“Mining” used to close Rural Landfill

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Public Works, September 1996

Many of the landfills in northern New England were once operated by municipalities using local employees with little or no formal training. As a result, the siting of landfills and dumps often was based solely on convenience, with little thought as to the operating criteria, or impacts to the surrounding environment. This article looks at one such landfill in the small town of Halifax, Vermont, and the use of “landfill mining” to close it.

Halifax is located along the Vermont/Massachusetts border in southern Vermont. The Town Sanitary Landfill is situated south of the town center on property used for sand and gravel operations and is owned by the town. The landfill had been operating in this location since the 1970s before closing in 1992, with final cover installation in 1995.

The Halifax landfill operations were typical of “usual landfill operations” in Vermont. The Halifax Highway Department provided a rubber-tired front-end loader and operator to push the waste into a specified area where it was marginally compacted and then covered with an inordinate amount of sand, or the “daily cover.” The extra thickness of the cover protected the loader’s tires against punctures. However, the sand also filled the landfill to capacity in a shorter time period, and created a landfill berm with very steep slopes.

Daily operations of this site were also typical of landfills in the “hill towns” of Vermont. Many of the small sites developed from older areas where waste was thrown over the edge of a hillside. Over time these sites created facilities with steep side slopes of 1 ft vertical (1:1), making closure a very difficult task. Innovative construction techniques were needed at Halifax, and in this case involved excavation, screening and re-compaction of refuse to bring the side slopes to a maximum slope of 3:1. This process has recently been termed “landfill mining.” Also typical of landfills in rural Vermont is the area of the site, which is less than one acre.

There have been many landfill mining programs in the eastern United States where wastes are excavated, screened, and recyclables removed, and in some cases the combustible fraction sent to a waste-to-energy facility. Other sites are being excavated, screened and re-landfilled on new, lined sites to take advantage of more capacity and recovery of valuable cover soils. However, with this project the engineers decided to utilize excavation, screening, and re-landfilling to establish the proper side slopes required for closure.

The calculation of the volume of material in the landfill to be screened was based on the amount of material that needed to be removed to shape the landfill to the proposed final closure contours. The initial plan for closure of this site was to excavate, screen, and haul excess refuse to a licensed landfill. This was changed when the state regulatory agency indicated state closure funds could not be used for on-site disposal costs. The project was re-bid with the understanding that no refuse would leave the site. Therefore allowances had to be made to accept the amount of refuse remaining after screening. To calculate this, several test pits were excavated to determine what the percentages of soil and refuse were at the site based on visual estimates. Once screening began, the contractor and engineer calculated the mix by counting loads of soil and refuse taken away during operations. After several random counts, it was agreed by both parties there was a 50/50 ration of soil and refuse.

To assist in the closure of the sites, the Vermont Legislature enacted a financial assistance program that calculated state landfill closure grants. Grant amounts are based on a formula using the number of tons received from the time Act 78 was enacted to the date of closure. The formula assumed the site owners would put aside $24 per ton of incoming waste into a closure fund. Estimated closure costs were calculated during closure design and the site was granted the amount of closure costs that exceeded the formula amount multiplied by the number of tons received within the eligible dates.

Act 78 refers to the Vermont regulation governing solid waste collection, processing and disposal enacted in 1988. The act overhauled the then existing regulations to bring the state into compliance with current solid waste management regulations that included, among other things, closure of all unlined landfills in the state.

Closure construction on the Halifax Landfill began in late April 1995. The contractor for the project brought a tracked excavator, wheel loader, small dozer, and a rotary screen to the site. The key piece of equipment for the initial stages of the construction was the rotary screen, a large drum made of circular steel ribs with heavy-gauge screen welded and bolted to the outside of the drum. This assembly sits on a frame, and is tipped to one end. The opposite end is the feed end of the screen and includes a hopper and a feed belt. As material is fed to the rotary screen, the drum spins. This action turns the refuse and cover sand mixture, the sand falling through the screen's 1-in. opening to a second conveyor below. The refuse, less the majority of the sand, is discharged out of the end of the screen.

This equipment is ideal for this application. The contractor used the dozer to strip off the intermediate cover sand from the top of the landfill and push it into stockpiles. The excavator then pulled the slopes back and excavated refuse from within the footprint of the existing landfill. The excavator would sit in a location, often on top of a refuse/cover soil stockpile, and feed the mixture into the hopper of the rotary screen.

Screen Set-up

The set-up of the screen is a critical element to the operation of the unit. At first the contractor set the screen such that the whole unit was tipped toward the discharge end. The theory being that the screen would have an easier time of segregating the sand and refuse, and would complete the operation faster. What were not anticipated were the additional axial loadings that were placed on the roller and guide bearings of the drum unit. Several bearing failures were experienced and at one point the drum shifted forward off of its cradle, and had to be picked by the backhoe, and pushed by the loader back into position. To correct the additional loadings on the screen, the contractor reset the screen to a position closer to the level. This reduced the stresses on the bearings, and operation of the drum resumed without problem.

