ABSTRACT

Whether it’s the closure of a landfill cell, the remediation of strip mine slopes, or the beneficial conversion of a former industrial zone, erosion control is necessary. It is essential to establishing sustainable vegetation, which in turn protects the entire site in the long term. Increasing regulatory attention and fines have also heightened the economic pressure on agencies, site owners, contractors and other stakeholders in land development and reclamation. Biotics in erosion control products, such as the incorporation of hydraulic growth mediums (HGMs) and beneficial growth stimulants, provide organic additives that are generally missing in the soils overlying critical sites. These growth mediums provide numerous benefits to stimulate natural microbial activity, soil aggregate formation and other natural top soil forming processes and thus ensure the long-term viability and benefits of healthy vegetation. This paper describes how the introduction of specific amounts of various organic materials into HGMs has improved poor and non-native soils (such as clean fill that is transported to a site) that need an organic additive and for slope erosion prevention. With two case studies, it will show how vegetation is established quickly and sustainably for long-term, effective protection; and for the improvement of the businesses utilizing these erosion control solutions.

Key Words: hydraulic growth mediums, tackifiers, mining, reclamation

INTRODUCTION

The field of erosion control is wound deeply into all aspects of land management, from the filing of erosion and sediment control plans ahead of site activities and in compliance with regulations (e.g., BC Environmental Assessment Act) to basic public relations and site responsibility in final site activities. At all stages of land use, some form of erosion control and sediment runoff containment may be needed, for compliance issues or even basic maintenance that allows operations to continue unimpeded. The location (e.g., municipality, province) and application/land use (e.g., residential development, mining closure) will determine the frequency and intensity of erosion control methods.

What unites all of these erosion and sediment control activities is the need to establish and maintain vegetation for the long-term stability of the site. This often means soils must be improved in order to maintain viable vegetation after the land has been disturbed.
Hydraulic growth mediums (HGMs) with biotic components and strong tackifiers are improving the performance and economics of erosion control, and they’re also improving on the overall development and building of healthy soils for the long-term sustainability of vegetative cover at environmentally sensitive sites.

**GROWTH IN HGMs**

Hydraulic growth mediums (HGMs) are a relatively new series of products that are proven to improve soil tilth through the addition of organics, microbial stimulating materials in the soil, build soil structure or stimulate soil aggregate formation, and thus improve on existing soil characteristics or build a topsoil layer from sub-soils while still offering exceptional erosion control characteristics. While the idea behind HGMs may initially seem basic “improve the soil” the science behind the products development has been ongoing for over 30 years. Pre-packaged products are essential to ensure the appropriate soil and plant science, chemistry and erosion control expertise is applied to each site.

The main components to be aware of when selecting a particular HGM for use are (a) the biotic system that will improve the soil and spur vegetation and (b) the tackifier that will secure the HGM to the soil and enhance soil formation processes and allow both the initial vegetation establishment.

**Soil Improvement**

Topsoil hosts many organisms, all of which help promote growth: bacteria, fungus, micro-organisms, etc. Regardless of where the soil is located and what organisms it supports, it’s made up of four primary components: air, water, minerals and organic matter. The fertility of soil is rooted in the interaction of these organisms and the balance of the top soil’s basic components. The HGM, properly formulated, increases microbial activity and the formation of micro- and macro-pores necessary for top soil building.

Considering that an inch of topsoil can take upwards of 100 years to develop yet can be lost many times over in less than a year if the vegetative cover is poor, erosion control is more important than simple surface coverage; especially at difficult sites. Long-term control means long-term vegetation, and that can only be possible with healthy soil (Howard, 1997).

The term “biotics” isn’t necessarily a well-established or well-used term in erosion control. While biotic implies a living nature, and might thus be said to be found in many traditional erosion control materials, the real meaning – and value – in the word “biotic” is what it does for the soil and thus for the vegetation. This is one of the reasons why it is not spoken of with traditional erosion control approaches, which tend to sit upon the surface and focus more on immediate surface protection from just detachment and transportation by wind or water. But long-term, sustainable growth, coverage and erosion control requires soil improvement so that future vegetation may flourish. The true function of biotic elements in an erosion control system is soil improvement. They should promote natural microbial activity, soil aggregate formation and other natural topsoil forming processes that are the hallmarks of healthy vegetation-supporting soil systems.
The HGMs with the incorporation of rich peat, beneficial growth stimulants, and soil building materials has been very successful on a wide-range of sensitive sites, including those with poor native soils and to which the hauling of a significant quantity of healthy topsoil is cost-prohibitive.

