RECLAMATION AND REVEGETATION OF MINE SPOILS USING BIOSOLIDS - PRINCETON TRIAL PROJECTS

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Abstract

Reclamation of waste rock or tailings piles is difficult at best. Repeated applications of fertilizer may not address the problems in waste rock or tailings such as an absence of organic matter, poor moisture regime, pH imbalance, surface temperature fluctuations, or low nutrient status. An application of biosolids (treated municipal wastewater sludge) can address these problems and speed the establishment of a sustainable vegetation cover which can support itself with reduced dependency on additional fertilizer applications.

Biosolids from Vancouver were applied to sites on the Tailings Pile located in the Town of Princeton and to waste rock dump sites at the Similco minesite in October 1992. The applications were made using a variety of different types of equipment and techniques to respond to the different site terrain and conditions. A wide range of biosolids application rates were tested. This report describes the application phase including site conditions, application rates and methods, sludge quality, monitoring, and research aspects of the project.
Introduction

Sludge is the organic solids that settle out at the wastewater treatment plant. The sludge is removed from the primary settling tanks and processed for 20-30 days in anaerobic digesters to reduce volume, odor, and disease producing organisms. Treated municipal wastewater sludge is called biosolids. Greater Vancouver Regional District (GVRD) biosolids are trademarked as an organic fertilizer called NUTRIFOR. Recycling treated municipal wastewater sludge, or biosolids, to disturbed lands is widely practised across North America. The benefits to the land are well proven and documented.

Biosolids are an excellent soil builder, rich in organic matter, plant nutrients and trace minerals essential for growth. In mine reclamation, the organic material in biosolids assists in providing a soil matrix upon which cover vegetation can be established. The nutrients and minerals found in biosolids release slowly over time because they are in an organic form. The need for further applications of fertilizer is reduced. Biosolids help stimulate plant growth, which helps to reduce erosion and to achieve reclamation goals.

The trial projects in the Princeton area will serve as a British Columbia example to demonstrate the many benefits of using biosolids in mine reclamation applications. Mine managers, reclamation consultants and engineers in British Columbia will be able to evaluate biosolids application as a part of their reclamation programs, based on the Princeton trials.

Biosolids Background

The four wastewater treatment plants in the GVRD produce about 50 000 wet tonnes of biosolids per year. This will grow to about 100 000 cubic metres per year after secondary treatment facilities are added. In addition to the annual biosolids production, stockpiles at Annacis Island and Iona Island wastewater treatment plants are estimated to be about 250 000 wet tonnes (January 1993).

GVRD biosolids are of relatively high quality when compared to regulatory guidelines and standards. Biosolids quality can be measured by considering physical characteristics of the biosolids such as solids content, pH, odor and amounts of carbon, hydrogen and oxygen present. Quality is also measured by considering macro nutrient levels (nitrogen, phosphorus, potassium, sulfur), micro nutrient or trace metal levels (magnesium, calcium, zinc, copper, vanadium, molybdenum, manganese, iron, cobalt, chromium, sodium, chlorine, selenium, and boron) and microorganisms.
Biosolids from the GVRD are typically dewatered to 25% - 30% percent solids cake (75%-70% water). At this solids concentration, the biosolids are moved and handled like a solid material using typical earth moving equipment. The pH of the biosolids is neutral to slightly alkaline (6.2 to 8.0). The average nitrogen content of biosolids is 3 to 4 percent of the dry solids. Approximately 90 percent of the nitrogen is in the organic form. This is significant because organic nitrogen breaks down or mineralizes to ammonia and nitrate (forms available to plants) slowly over time. This means that nitrogen will be available to plants for 3-5 years after biosolids application, and higher first time application rates can be used without resulting in nitrate leaching.

Sludge contains a variety of microorganisms - many are beneficial however some can cause disease. The anaerobic digestion process reduces the number of disease causing microorganisms by 95 to 99 percent. Additional bacteria and viruses die off after land application due to exposure to ultraviolet light, heat, lack of moisture and competition from soil organisms. Leaving adequate distances or buffer zones from surface waters, restricting site access, and following common hygiene practices for workers applying sludge assure that human health is protected.

GVRD biosolids easily meet Ministry of the Environment, Lands and Parks (MOELP) Guidelines for the application of biosolids to agricultural lands. In addition, they compare favorably with EPA criteria for “clean sludge”, or sludge that has no restrictions on its use. Biosolids concentrations are compared with existing guidelines and criteria in Table 1. In this table, the concentrations in the biosolids are the median values of composite samples taken since 1985 (Annacis Island Biosolids). The concentrations given in the MOELP Agricultural Guidelines and the EPA 503 Regulations are maximum allowable concentrations.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>GVRD Biosolids</th>
<th>MOE Agricultural Guidelines</th>
<th>EPA Clean Sludge</th>
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<tr>
<td>Arsenic</td>
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<tr>
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<td>Copper</td>
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<tr>
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<tr>
<td>PCB</td>
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</table>

Table 1 - Concentrations of Micro nutrients/Metals in Biosolids
Project Development and Schedule