The engineers and contractor believe that the major problem with this particular screen was its age and the lack of use for over a year. The screen was used previously to successfully screen hundreds of thousands of yards of refuse. The manufacturer of the unit has upgraded and improved the unit over the years to specifically target landfill-screening work.

As with any operation involving grit, sand, dirt, and steel scraps contained in the refuse, lubrication of critical points of the equipment and protection of these points against wear and fatigue, is a common O&M practice. The conveyor that moves the sand from the bottom of the drum to the discharge point at the midsection of the screen unit is exposed to all of the grit and abrasives in the mix. In this case, the abrasive elements of the mix-combined with extended operations at another location prior to this project-caused the main roller of the conveyor to freeze. The contractor removed the entire roller assembly and belt from under the screen and allowed the sand to fall directly into a receiving pit constructed under the screen.

Between the roller and guide bearing failures and the conveyor failure the contractor lost approximately four workdays due to downtime. This was time added onto what was originally expected to be about seven or eight operating days in the landfill to complete the screening portion of the project:

Once the initial issues of operating the screen were conquered, the screening project concluded quickly. About 95,800 cubic yards of material were screened. The 50 percent refuse portion of this material was re-landfilled into the excavated area of the landfill. As the refuse was placed back into the landfill, the waste was re-worked and compacted with a small bulldozer, a Caterpillar D3. Larger dozers could not be used on this site because of the lack of working area.

As excavation continued, the stratification of the original refuse and daily cover “lifts” became evident, and each clearly identifiable. The landfill operator had ready access to the sand cover material during operation of the landfill (since it was located in a sand pit). As mentioned earlier, the liberal use of sand diminished the life of the landfill as it was filled quickly with sand cover rather than with refuse. This fact became evident during excavation as we often noted refuse lifts of two ft, with sand cover in excess of three or four ft in several instances, rather than the six in. required by the regulations.

Once the screened refuse was placed and shaped to final subbase grades, a layer of sand cover soil was placed on top of the waste. The cover soils act as a base for placing the clay final cover and as a landfill gas filter medium to conduct methane to passive gas vents installed in gravel-filled interception vent trenches.

One concern of this project was the possible contaminants that might be found in the screened soils. Based on a literature search of testing performed on the screened cover soils in other similar projects, it was determined there was little likelihood of finding any appreciable contaminants in the soils. Also, the demographics of Halifax suggested the likelihood of a lack of contaminants since the town is very small with no industrial or commercial establishments. Testing of the screened solid revealed no volatile organic compounds or heavy metals. The soils were stockpiled on-site and are being used for fill and roadbase materials within the town.

To cap the re-shaped landfill, the original plans approved for the site-required placement of two ft. of clay with permeability no greater than 1.0 x 10^{-5} centimeters per second (cm/sec) to be placed on the landfill. The clay cap is required to be installed in two, 12-in. lifts, and compacted to a minimum of 90 percent compaction via the modified proctor method.

Due to the amount of moisture in the clay, the initial in-place compaction tests indicated that the clay was not meeting specification for compaction. After reworking and allowing additional drying to take place, the in-place density and in-place compaction tests indicated that the clay had achieved the desired compaction. Laboratory analysis of the clay also indicated that the in-place permeability had exceeded 1.0 x 1^{-5} cm/sec with several of the tests yielding results of 1.0 x 1.0^{-7} cm/sec or less.

The project specifications called for the placement of a minimum of six in. of topsoil over the clay cap. Topsoil is scarce in mountainous Vermont and to accommodate this requirement, the contractor proposed to "manufacture" topsoil for the project using screened sand from the landfill and stabilized biosolids from a nearby wastewater treatment facility. The biosolids were mixed one part biosolids to three parts of screened sand, which had worked successfully at other landfill closure projects. Initially, the mixture had some odor, but after placement the odors quickly dissipated. The topsoil was seeded and mulched after placement and despite a very dry summer, a new growth of vegetation was quickly established.

One interesting note regarding the use of biosolids in this application: Seeds from a variety of fruits and vegetables remain viable after digestion in the human system, and through the treatment process of a wastewater facility and biosolids handling process. Several weeks after the placements of the "topsoil" on the landfill, the project team returned to complete additional monitoring work at the landfill and development of "as-built" drawing. At that time, the engineers for the project noted the establishment of tomato, pepper, and melon plants at the landfill. All of these resulting from the deposition of seeds in the topsoil mix.

Lessons learned through this experience have given both the contractor and the engineer valuable information for future landfill mining projects. One of the foremost issues is the age and mechanical integrity of the screening device. After using an old screen that was not in good shape, both the engineer and the contractor believe the money spent renting a newer screen in good mechanical condition and one that is designed to handle landfill screening will save money and time on the job. Second, test pits need to be dug in various areas of the landfill to determine the soil/refuse mix and the contractor and engineer should develop procedures to adjust the contract if the ratio varies from the original estimate.