

**PROGRESSIVE RECLAMATION UTILIZING BIOSOLIDS AT THE HEDLEY GOLD
TAILINGS PROJECT, HEDLEY, BRITISH COLUMBIA, CANADA**

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ABSTRACT

The Hedley Gold Tailings Project was a heap leach gold extraction mine that operated between 1988 and 1995 beside Hedley, British Columbia. Tailings from the historic Mascot and Giant Nickel mines were deposited to the north and southeast of Hedley between 1904 and 1955. These tailings were mined, agglomerated, stacked into a heap and leached for gold, most recently by Candorado Operating Company Ltd. The Greater Vancouver Regional District progressively reclaimed some of the disturbed tailings areas in three phases during 1996, 1997 and 2000 utilizing biosolids. Forage establishment with biosolids was successful for all reclaimed tailings areas, improving their aesthetics and dust control. Public consultation was integral to each reclamation phase that utilized biosolids. Effective collaboration between public agencies enabled successful execution of the third phase. Continued reclamation progress at this site has demonstrated the value of public consultation and the capacity for collaboration between public agencies to enable progressive reclamation for the common good at a financially constrained mine site.

INTRODUCTION

This paper is a concise review of the progressive reclamation utilizing biosolids at the Hedley Gold Tailings Project. Mine closure and other reclamation matters for this property are beyond the scope of this paper.

BACKGROUND

Hedley, British Columbia

Hedley is a historic mining community with a population of approximately 400 residents located in South Central British Columbia near the confluence of the Similkameen River and Twenty Mile (Hedley) Creek. As recent local mining activity slowed in the late 1990s the development of local tourism has become increasingly important. The Hedley community and the nearby Upper Similkameen Indian Band have had an active interest in the closure and reclamation of the Hedley Gold Tailings Project. Important local issues have included dust control and aesthetics for the tailings and heap leach areas used by the Hedley Gold Tailings Project. Tailings metal characteristics, particularly arsenic, and water quality protection have also remained important local concerns.

Hedley Gold Tailings Project

The Hedley Gold Tailings Project was a heap leach gold extraction mine that operated between 1988 and 1995. Tailings previously deposited by the historic Mascot and Nickel Plate mining operations were mined, agglomerated with cement, progressively stacked into a seven hectare heap through a series of pads and leached with a cyanide solution to extract gold. Gold was removed from the pregnant cyanide solution on site. The barren cyanide solution was recycled to the heap leach for reuse. The Hedley Gold Tailings Project could operate at a designed rate of 36,000 tonnes per month (MINFILE 092HSE144). In 1990, over 360,000 tonnes were reprocessed and stacked on the leach heap. The mining of tailings ceased in 1995 when gold prices declined. Over 480,000 grams (15,400 ounces) of gold and about 11,800 grams (380 ounces) of silver were extracted by the project between 1988 and 1993. Tailings used in the heap leach graded from 0.8 to 1.5 grams per tonne. The most recent mine operator was Candorado Operating Company Ltd.

Tailings Areas

Tailings for the Hedley Gold Tailings Project came from four District Lots (DL) which from north to south were: DL 1796, DL 3186s, DL 2900 "Old Tailings" and DL 2900 "New Tailings" (Figure 1).