Approvals from the Ministry of Environment, Lands and Parks (MOELP) are required for land application projects using biosolids. Brown and Caldwell, environmental consultants with extensive experience in biosolids land application projects, designed the trials and prepared the Approval applications required by the MOELP. The Applications for Approval for these projects were submitted by the Greater Vancouver Sewerage and Drainage District (GVS&DD) in July 1992. The approvals were received in September/October and biosolids application to the sites took place in October 1992. The biosolids were transported to the site using gravel trucks with transfer units. The GVS&DD contracted the implementation of the project to Terrasol, a company with fifteen years of experience designing and implementing reclamation programs. Terrasol managed the coordination of trucks at the field sites, application of the biosolids in the field, some initial site preparation and infield modifications. Samples of soil, vegetation and water were taken prior to the biosolids applications and will continue in 1993.

Project Details

Projects Located on Waste Rock Dumps

About 300 dry tonnes of biosolids were applied to five one-hectare plots including flat and sloped faces of waste rock dumps located on the Copper Mountain and Ingerbelle sides of Similco Mines Ltd.

Table 2 reflects the application rates for the sites. Hydraulic seeding equipment was used to apply the biosolids to the sloped dump faces. The hydraulic seeding equipment consists of a tank with mechanical agitator, pump, discharge piping and fire monitor. Water and biosolids were mixed in the tank to produce a homogeneous slurry with a solids content of about 12%. The pumping and discharge system was capable of applying the biosolids to distances of 65 metres from the truck. For the flat sites, the biosolids were spread using mine graders. Biosolids application to Plot 3 was only partially completed at the onset of snow in the area and will be completed as early as possible in the spring.

Most of the plots at the Similco project have been seeded. Plot 1 did not require seeding as vegetation from previous reclamation efforts was already in place. Plot 2 was hydroseded - the lower half was also hydromulched using a woodfibre mulch, Ecofibre, manufactured by Canadian Forest Products Ltd. The northern half of Plot 4 and the southern half of Plot 5 were also hydroseded.
Projects located on Tailings

About 375 dry tonnes of biosolids were applied to four one-hectare demonstration sites on the tailings pile located in the Town of Princeton. Several different application rates were researched. Sites 2 and 3 (1 hectare each) were sub-divided into four sites of 0.5 hectare each. For one half of these sites, the application is two-time - i.e. one half of the total application rate was applied in October 1992 and the other half of the application rate will be applied in Autumn 1993. All the other plots received one-time application rates as noted in Table 3 below.

Table 3: Application Rates - Tailings Pile
The biosolids were applied using hydraulic ram manure spreaders followed by tilling with an 8" (20 cm) farm disk. The plots were drill seeded and rolled to control seed loss from wind erosion. The biosolids applied to the alfalfa field (Site 1) were not tilled in and this site was not seeded. Biosolids applied to Site 4 were mixed with 198 cubic metres of wood waste prior to spreading.

### Site Monitoring Data

Soil samples were taken prior to the application of biosolids and analyzed for nutrients and total metals. It was difficult to find any soil to analyze on the waste rock dump sites. What little soil that was collected was found in the crevices between rocks or in the overburden present on some of the sites. Tailings soil samples were taken to a depth of 1.5 metres. The soils were analyzed for total nutrients, total metals and plant fertility - i.e. available macro and micro nutrients. The analyses for the soils from the waste rock dumps and the tailings showed poor to no plant fertility. Samples of soil from the sites will be taken again after the spring snow melt and in the autumn of 1993 to compare soil fertility. Percent cover, species survival characteristics and vegetation nutrient uptake will also be measured in 1993.

Water samples from nearby wells used for potable water were taken prior to the biosolids application and will be monitored throughout the project for quality. All of the water samples taken prior to the applications met Canadian Drinking Water Quality recommendations. Water samples will be collected and analyzed after the spring melt and in the autumn of 1993.

### Public Involvement

Years of experience in the United States with biosolids land application projects have proven that any waste management project, no matter how appealing, is subject to some degree of public scrutiny. The public expects and demands to be consulted on projects that affect their communities, including recycling and beneficial projects. For the trial projects in Princeton, the District relied on a Communications Consultant to help set up a proactive, open and available program which responded to peoples' concerns about the project. Princeton residents were invited to two open houses which were held prior to and during the project. A window display in the Economic Development Office invited residents in to peruse brochures, pictures and technical information, or have questions answered. Ongoing consultation and informational activities are planned for the remainder of the project, including project update mailings to interested persons in the spring and winter of 1993.
Summary

Biosolids are an excellent soil builder, rich in organic matter, plant nutrients and trace minerals essential for growth. A single application of biosolids to disturbed land including waste rock dumps or tailings can speed the establishment of a foliage cover which can support itself sustainably with reduced applications of fertilizer. The nutrients and minerals found in biosolids release slowly over time reducing the need for further applications of fertilizer. Biosolids help plant growth, which helps reduce erosion and achieve reclamation goals.

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Bibliography


