GROWING SUCCESS WITH RECYCLED RESIDUALS FOR LAND RECLAMATION

Major projects in eastern provinces demonstrate the value of biosolids and paper mill residuals

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Top: Thetford Mines after – aerial - October 2015.

1) Gagetown aerial, 2003.
PHOTO CREDIT: TRANSAQUA/ GREATER MONCTON WASTEWATER

2) Thetford Mines – Phase 1-2, May 2015.

3) Thetford Mines – Close up of SPF and germination, May 2015.

With demonstrated successes dating back to the 1970s, using municipal biosolids and other residuals has proven to be an environmental win-win, providing rapid ecosystem restoration while putting to use materials once considered "wastes."

Today, the variety of recyclable residuals includes biomass wood ash, water treatment residuals, effluents, food wastes, and construction debris (e.g. gypsum board). This variety allows engineered topsoils tailored to meet the specific chemistry and needs of diverse sites. The challenge comes in matching reclamation needs with the residuals locally available. And, especially when municipal biosolids are involved, projects must consider potential negative public perceptions.

Across Canada, high-profile mine reclamation projects with residuals are ongoing. For example:

- Award-winning work at Sechelt, B.C. – where biosolids are used to support poplar plantations;
- Pronto Mine at Elliott Lake – the first tailing reclamation in Ontario using

Thetford Mines after – Talus Bench – 2015.

papermill residuals; saving the mine $2 million and halving the paper mill's cost for residuals disposal; and

- Sudbury, ON – where residuals are critical in ongoing reclamation.

Although fewer in number, there are similar successes in eastern provinces.

HISTORY AND RESEARCH

Extensive research on the use of biosolids/residuals for land reclamation began in the 1970s. Experiments were conducted at coal mines in Pennsylvania and hard rock mines in the west. Published literature accumulated, documenting understanding of the decreased bioavailability of heavy metals in soils after application of biosolids, the establishment of stable ecosystems, and the reductions in water quality impairment. Several researchers closely monitored the quality of vegetation and the health of mammals and other organisms that took up residence on reclaimed sites, finding no significant negative impacts. This accumulated research led to best management practices that minimize negative impacts while maximizing the many significant benefits.

REVEGETATING MILITARY TRAINING GROUNDS AT GAGETOWN, NEW BRUNSWICK

In 2003 and subsequent years, the Department of National Defence (DND) and its Cape Gagetown, NB base worked with Greater Moncton Wastewater's biosolids compost program to research the use of compost to "restore soil fertility in a denuded section of the Range and Training Area (RTA), and to restore a self-sustaining vegetative cover to minimize soil erosion and the sediment-laden runoff that leads to water quality degradation." The RTA had been deforested, with debris bulldozed into windrows, to create a training area that would look like a particular combat zone (Bosnia). No restoration efforts had been made. Federal authorities required action. Conrad Allain at Greater Moncton Wastewater, recalls that "base employees were very skeptical of being exposed to 'human waste' – biosolids."

Initial trial plots were worked in the fall of 2003. The existing soils had only one to two per cent organic matter and pH of 5 or lower. Three four- to seven-hectare areas were graded, with the decomposed wood-waste windrows spread evenly over the surface. This was the only treatment in one area. On the other two plots, biosolids compost was applied at an estimated average rate of 188 tonnes/ha. On one, the compost was tilled into the soil; on the other, it was left on the surface.

The 2003 trial included testing a variety of equipment for efficient land work and compost application. In addition, hours for various tasks and costs were tracked. In one day, 0.6 ha were completed by one bush-hog, two excavators, and two dozers preparing the sites, and one loader, one small dozer, and one towed straw mulcher/seeder completing the compost application and seeding. The total project cost was ~$220,000, or an estimated ~$15,300/ha (2003 dollars).

Convincing Gagetown management and other stakeholders of the safety and success of the project depended on monitoring of compost and surface water quality. No significant negative impacts were measured, and the trial was deemed a success.