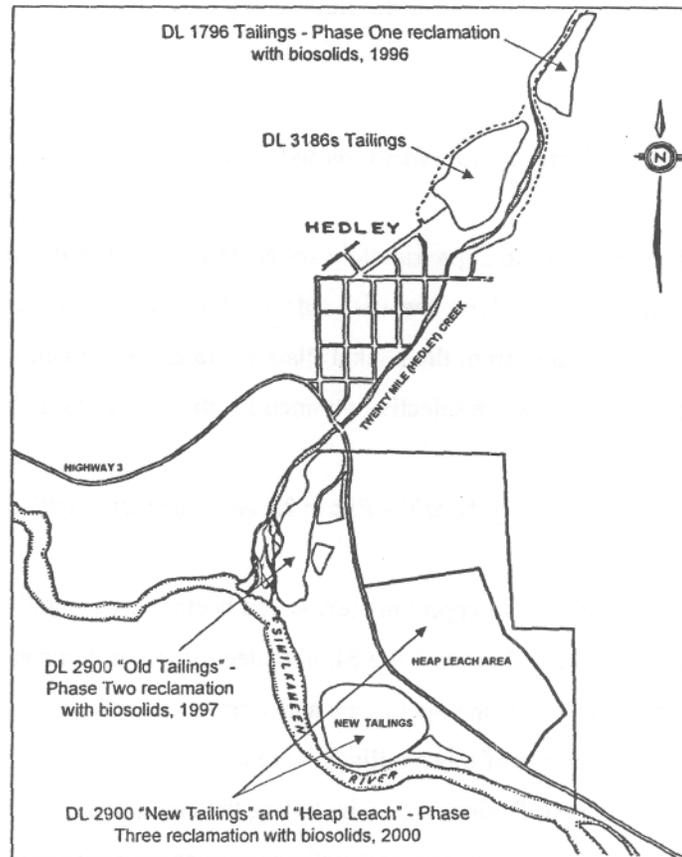


Figure 1: Tailings sites at the Hedley Gold Tailings Project, Hedley, British Columbia.

DL 1796 Tailings - Phase One reclamation -with biosolids, 1996

DL 1796 contained approximately three hectares of tailings and is located about two kilometers north of Hedley on the east side of Twenty Mile Creek (MINFILE 092HSE244); (Figure 1). These tailings were deposited from the Hedley Mascot Gold Mines Ltd. between 1936 and 1949. They were almost completely removed and reprocessed for the Hedley Gold Tailings Project.

DL 3186s Tailings

DL 3186s has approximately six hectares of tailings located immediately north of Hedley on the west side of the Twenty Mile Creek (MINFILE 092HSE244) (Figure 1). These tailings were also deposited from the Hedley Mascot Gold Mines Ltd. between 1936 and 1949. Only a small portion of the tailings that

were located at the southeast corner of the pond were used by the Hedley Gold Tailings Project. This area is now being used as a parking lot for the Hedley ball diamond. Biosolids have not been used on DL 3186s.

DL 2900 "Old Tailings" - Phase Two reclamation with biosolids, 1997

The DL 2900 "Old Tailings" is an approximately six hectare area of tailings on the west side of DL 2900 that runs from Highway Three along the east side of Twenty Mile Creek to the Similkameen River (Figure 1). These tailings came from the Nickel Plate Mine and were deposited between 1904 and 1955 (MINFILE 092HSE038). They were selectively mined for the Hedley Gold Tailings Project.

DL 2900 "New Tailings" and "Heap Leach" - Phase Three reclamation with biosolids, 2000

The DL 2900 "New Tailings" is an approximately seven hectare area of tailings located on the south side of DL 2900 between Highway Three and the Similkameen River to the south (Figure 1). These tailings also came from the Nickel Plate Mine operations and were deposited between 1904 and 1955 (MEMFILE 092HSE038). Selected portions of these tailings were also mined for the Hedley Gold Tailings Project. The entire seven hectare "New Tailings" area, including the cement agglomeration area for the heap leach operation, the seven hectare heap leach pad with its adjacent six hectare south and west field areas collectively became Phase Three of reclamation with biosolids for the Hedley Gold Tailings Project.

RECLAMATION EXPECTATIONS

Reclamation expectations for the Hedley Gold Tailings Project were generally articulated in the amended B.C. Ministry of Energy Mines and Petroleum Resources M-183 Permit of December 11, 1995. These expectations included the establishment of forage vegetation and suppression of dust from the mine site by that vegetation.

The community of Hedley also had expectations for reclamation. They had struggled with historic tailings dust for many years and more recently with dust from the Hedley Gold Tailings Project. Dust was a critical concern for the community. Water quality was also a key issue for the community, in particular the community's water supply, Twenty Mile Creek and the Similkameen River. The Hedley Advisory Committee (HAC) was formed to address these and other community issues related to the mine.

