A Project of Many Firsts
The South Hadley Landfill Cell 2D Vertical Expansion

2012 SWANA Landfill Reuse Excellence Award Nomination

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Executive Summary

With only a few years of capacity remaining prior to permanent closure, and confined due to lateral expansion constraints in nearly every direction, only an MSE berm-facilitated vertical expansion could economically extend the life of the South Hadley Landfill (SHL), located in South Hadley, Massachusetts. Accordingly, South Hadley Landfill, LLC, a Interstate Waste Services Company, hired ARM Group Inc. (ARM) in 2006 to begin exploring the feasibility of using an MSE berm to support a vertical expansion in a State (i.e., Commonwealth of Massachusetts) that had never permitted an MSE berm for capacity development at a waste containment facility. Over the course of the next 4 years, ARM worked with the Town of South Hadley and various levels at the Massachusetts Department of Environmental Protection (MassDEP) to gain approval for the use of an MSE berm to construct what is referred to as the “Cell 2D Vertical Expansion” (Cell 2D) at the SHL. Among other innovations, Cell 2D involved the use of an MSE berm, underlain by a geosynthetic liner system, founded on municipal solid waste (MSW) and included a patent-pending integrated solar system mounted on the exterior face of an approximately 400-foot segment of the berm.
Section 1: Design and Construction

1.1 Site Location and History

The South Hadley Landfill (SHL) is located in South Hadley, Massachusetts and is owned by the Town of South Hadley. Operated by South Hadley Landfill, LLC, an Interstate Waste Services Company, the SHL is located in an industrial complex and is approximately 3,000 feet from Westover Metropolitan Airport and Air Reserve Base (Westover). The landfill site is in a relatively low-lying area surrounded by wetlands, conservation lands, and industrial businesses. The proximity of the surrounding environmentally sensitive areas and industrial businesses severely limited the ability of the landfill to be laterally expanded. The proximity to Westover limits the height of the facility due to aircraft safety considerations.

The SHL has disposed of municipal and industrial solid wastes since approximately 1951. From 1951 to 1969, the landfill was operated as an open-burning pit where solid wastes disposed on-site were generally left uncovered and periodically burned along with liquid wastes. From 1969 to 1996, SHL was operated as a sanitary landfill. From 1996 to 2003, no landfilling operations occurred at the site, in compliance with an Administrative Consent Order. From 2003 to 2010, several new double-lined landfill cells were constructed, with two of them overlying the existing unlined landfill, and waste disposal resumed at the facility during this period.

With only a few years of capacity remaining prior to permanent closure, and confined due to lateral expansion constraints in nearly every direction as shown on Figure 1, only an MSE berm-facilitated vertical expansion could economically extend the life of the SHL. Accordingly, South Hadley Landfill, LLC hired ARM Group Inc. (ARM), headquartered in Hershey, Pennsylvania, in 2006 to begin exploring the feasibility of using an MSE berm to support a vertical expansion in a State (i.e., Commonwealth of Massachusetts) that had not previously approved an MSE berm for capacity development at a waste containment facility. Over the course of the next 4 years, ARM worked with the Town of South Hadley and the Massachusetts Department of Environmental Protection (MassDEP) to gain approval for the use of an MSE berm to construct what is referred to as the “Cell 2D Vertical Expansion” (Cell 2D) at the SHL.

![Figure 1 - Aerial image of South Hadley Landfill displaying the lateral constraints of the site. The proposed Cell 2D expansion area is highlighted in green.](image-url)
permitting and construction of the Cell 2D MSE berm, numerous challenges were encountered and unique innovations were employed to successfully complete the first MSE berm in Massachusetts for a waste containment application. At the time when construction of the first MSE berm-facilitated vertical expansion (i.e., Cell 2D) commenced in the fall of 2010, the SHL had less than 6 months of capacity remaining.

1.2 Subsurface Conditions

A subsurface investigation was performed by ARM in order to collect information that was crucial to designing a stable MSE berm. An extensive test pitting and test boring investigation program was completed along the proposed alignment of the Cell 2D MSE berm. Proper characterization of the extent and composition of the materials underlying the proposed MSE berm was essential for comprehensive analysis and for optimizing the geometry and geogrid reinforcement requirements for the berm.