In the fall of 2005, another 39 ha were treated with different biosolids composts. The application rate was lower: ~70 tonnes/ha. Otherwise, the same procedures were used. Within one month, vegetative cover was robust on 70 per cent of the site area. Water quality and other environmental monitoring found no significant concerns.

Allain notes that the project ameliorated any skepticism about biosolids use and included training of Camp Gagetown operators, so they could continue ongoing reclamation if they so chose. "They went from being very skeptical to working with the compost. I don't know if the project has continued…. The area to be completed is very large. But vegetation has gradually taken over windrows and stripped areas, resulting in less silt runoff. The urgency to complete more reclamation may no longer be there."

RECLAMATION OF ASBESTOS MINE TAILINGS AT THETFORD MINES, QUEBEC

There is urgency for reclamation at asbestos mines in Quebec. Beginning in 2011, residual management companies collaborated with mine owners, providing residuals, engineering, and expertise to mitigate asbestos tailings at Thetford Mines. The environment ministry-approved demonstration project led to the revegetation of soil- and nutrient-deficient talus slopes and benches of coarse tailings, as well as finer, post-processing tailings (~10 cm or less in size). The project was seen as sustainable development: using residuals to restore a large site in a stigmatized area where years of intensive exploitation occurred during the last century. As with the Gagetown project, it involved developing a topsoil recipe using local residuals; determining the most efficient site preparation and application techniques; and monitoring environmental parameters.

Creating the engineered topsoil recipe began with lab experiments with various tailings mixed with various recipes of mu-

Gagetown after reclamation, with Conrad Allain.

nicipal biosolids, paper mill residuals, and wood waste. Focus was on the levels of key agronomic parameters. An effective mix of residuals and tailings needed to address all of the following:

- providing adequate organic matter and release for plant uptake of N;
- providing adequate concentrations of other critical plant nutrients, including P and potassium (K);
- being able to incorporate the chosen mix 20 to 30 cm into the dense (1.75 tonne/lm^3) tailings;
- addressing the unique characteristic of serpentine tailings – toxic levels of magnesium; and
- ensuring total trace metal concentrations were acceptable.

Final recipes included paper deinking residuals (for organic matter and bulk), municipal biosolids (for plant nutrients), and, in parts of the site, wood waste (for added organic matter).

Site work began in 2011, and residuals were stockpiled at one location for mixing with a bulldozer. Thorough mixing was critical, because any reclaimed spots with excess papermill residual with high C:N ratio would not support vegetation. The mix was transported to the reclaim areas, spread with dozers, and worked into the tailings. Various seed mixes were applied, some of which included legumes. The resulting germination resulted in plant cover of 90 to 100 per cent on slopes and benches. Some bare spots were reworked and reseeded subsequently, although many became vegetated on their own over time.

Monitoring of the reclaimed sites continued through 2014. The soil organic matter generally ranged from five to 20 per cent and the pH was somewhat alkaline due to the chemistry of the tailings. Available phosphorus levels were found to be high, but that was deemed acceptable because further P additions are not expected. Water quality monitoring demonstrated no significant impacts to nearby streams and minimally elevated N in shallow groundwater, which is expected and unavoidable when first establishing vigourous vegetation; excess levels decrease with time. Monitoring found no indication of any remaining toxicity from metal contaminants; even the unique concern of excess Mg had been addressed by balancing the Ca:Mg ratio.

The project was completed without any registered complaints over the three-year period, in part because of the isolation of the sites and in part because of careful management of those residuals that could potentially cause odours.

CONCLUSION

Residuals can help address numerous environmental challenges. As healthy soils and carbon accounting initiatives advance, they are being recognized for their role in replacing fertilizers and topsoils and building soil carbon stores. Their use can generate carbon credits; currently, Quebec and Ontario are developing protocols for marketable carbon credits for organic residuals diversion under their new cap-and-trade programs. In California, biosolids are central to healthy soil initiatives. These 21st-century benefits increase the value – beyond the already-demonstrated benefits – of using residuals in land reclamation.

Gagetown before.

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