The utilization of Canadian sphagnum peat moss, for example, has given a newer breed of hydraulic growth mediums an organic additive that poor soils generally lack. These mixes are particularly relevant for sites that do not receive adequate moisture, have not addition of topsoil, or lack the presence of organics – which is very much the case in a great many former mining, refining and industrial processing sites. The incorporation of Canadian sphagnum peat and beneficial growth stimulants in an HGM system performs well even on slopes up to 1:1 for vegetation re-establishment and when used in conjunction with other erosion control devices.

While peat, compost and top soil are the three primary growth mediums, peat is often used by greenhouse operations because of attractive qualities. It’s weed-free, versatile, cold-weather tolerant, and lasts up to eight years versus one year for standard, trucked-in top soil installed on many sites. (In this way, where special fill must by imported, HGM application can improve those soils too and extend their healthy impact on the tilth.). In addition, as peat degrades it releases important humic acid into the soil as an energy source for the microbial population and works as an organic binder to start soil aggregate formation.

However, there is no singular soil-enrichment approach to HGM use on all sites. Mixtures such as 70% wheat straw and flexible flax fiber (for soil-mix reinforcement) and 30% peat moss, for example, have been used successfully. More robust mixtures of 40% wheat straw/flexible flax fiber and 60% sphagnum peat moss, plus additional growth enhancements and mycorrhizae have been shown to be excellent for slopes, channels, riprap support, and subsoil improvement. Even stronger mixtures have been developed with 70% wheat straw/flax fiber, 20% peat moss, and 10% cross-linking polymers, mycorrhizae, growth stimulants and micronutrients to create a more intensive application-oriented bonded fiber matrix.

Additional steps can be taken, such as adding alfalfa meal to the HGM to recondition poor soil, degrade hydrocarbons and reduce sodium. The more intensive the application (as determined by slope, soil quality, expected climate conditions, etc.), the stronger the formula should be and may require greater application rate. The growth stimulants within these mixtures and organic bases such as peat and the interlocking characteristics of the flax fibers promote the essential long-term erosion control support: vegetation and healthy soil.

Importance of Tackifiers

While HGMs have been shown to be very effective in spurring the growth of strong-rooted, long-term vegetation, these formulas really would not succeed without the inclusion of tackifiers.

HGMs do not have any netting or stakes; so something needs to create the initial protective bond that allows vegetation and soil amendment to begin. Tackifiers play that role.
Tackifiers are engineered to create a bond in the hydraulic growth medium. Without them, storm events or other erosion-inducing agents, such as overflow or runoff or even wind, could disturb the growth medium prior to vegetation establishment. This could lead to uneven vegetation or areas without any growth; and that might lead to the development of rills that could ultimately undermine the system’s effectiveness.

The use of a combination of tackifiers and soil stabilizing polymers strengthen the HGM. They are made from a number of sources, but the technical nature behind their development does set some of them apart. The soil stabilization polymer company Earth Chem Inc. has produced high-quality soil stabilizers with its EarthBound® series for numerous years. Combining the chemistry behind their long chain polymers and the addition of cross-linking molecules in conjunction with hydrocolloid vegetable gum-based tackifiers results in an exceptional soil stabilizer/tackifier. The adherence to the soil surface has been strong and the soil structure has been stable. Importantly, infiltration is still allowed, which means that the soils pores can take in and transfer water, biotic activity can take place, organic material moves down into the soil, and permanent, strong vegetation roots can develop (Harrison, 2009).

SUITABILITY IN RECLAMATION

Mining, industrial processing, waste cell construction, and similar land uses rarely take place in close proximity to populated areas. Furthermore, they often take place in regions that are not well-suited to residential development for reasons of climate, access, available services or poor soils. The way the land is used during mining, waste management and other intensive land disturbance activities further degrades the viability of the soils. (Polster, 2007) This combination of distance and poor soils make reclamation and beneficial re-use difficult and potentially very expensive.

