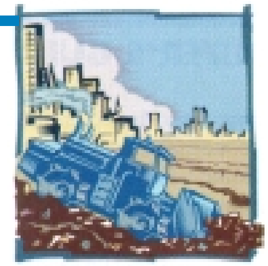

Empire Landfill

This landfill was designed and constructed as a state-of-the-art waste containment site with all phases of the construction to meet or exceed current design guidelines. Empire has perimeter down chute channel protection using a cellular confinement system with concrete infill.

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Empire Landfill in Taylor, PA is situated on a 600-acre site, with 203 acres currently under permit for waste disposal. In anticipant of current and future environmental concerns, the management of Empire Landfill, Inc. has ensured that the landfill exceeds today's design and operational guidelines.

Empire Landfill features double-lined cells, with a "geosynthetic sandwich" of geotextile, two 100 mil HDPE liners, and stone aggregate atop a clayey soil subbase. A complete storm water management system for surface run-on and runoff includes a series of channels, with high erosion potential in the diversion and interceptor channels.

Interceptor channels follow the landfill toe, with a gradient ranging from 2 to 16%. These channels are in a trapezoidal configuration, with an eight-foot wide bottom and 2:1 side slopes. In the past, 18-in. thick rock-filled baskets or shot rock were being employed to protect the interceptor channels from erosion. Alternate hard armor systems were considered in an attempt to enhance the storm water management system and to minimize labor and site disturbance required with the installation of the 18-in. baskets.

An alternate channel armament system was chosen which consists of a 4-in. thick cellular confinement system, underlain with a nonwoven geotextile and infilled with concrete. The cellular confinement technology was originally developed in the late 1970s in cooperation with the Army Corps of Engineers. Cellular confinement technology is based on confinement principles of granular materials in a cellular system. The cellular confinement system is an engineered expandable, polyethylene, honeycomb-like cellular structure.

Empire Landfill, located northeast of Scranton, PA, receives approximately 4,000 to 5,000 tons/day (tpd) of municipal solid waste from the tri-state area. The landfill itself features tomorrow's technology, today. It is built with double-lined construction, offering quality control in an environmentally sound landfill.

Installation of the Geoweb system was completed by a three-person crew [one equipment operator and two laborers].

Both the primary and secondary liners are made of a minimum of 100-mil thick, high-density polyethylene. This thickness exceeds state requirements. In addition, Empire goes beyond normal requirements relative to storm water management.

Project Background

Empire Landfill first opened in 1987. Over the past several years, Empire has continued to prepare a new cell as one cell is being filled and another cell is being constructed. In 1995, Martin & Martin, an engineering consulting and design firm, was retained to design the construction and closure of the landfill. This design was to include all the necessary components of an effective, cost efficient and long-lasting system to protect the facility and surrounding area from accelerated erosion, while accommodating the flows from a 100-year, 24-hour storm.

Empire was designed and constructed as a state-of-the-art waste containment site with all phases of the construction to meet or exceed current design guidelines. As an example, Pennsylvania requires the primary liner to be 50-mil HDPE and the secondary liner to be 30-mil HDPE. Empire has and continues to use 100-mil HDPE in the construction of the primary and secondary liner systems.[1] The site is being constructed in phases. New cells are constructed as required and the filled cells are capped.

The Problem

Current regulations from EPA Subtitle D, and Pennsylvania Department of Environmental Protection, Chapter 273, require that storm water management systems be designed to accommodate 100-year, 24-hour storm events for run-on control, and 25-year, 24-hour events for run-off management. These systems include both run-on diversion and run-off interceptors around the site perimeter, as well as channels and down drains from the terraced landfill area. On the landfill footprint, regulations require a geomembrane cap system; thereby maximizing run-off that the storm water system must accommodate.

Martin & Martin was familiar with methods of accomplishing the task of storm water management on the landfill site and especially the removal of storm water from diversions, interceptors, and from each capped cell. In the past, rock filled gabion baskets and/or rip rap lined channels had been used to construct a series of channels to remove surface rainwater. While these systems are effective, Empire was interested in pursuing more cost-and-time efficient alternatives which would adequately handle the flows, and be easy to maintain.

The Solution

Empire and Martin & Martin worked with ACE Environmental, Inc. looking for some potential alternate means of constructing the perimeter storm water channels. Empire, in analyzing the cost of gabion baskets and the stone to place in the baskets, realized that substantial excavation was required to fit the .457 meter thick (18-in.) gabion baskets into the trapezoidal configuration.

An important factor in considering any alternate product was that it had to meet the requirements of the State Department of Environmental Protection. ACE suggested that a product called Geoweb, a cellular confinement system, be evaluated for this application.