PHASE ONE AND PHASE TWO RECLAMATION WITH BIOSOLIDS, 1996 AND 1997

In 1995, the Greater Vancouver Regional District (GVRD) sought to demonstrate the potential of biosolids for sustained growth on Hedley's tailings and entered into an agreement with the Candorado Operating Company Ltd. to reclaim DL 1796. After public consultation and under substantial regulatory and public scrutiny,, Phase One of the tailings reclamation with biosolids was carried out in 1996. Excellent germination and growth of forage grasses was observed the following year. Based on the success of the Phase One reclamation, the use of biosolids became more accepted by the community, and Phase Two reclamation utilizing biosolids followed in 1997 for the "Old Tailings" area of DL 2900. While there was agreement to share reclamation costs between the Candorado Operating Company and the GVRD, the mine operating company was unable to fulfill its obligation. The GVRD proceeded with the work and paid the entire cost of reclamation as it did not wish to leave the community of Hedley without a solution to the dust problem. Both reclaimed areas are now sustaining a mix of dryland grasses, and are used for recreation *by* the community. In 2001, Phase One was in its fifth growing season and Phase Two was in its fourth growing season. The forage vegetation established has stabilized the tailings surface and has noticeably reduced tailings dust. It has also improved the aesthetics of the town. Both projects were accompanied by extensive environmental monitoring including sampling of surface waters, the town well, soil and vegetation. No adverse effects from the use of biosolids have been observed in the monitoring data.

BACKGROUND TO PHASE THREE RECLAMATION WITH BIOSOLIDS, 2000

In early 1999, tailings dust incidents involving the heap leach became of increasing concern to the community and, in at least one instance, caused temporary visibility concerns for the adjacent highway. Members of the HAC and the Friends of the Similkameen, a regional environmental group, also lobbied the South Central Mine Development Review Committee (SCMDRC) about reclamation progress. (The SCMDRC is an intergovernmental committee with several federal, provincial and regional agencies including the British Columbia Ministries of: Energy & Mines (MEM); Water, Lands and Air Protection (MWLAP); Transportation (MT); Okanagan Similkameen Health Region (OSHR) and the Regional District of the Okanagan-Similkameen (RDOS)). At this point MEM negotiated an arrangement with the mining operator to contour the heap leach and place a minimum 50 cm talus layer over the entire heap leach to control its dust. Talus material was available near the heap leach's north side. Progressive

installments of the reclamation bond held by MEM, which had been held as required by permit M-183, were released for this contouring and capping work. This work was largely completed in the spring of 1999.

By late 1999, the financial constraints of the mine operating company and the diminished state of the reclamation bond limited further development of the heap leach cover and general mine site reclamation. In December 1999, MEM approached the GVRD to consider the possibility of using biosolids to assist in the reclamation of the heap leach area and the DL 2900 "New Tailings" area, despite the non-payment history of the mine operator for the Phase One and Phase Two reclamation with biosolids. After consideration the GVRD agreed to pursue this request under several specific conditions: that the GVRD would only deal directly with MEM; that there be solid support from the local community; that the project schedule be determined by the GVRD based on biosolids availability; and that project management and monitoring costs be shared among other agencies. It was also agreed that the GVRD's involvement would be limited to vegetation establishment, excluding other reclamation and closure issues. A proposal for reclamation using biosolids was presented to the SCMDRC in February 2000 and was subsequently endorsed.

PHASE THREE RECLAMATION WITH BIOSOLIDS, 2000

The primary objective for the GVRD's Biosolids Recycling Program is to beneficially recycle biosolids within an environmentally, socially and financially sustainable business model. More specifically for the mine reclamation sector, the GVRD's goal is to help create self-sustaining vegetative covers on mine spoils, within the larger context of a mine companies' objectives for health, safety and reclamation for a mine site.