The ability to improve native site soils presents a tremendous savings from economic and environmental perspectives. If the majority of site soils are salvageable – that is, have not been prohibitively contaminated during operations – a biotic-rich, soil-improving cover saves on the cost of hauling many inches of new top soil to the site.

From an environmental perspective, one saves on the number of heavy trucks that would otherwise be required to transport so much new soil to the site.

Also, when reclamation and closure work involves sensitive installations, such as geosynthetic cap layers, the need for sustainable vegetation is heightened. The importance of vegetation cover must not be discounted. When sensitive or contaminated soils are stored on site, or when protective caps have been installed, preserving the top cover on the site is primary to preventing infiltration into those cap layers and environmentally sensitive soils. Poor vegetation breaks up, top soil is exposed, and water and wind begin to strip it (Sloat, 2005). Ultimately, failure might occur. Slopes can be especially sensitive, and when combined with capping systems may lead to failure (Koerner, 2005).

Strong vegetation cover atop a reclaimed or closed site helps protect not just the surface but all of the other investments (work, labor, compliance) that have been made prior to top soil improvement.
The benefits of using this HGM approach to erosion control at sensitive sites are not limited solely to the client. For contractors providing erosion control services to reclamation projects, the application of a soil-improving HGM allows for an erosion protection solution that is competitive with traditional blankets on cost and can be used in conjunction with them where needed. It gives the contractor flexibility. The diminished need to import special soils reduces the transportation and labor costs for contractors. Also, fewer site workers are needed to install an HGM cover (Photo 1) and the construction window can be shorter. All of these savings can be realized without sacrificing the integrity of the installation.

Photo 1. Application of hydraulic growth medium by small crew.

As the Milner case study that follows found, providing quality top soil with an HGM approach cost just slightly more than half of what it would have cost to use a thicker, non-HGM top soil layer.

CASE STUDY: MILNER RIDGE, MANITOBA

The integration of both erosion control blankets and HGMs on the same site has been shown to be particularly successful for sustainable vegetation establishment and long-term soil improvement while also offering exceptional erosion control. For Milner Ridge, Manitoba Infrastructure and Transportation (MIT), a Department of the Government of Manitoba, was concerned with the structural integrity of a wastewater lagoon. The glacial sand deposits on which the facility was constructed were eroding, which threatened approximately 70,000 m² of slopes and channels on the site. Of note, it was the land side of the facility’s berms that were experiencing erosion.

While many assume that the water-abutting side of a berm is where failures will begin, it’s important to note the significant role that the non-water side can play in the onset of a failure. This is important to consider in reclamation activities, as former mining sites often have water bodies, contained or flowing, incorporated into their sites, if not added to them as a result of voids created by mining activities. Erosion to the surface of the non-water side can allow stormwater incursion to the core of a constructed or natural embankment. That process weakens the structure from the inside-out (Heerten, 2008). Eventually, it can lead to structural failure. This was a central concern at Milner Ridge.
The site soils, typical of this cold weather region, could have been cured through the transplanting of topsoil; but the volume needed would have been enormous. The expense associated with transporting such a significant amount of non-native soil to the site was too great. And even if it had been brought to the site, additional erosion control and vegetation materials would have been needed.

What the site needed was both subsoil improvement and strong vegetation that could be established quickly and that would be self maintaining for a long period of time.

Situations like this are exactly why hydraulic growth mediums have grown in popularity and why renewed interest has gone into product development and application: to provide the living base for vegetation without the need to overhaul the entire topsoil structure.

It isn’t just site cost controls that are of concern or attractive here. The trend towards “green,” or “sustainable,” engineering and construction principles also play a role. If significant quantities of soil do not need to be hauled in, then one also realizes environmental benefits in reducing transportation pollution. And if soils were trucked in, they would have to be stripped from someplace else. So in this instance, improving the soil so that it can support the appropriate type of erosion-stopping vegetation is beneficial to both the health of the site in question and larger environmental issues.

At Milner Ridge, design engineer Tim Lasuik of J.R Cousin Consultants Ltd. (Winnipeg) worked with the project manager, Harry Schroeder. For reasons of cost and time, topsoil and seeding were deemed prohibitive, as was “staked” sod.

If topsoil was to be used, the project team estimated that properly protecting the site from erosion would require four inches of topsoil. The projected cost was $6.00/m².