The initial subsurface investigation consisted of a total of 26 test borings and 9 test pits along the approximate alignment of the MSE berm. Based on information collected during the initial investigation, a supplemental subsurface investigation was performed and consisted of 6 additional test pits and 4 additional test borings.

The 30 test borings were completed in accordance with American Society for Testing and Materials (ASTM) procedures (i.e., split-spoon sampling and standard penetration testing [SPT]). Four of the test borings were extended to 72 feet below grade, while the remainder of the borings were extended to approximately 32 feet below grade, with the exception of one boring, which encountered auger refusal in the form of construction and demolition (C&D) waste at 22.5 feet below grade.

The test pits were typically excavated to the maximum reach of the excavator or at least 4 feet below the bottom limit of encountered waste. The test pits were generally used to characterize the composition and consistency of the waste and to aid in determining the waste thickness.

Overall, the subsurface conditions were characterized based upon field observations made during the completion of the test pits and test borings, laboratory results from samples collected during the investigation, SPT test results, and historic data. Based on the test boring and test pit data, the subsurface materials along the alignment of the MSE berm were determined to be highly variable. In general, the upper 20 to 30 feet consisted of a mixture of non-native fill and various municipal and industrial waste materials. On average, approximately 5 to 10 feet of non-native miscellaneous fill overlaid an average of approximately 10 to 15 feet of waste. The waste was largely underlain by native material consisting primarily of sandy soils classified as SW or SP-SM according to the United Soil Classification System (USCS).

The non-native fill near the surface was generally characterized as a moist, non-plastic soil with varying density that was classified as a silty sand (SM) or clayey sand (SC); the material contained occasional gravel lenses. The buried waste was heterogeneous both in density and composition. Types of waste encountered during test borings and test pits included: paper; wood; plastic; cloth; cardboard; insulation; wire; concrete; asphalt; brick; glass; metal; and tires. The waste encountered tended to consist of more C&D waste rather than household or general municipal solid waste (MSW). The waste was not observed to have a high organic content, and it produced minimal landfill gas (LFG). The density of the waste varied substantially from “very loose” to “very dense”.

The material underlying the waste was generally native, sandy soil classified as a well-graded sand (SW) or poorly-graded sand/silty sand (SP-SM). This fairly uniform sandy soil layer demonstrated densities ranging from “medium dense” to “very dense”. The soil sequence typically coarsened with depth and some of the test borings displayed some thin gravel lenses. No bedrock was encountered in any of the test borings.

Soil samples were obtained from the soil borings and sent to a soils laboratory for analysis. Samples were taken from each boring location at varying depths. The samples were generally found to be non-plastic and had moisture contents varying from 6% to 26%.

In addition to field observations and laboratory data, historic topographic surveys were utilized to determine waste thickness, waste age, and historical conditions prior to waste placement activities. Geologic mapping was examined to determine the typical subsurface strata for the site (Daukus, 2007).
1.3 Vertical Expansion Design

Due to existing constraints, the only economical way to expand the SHL was through the use of an MSE berm. The resulting Cell 2D MSE berm design was approximately 1,490 linear feet with a maximum height of 46 feet and an average height of approximately 21 feet. Figure 2 provides a rendering of the Cell 2D vertical expansion, which envelops the southern perimeter of the SHL. Since historic waste largely extends to the property line along the southern boundary of the SHL, it was necessary to design the Cell 2D MSE berm to be founded on historic waste that was overlain (capped) by an existing flexible membrane liner (FML) and cover soils.

Figure 2 – GIS Rendering of the Cell 2D Vertical Expansion.

It was economically infeasible and environmentally undesirable to attempt to excavate and relocate all of the existing waste within the footprint of the proposed Cell 2D MSE berm footprint. Due to the sloping nature of the existing waste, it was necessary to excavate and relocate some of the existing waste to achieve a level subgrade for MSE berm construction. All excavated waste was relocated to an on-site, active double-lined landfill cell. Where the existing cap system was removed to enable subgrade construction, a “replacement cap” system was installed to isolate the MSE berm backfill from the existing waste and to minimize leachate generation from an unlined portion of the landfill.