Cellular confinement of soil, aggregate or concrete infill materials has been used successfully since its development in the late 1970s by the Army Corps of Engineers and Presto Products for:

❒ Protection and stabilization of steep slope surfaces

❒ Protective linings of channels and hydraulic structures

❒ Static and dynamic load support on weak subgrade soils

Multi-layered earth retention structures

For this project, a 100-mm (4-in.) concrete filled textured Geoweb system with tendon and J pin anchorage was able to satisfy all of the design objectives and requirements. The textured Geoweb maximizes the mechanical bond between the concrete and cell walls, locking the concrete infill into the individual cells of the system. High strength concrete infill into the individual cells of the system. High strength LDPE coated polyester tendons inserted through the Geoweb provide a connection element for the J pin anchors.

CASE HISTORY

The function of the 170g/m^2 (6 oz./yd^2) was to provide drainage and soil filtration.

The Design Solution

Martin & Martin and Empire's internal design staff worked with Presto Products' consultant InterSol Engineering to determine the flow conditions in each channel section. The following project parameters were used to determine the type of Geoweb lining system required.

- Maximum bed slope = 16.2%
- Discharge = 6.0 m^3/sec (210 ft^3/sec)
- Velocity = 7.22 m/sec (23.7 ft/sec)
- Critical interface friction (soil/geotextile) = 28°
- Factor of safety downstream sliding = 1.3

A channel analysis program developed by InterSol Engineering was used to analyze the stability against sliding due to drag forces of the Geoweb channel lining system. The program calculates downslope and downstream driving and resisting forces, and calculates a resultant factor of safety for each element of the channel cross section. Elements are the components (i.e., invert, slide slopes of flood plains) of a single cross section defined by the user.

Considerable testing has been carried out on various block systems to establish the limiting velocities in relation to block weight and system flexibility. The findings of a number of such tests have been published by the U.S. Department of Commerce[2] and CIRIA[3] together with recommended maximum flow velocities as follows:

1. Blocks the face-to-face contact length less than 75%; Maximum design velocity 6 m/sec (20 ft/sec)
2. Blocks with face-to-face contact length greater than 75%; Maximum design velocity 8 m/sec (26 ft/sec)

A minimum superficial mass of 125 kg/m2 (28 lb/ft^2 is also required.

The selected 100-mm (4-in.) thick concrete-filled Geoweb lining system meets the requirements of the higher limiting velocity, due to its 100% face-to-face contact and a superficial mass of 238 kg/m^2 (49.5 lb/ft^2).

The Geoweb extended up the channel side slopes a distance of 1.2 m (4 ft). It was determined that J pin anchors, 13 mm by 600 mm (0.5-in. by 24-in.) would be required at 812 mm (32 in.) by 488 mm (19.2 in.) centers in conjunction with the three tendons per section to anchor the system. This not only facilitates the placement of the Geoweb, but ensures intimate contact with the ground surface prior to, during the filling process, and during peak flow conditions.

The sequence of construction was to first excavate the channel and place the nonwoven geotextile.

Construction

Installation of the Geoweb system was completed by a three-person crew (one equipment operator and two laborers). The total area protected was 2,839 m^2 (20,560 ft^2), which resulted in a channel length of 582 m (1,910 ft).

The sequence of construction was to first excavate the channel and place the nonwoven geotextile. The nonwoven geotextile was temporarily pinned in place to prevent movement while expanding the Geoweb sections. Tendons were then cut to measured lengths that included the length of the expanded Geoweb sections, with an allowance for knots to be tied at either end. The tendons were inserted through the factory drilled holes in the Geoweb sections. Knots were tied at either end to hold the tendons in place while the Geoweb sections were expanded into position.

The Geoweb sections were then expanded longitudinally down the channel invert. Adjacent sections were then mechanically attached by interweaving the ends of outside cells and stapling with a pneumatic stapler, The expanded Geoweb sections were then anchored into position the J pin earth anchors. Each J pin was hooked over a tendon at the specified spacing and driven flush with the ground surface. Concrete was then placed into the Geoweb using a 0.8 m^3 (1 yd^3) track backhoe and filled level with the top of the cells. The concrete was then given a raked finish.

Conclusion

Empire Sanitary Landfill continues to operate a state-of-the-art landfill in northeastern Pennsylvania. With innovative solutions to problems such as the removal of storm water with the concrete filled Geoweb lined channels, it continues to lead the industry into the 21st century. The Geoweb has handled the storm water during one of the wettest summers on record in the east.

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