monitoring program.

Photo 6: Mine development and associated efforts to manage water on the site has increased the size and number of lake/wetland habitat on the site and enhanced wildlife habitat. (Photo credit: Alan Peatt)

The small lakes and ponds on the mine site also receive significant spring-fall use by staging and breeding waterfowl. Created to manage water on the site, two larger lake features support waterfowl and shorebird

use that would not be occurring on the site, in the absence of former mining activity. Barrow's Goldeneye *Bucephala islandica* broods are commonly observed and are another species that is being monitored at three year intervals. Aquatic insect life associated with ponds, lakes and waterways is abundant; supporting flocks of insect eating birds such as tree swallows. One of the characteristics of the Okanagan is the limited supply of small to medium sized lakes; where these occur they receive intensive use by wildlife. Thus, the addition of this type of habitat makes a significant contribution to biodiversity in the area and helps support species that either would not otherwise be present on the mine site, or would have occurred occasionally or in smaller populations. Nest boxes and planting wildlife trees help provide habitat for cavity nesting species.

Before mine development, there was very little habitat in early seral stage (grasses/forbs and shrubs) adjacent to or part of the mine site. Efforts since mine closure have focused on reducing erosion, stabilizing soil and re-establishing vegetation on tailings areas, waste rock piles and other cleared sites. After seeding with a mixture of agronomic grasses and forbs, meadows established over the tailings area have been maintained through periodic fertilization. The result of these efforts is "old field" type habitats such as seen in less intensively used farming operations. Such habitats support a novel community of small mammals (e.g. pocket gopher and yellow-bellied marmot) and various associated predators (Coyote *Canis latrans*, Red-tailed Hawk *Buteo jamaicensis* and other more unusual visitors like Golden Eagle *Aquila chrysaetos*). While the predators identified on the property to date are relatively common in the area, they appear particularly abundant on the mine site. It is possible that other rarer predators like

Photo 7: The Brenda Mine site supports a diversity of species in tailings areas. Old field habitat developed from 1990s seeding of agronomic grass to stabilize soils and prevent erosion. (Photo credit: Alan Peatt)

American Badger *Taxidea taxus* and Short-eared Owl *Asio flammeus* will be identified on the site over time. With the extent of existing impacts to grassland, there is recognition that old field habitats are valuable (Metro Vancouver, 2009). Thus, despite the value of rehabilitating sites with native plants, the choices made at Brenda have created a different alternative that supports a significant diversity of species. Over time, enhancing vertical structure and replanting areas with native vegetation will continue to enhance wildlife use of these areas.

Although buildings on the property are limited, there is a water treatment plant and office, several small pump houses and a substation building. The mill has been dismantled and removed, although an ore silo remains. Mining has also increased the supply of isolated rocky cliffs. The supply of small buildings, the available source of mud associated with tailings areas, the wetlands and lakes created by mining activity and the rocky/cliff habitat together provide habitat for species that would likely not otherwise occur on the site. Barn Swallows *Hirundo rustica* are another SARA-listed *Threatened* species that use all of these features and are known to be associated with less intensive agriculture (e.g. old field habitats) (COSEWIC, 2011). Barn Swallows are also a target species for monitoring biodiversity. Other species known to exploit modified habitats created by mining include: Northern Pocket Gopher *Thomomys talpoides* and Yellow-bellied Marmot *Marmota flaviventris* (abundant and associated with modified tailings soils); American Pika *Ochotona princeps* and Columbian Ground Squirrel *Spermophilus columbianus* (associated with the rock piles); and Mountain Goat *Oreamnos americanus* (occasionally visiting areas near the open pit cliffs).

ADAPTIVE MANAGEMENT

Every good science-based program includes a mechanism for learning from the past and monitoring to adapt current management to reflect previous results. Three main conclusions are defined based on managing for biodiversity at Brenda Mine.

First, there is value in planning ahead to integrate the different land uses occurring on the mine site. There have been both challenges and opportunities in our efforts to integrate the goal of managing for wildlife with the requirements of managing a closed mine site. For example, to maintain effective drainage on the site and safe operation of power lines, vegetation clearing has been required along linear waterways and utility corridors. Given that the biodiversity objective includes efforts to enhance vertical structure and vegetation in open areas, a balance must be found between the operational need to remove trees in one area while trees are being planted elsewhere. Since the vegetation removal was necessary, the harvested trees and branches have been temporarily piled and some of the material will be moved to augment/create additional brush piles and woody debris in open areas. This practice reduces the cost and environmental implications of burning the felled vegetation. For future clearing programs, the efficiency of using slashed vegetation could be further improved through directly incorporating biodiversity enhancement objectives into the activity – for example, purposely constructing the slash piles as in-place wildlife habitat enhancement features, and taking advantage of equipment availability to move larger trees and other suitable woody debris out to central distribution points at the site.

Second, and similar to the challenges of coordinating mine management goals (e.g. water management and wildlife habitat), there are also challenges coordinating mine management goals and regional forestry priorities. The recent pine beetle epidemic has created pressure for local forest companies to remove diseased trees from the mine site. While limited forestry is considered consistent with site management goals, there has been extensive removal of forest cover on the site. Until forest succession advances further, efforts to enhance wildlife trees, vegetation and vertical structure elsewhere would be diluted by additional forest harvesting at this time. Integrating the potentially competing objectives of forestry and vegetation restoration has been challenging and has highlighted the value of having a spatial plan that divides the mine site into zones (or areas) with well defined management priorities. Some areas would need to be zoned with a priority for "closed mine site operations". These would include drainage ditches, power lines, roads, and the water treatment plant and system. Other areas may have to balance several objectives including forestry, mining and wildlife. Anticipating some of these management issues and providing some direction on priorities for each area would be helpful before further challenges develop. The development of a simple spatial plan would help to guide future land use decisions and focus biodiversity enhancement efforts for maximum benefit.

Third, there are significant opportunities to speak about valuable habitat benefits being provided on the mine site. Moving beyond a discussion of the diversity associated with early seral areas, there are meaningful opportunities to highlight the significant advantages that closed mine sites can provide. Mine sites change over time. The mine site during development and mining is substantially different from the site decades after mining and reclamation is complete. More information about wildlife values on closed mine sites would help people understand how sites change over time. Using a few modern technological tools, a modest budget and moderate effort, mining companies can demonstrate a wealth of positive contributions to biodiversity.

ACKNOWLEDGEMENTS

The authors would like to thank Xstrata Canada Corporation (Xstrata Copper Canada Division) for permission to share our work to date on Brenda's Biodiversity Enhancement program. A particular thank-you is also extended to Georges Guilleminot, Dallas Rodier, Trevor Kostiuk and others who work at the site for their interest and great assistance.

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