Conversely, an approach using a hydraulically-applied system – in this case, Verdyol Biotic Earth™ Black – came in at $3.15/m². Included in the HGM application cost were the soil-amending tackifiers and the utilization of single-net and double-net straw blankets for additional protection of the steeper sloping areas on the site. Those blankets were manufactured by ErosionControlBlanket.com.

Once the plan was approved, Mid-Canada Hydroseeding (St. Andrews, Manitoba) was brought in to conduct the application. Company personnel applied seed and fertilizer along with 3900 kg/ha of the biotic material with its Canadian sphagnum peat moss.

Within several weeks of the project’s completion, it was put to the test: approximately 100 mm of rain fell within a 48 hour period.

The project team’s expectations were met and exceeded, with virtually no erosion observed and the establishment of an effective layer of vegetation to provide long-term erosion control.
The Milner Ridge site stands as an exemplary use of these new grades of hydraulically-applied materials in sensitive infrastructure developments. After one year, it is thriving (Photo 2).

Photo 2. One year later, firm roots and thick vegetation characterize the site.

CASE STUDY: HYDRO-QUÉBEC

There are certainly quality cases to examine older than one year. In 2004, the large energy generation company, Hydro-Québec, wanted to combine peat moss with its wheat-based straw mulch to help reclaim road sides that were being built on their northern construction sites near James Bay. This project was located in the Northern Boreal forest where salvaging topsoil was impossible. Importing topsoil to this area was not possible. To further complicate matters, the subsoil was highly erodible sand and their growing season extremely short. Vegetation needed to be established within one season to make it sustainable without the use of topsoil.

To accommodate this requirement, a Verdyol Biotic Earth HGM was applied at a rate of 2000kg/ha - a decent speed of application and one that perhaps helps underscore the time saving that a hydraulically-applied erosion control product can present. A great deal of space can be covered quickly.

Another attractive feature of these HGM applications is that a good operator can incorporate a smart seed mix to get the variety of plantings many project teams prefer. The seed mix established with Hydro-Québec consisted of: 34% Creeping red fescue; 8% Timothy; 5% Bent Grass; 20% Birdsfoot trefoil; 15% White Clover; 15% Barley; and 3% Reed Canary grass.

The mix was applied at a rate of 175 kg/ha. It was also a key element to working with this company, which has a very good reputation for renewable energy production. Environmental responsibility is part of its corporate identity. As such, coming up with a seed mix that met the company’s goal of “re-naturalization” of the land and incorporating the right tackifier to hold this HGM system intact and allow the soil amendment and vegetation to develop was extremely important.
To further highlight how these application elements are released to promote the right setting in of growth: a 12-18-12 fertilizer was used and 25% of this fertilizer was slow release. The tackifier was applied at a rate of 80 L/ha on the steeper slopes to firm up those sections and make sure they would not lose cohesion during storms that might come prior to full vegetation.

Grass grew within the first season and within the second season the birdsfoot trefoil bloomed. This is, in the authors’ experience, the typical pattern with these HGM systems: strong, thick-rooted grasses at the outset that get the site into and through first winter, followed by more advanced growth of additional vegetation in the next season.

More than six years later, this site continues to function well and Hydro-Québec still specifies in its northern areas a straw-and-peat mix as developed for this project.

**SUMMARY**

The comparative performance of hydraulic growth medium (HGM) materials in erosion control versus more traditional measures and the better economics involved with HGMs for contractors, site owners, government agencies and other project players suggests a significant period of utilization is forthcoming. Sectors with tougher erosion control and vegetation establishment issues, which include mining closure and reclamation, stand to gain a great deal in adopting HGMs more widely. In addition to lower costs in construction with HGMs, a number of environmental benefits have been shown, from the simple reduction of heavy truck traffic to significant soil improvement.

HGM systems promote natural microbial activity, soil aggregate formation and sustainable top soil—something traditional measures cannot. For northern regions with difficult seasons and soils, this is particularly important. It is even more important for the closure and reclamation of environmentally sensitive sites. With tougher land management and monitoring regulations, the need for long-term erosion control care that outperforms traditional measures has increased. The flexibility allowed in HGM mixes (seeds, biotic elements, tackifiers) and the long-term soil strengthening they promote, successfully address these erosion control concerns.

**REFERENCES**