Phase Three of the Hedley Gold Tailings Project presented some unique challenges. These were largely resolved by pooling the skills and resources of the GVRD and the SCMDRC agencies, Weyerhaeuser Canada and experienced contractors. The issues included the need to: address a heavy infestation of knapweed surrounding the heap leach; prevent access to all terrain vehicles and the public; address public concerns; and mitigate the effects of the dry and exposed heap leach site. The proximity of the Phase Three site to three tourism-based businesses was also unique to the third phase and their business concerns regarding biosolids odours and dust generation during operations also needed addressing.

Public Consultation

A number of opportunities were taken to provide the community information about the project and to give feedback. All the immediate neighbours as well as the Upper Similkameen Indian Band were independently contacted and the project discussed with them directly; a public information meeting was held; and subsequent meetings with interested groups and individuals were held during and following operations. The strongest support came from all the immediate neighbours, although they were concerned about the potential for odours. Biosolids applications were scheduled after the September Labor Day weekend to reduce any potential impact for the tourism-based businesses. In addition, contractors were instructed to incorporate biosolids on the same day that it was spread to further minimize odours.

Site Preparation

Initial site preparation included cleanup of small debris left from mining operations such as pieces of liner, posts, scrap metal and cable. Contractors stockpiled these materials near the process building for future removal. DL 2900 "Old Tailings" all terrain vehicle (ATV) access was reduced with placement of concrete highway barriers by the MT.

Weyerhaeuser Canada (Princeton plant), supplied and delivered a clean woodwaste of fine chips and sawdust. Contractors spread the material on all the tracks and tailings areas to minimize dust generated by trucks and machinery moving over the tailings. This proved to be an effective dust control method.

Before applying biosolids several tailings areas were contoured and groomed using a small dozer to facilitate machinery access and improve aesthetics of the site. Around the edges of the heap leach, the liner that lies underneath and isolates the heap was partly exposed. In order to protect the liner from possible damage from biosolids application equipment, a 50 cm layer of soil was placed on top. Talus rock material was excavated from behind the heap leach and used to cap any remaining bare tailings on top of the heap, that were missed in the original capping work, also to a 50 cm depth.

Due to the severity of the knapweed invasion around the heap leach, the control method selected was a residual herbicide applied in July and August 2000 under contract with MEM. The treatment was applied in accordance with the *Pesticide Control Act*, and was substantially funded by the RDOS. The MT also

had the knapweed hand pulled or sprayed along the entire Highway Three right-of-way east of Twenty Mile Creek that was adjacent to the Phase Three area.

Biosolids Application

Biosolids were applied in September and October 2000 using best management practices, and under the specifications of a permit from the MWLAP (PE 14930). Permission from the OSHR and MWLAP was received to apply biosolids closer to the river than originally specified in the permit. This was to enable reclamation of the entire lower bench of the DL 2900 "New Tailings" area. A total of 7 626 bulk tonnes of biosolids was delivered and applied to approximately 20 hectares.

Biosolids Quality

All biosolids used on the site were supplied by the Annacis Island wastewater treatment plant, which produces a Class A product as defined in the MWLAP's Organic Matter Recycling Regulation, Draft 3.0. The biosolids were produced by thermophilic anaerobic digestion, which results in a 99.999% pathogen destruction, and then centrifuge dewatered. The biosolids provides plant nutrients and organic matter content. The physical and chemical properties of biosolids make it well suited for amending poor mineral soils or mine spoils that are low in nutrients and organic matter. Its effectiveness as a growth medium amendment has been demonstrated at a number of agricultural and mine reclamation sites in B.C.

Application Rate

The biosolids application rates were selected from the GVRD's experience with tailings and waste rock reclamation. Limited availability of biosolids was also a factor in determining rates. The target biosolids application rates were 100 dt/ha on the "New Tailings" area, and 140 dt/ha on the heap leach section. The higher rate on the heap leach was designed to compensate for the coarse texture of the talus rock and its exposure to wind and heat. The target application rate for the existing grasses on the west side of the heap was 25 dt/ha as a topdress application. The actual application rates were close to the targets: 101 dt/ha, 143 dt/ha and 24 dt/ha respectively.

The woodwaste from Weyerhaeuser while; applied primarily as a dust suppressant, was also an additional source of organic matter along with the biosolids, and also as an aid for controlling odours. The

woodwaste was applied at a 1:1 volume ratio with the biosolids on the whole of the "New Tailings", and on any bare tailings areas surrounding the heap leach. The combination of woodwaste and dewatered biosolids was successful on the Phase One site.

Methodology

Biosolids was applied to level areas with a rear-discharge manure spreader. On sloped areas biosolids was applied by blading down the slope with a dozer. To ensure an even application the bladed biosolids was harrowed to break up clumps. Incorporation and mixing of the biosolids to a depth of 15-20 cm was achieved by a first pass with a dozer and brush rake, followed by several passes with breaker discs and chain harrows. A final pass with the harrows groomed the site for aesthetics and prepared a seedbed. Difficulty was experienced with achieving thorough mixing and depth of incorporation on some areas of the leach heap due to compaction. In these areas the blade of the dozer was used to cut deeper into the material, with some success. On the steep slopes of the heap leach's north side, biosolids was placed with an excavator. The very steep drainage pits within the heap leach were avoided altogether for safety reasons.

Seeding and Germination

The seed mix was selected to meet site specific criteria such as drought tolerance, competitiveness with knapweed, low accumulation of arsenic and low palatability. Species used were Crested Wheatgrass, Intermediate Wheatgrass, Canada Bluegrass, Smooth Brome, Creeping Red Fescue, Sheep Fescue. All flat and moderately sloped areas were broadcast seeded at a rate of 65 kg/ha, followed by a light chain harrow. The steepest slopes and drainage pits were hydroseeded with a single mulch. Seeding was completed in late November 2000.

Germination and forage establishment was qualitatively assessed throughout the first growing season in 2001. Results on the "New Tailings" area were favourable showing good germination and growth following July precipitation. Germination on the heap and surrounding areas was very limited, likely due to the fact that the site is highly exposed to wind and heat. Another limiting factor was that the region had a low April to July precipitation, which was 55% percent of the 1936 to 1990 average for those months (Princeton weather station).

Environmental Monitoring

Environmental monitoring requirements for Permit PE 14930 included a single sampling of surface waters of the Similkameen River and Twenty Mile Creek after biosolids application, as well as collecting pre-application soil samples representing the 20 hectare site. Soil samples were collected by GVRD in June 2000 to represent the different tailings areas, the talus material, and surrounding mineral soils. Water samples were collected by MEM in June 2001 following a precipitation event. MEM is monitoring forage quality, specifically for metals uptake (e.g. arsenic), and samples were collected in July 2001.

FUTURE CHALLENGES

Future challenges for the Phase Three reclamation with biosolids include forage establishment on the heap leach and its field areas, weed control, restriction of ATV access and monitoring of vegetation for metal (e.g. arsenic) uptake.

CONCLUSIONS

In 2001, DL 1796 Tailings - Phase One reclamation with biosolids, 1996 and DL 2900 "Old Tailings" - Phase Two reclamation with biosolids, 1997 at the Hedley Gold Tailings Project have shown continued forage production for five and four growing seasons respectively without further treatment or chemical fertilization. This forage establishment has resulted in decreased tailings dust and improved aesthetics for the Hedley community. No adverse effects to the surface or ground water, soil or vegetation have been observed in the monitoring data from the application of biosolids. Local public acceptance of the use of biosolids for reclamation has increased.

DL 2900 "New Tailings" and "Heap Leach" - Phase Three reclamation with biosolids, 2000 at the Hedley Gold Tailings Project has demonstrated the capacity for public agencies to effectively work together for the common good, despite the challenges at a financially constrained mine site. The public was consulted, their concerns addressed and their reclamation expectations largely met. ATV access has been restricted and a knapweed control program applied. An improved growth medium utilizing biosolids was created. Forage establishment for the "New Tailings" area has been successful.

ACKNOWLEDGEMENTS

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