1.3.1 Shear Strength Parameters

MSE berm stability is always a key design consideration at any site proposing to expand vertically using MSE berm technology. Where MSE berm subgrade conditions are highly variable and potentially compressible, stability considerations warrant special emphasis and care.

The accuracy of a slope stability analysis is largely dictated by the material strength parameters that are utilized for the analysis. To produce valid slope stability analyses for the proposed SHL MSE berm, it was necessary to select appropriate and reasonably conservative material strength parameters for all existing subsurface materials and proposed construction materials. Shear strength parameters were identified for a variety of materials, including: existing waste; future waste (to be disposed of behind the berm); native soil; non-native fill; structural fill; existing geosynthetics; and proposed geosynthetics.

Shear strength parameters were assigned to each material based on a variety of considerations, including: field investigation data; laboratory test results; historical data; published scientific research; and engineering judgment. Laboratory test results were largely utilized to quantify the interface shear strength properties of the proposed geosynthetic interfaces. Historical data (i.e., the design and testing of prior geosynthetic systems at SHL) was employed to assign shear strength parameters to existing geosynthetic systems.

Geosynthetic reinforcement (i.e., geogrid) was assigned strength parameters based on the manufacturer’s specifications, which were adjusted for site and embedment conditions, and confirmed with conformance testing prior to construction. A variety of geogrid strengths were used within the reinforced portion of the MSE berm in order to provide an adequate factor of safety (FS).

The shear strength characteristics of the earthen and waste materials were selected based on SPT values, laboratory test results, test pit and test boring log data, and engineering judgment. Strength properties for the proposed MSE berm backfill sources were based on triaxial and direct shear strength test results. The non-native fill and native soils were assigned shear strength parameters based largely on corrected N-values from the SPT results. The field N-values were corrected to account for the following: 1) overburden pressure; 2) hammer weight; 3) rod length; 4) sampler type; and 5) borehole diameter, in accordance with Bowles, 1996. The selected
effective stress friction angle was based, in part, on a correlation to N-values from each soil stratum guided by the Shioi and Fukui (1982) relationship (Bowles, 1996).

With respect to the existing waste underlying the proposed Cell 2D MSE berm, an effective stress friction angle of 33 degrees and a cohesion (c) of 0 pounds per square foot (psf) were selected and deemed to be sufficiently conservative, and consistent with standard engineering practices. Employing extensive experience with the strength properties of MSW relative to landfill design and construction, and following exhaustive research and dozens of stability analyses using MSW shear strength values/combinations based on recommendations from a host of prominent authors and researchers, the chosen MSW shear strength parameters were well-supported, appropriately conservative, and the proposed MSE berm, as represented by the four critical design stability sections, was demonstrated to be stable under both seismic and static conditions by achieving FS’s of at least 1.1 and 1.5, respectively.

1.3.2 MSE Berm Stability

Cross-sections were developed approximately every 50 feet along the alignment of the MSE berm. The cross-sections were generated using the data collected during the subsurface investigation. The proposed Cell 2D grading was incorporated into the cross-sections to show the interaction between existing and proposed conditions. A sample of one of the cross-sections is shown below as Figure 3.

![Figure 3 - Geotechnical cross-section developed from the subsurface investigation.](image)

All cross-sections were analyzed to determine those that exhibited potentially critical conditions relative to global stability. When determining which cross-sections presented the critical conditions, several criteria were considered, including: MSE berm toe slope steepness and length; height of the MSE berm; loading on the MSE berm (i.e., retained waste); and subsurface conditions.

The global stability of the MSE berm was analyzed under several conditions for each critical section. The geometry and the material properties of each of the critical cross-sections were analyzed with the assistance of the computer program, SLIDE, to compute the factor of safety for each type of analysis. In total, four types of analyses were performed on each of the critical cross-sections. Circular failure surfaces were analyzed for both static and seismic conditions. Similarly, translational, or block failure surfaces were also evaluated for both static and seismic conditions.

Global stability was also examined in accordance with guidance by Zekkos, et. al. (2010), which recommended that a confining stress-based variable MSW shear strength be applied to address potential concerns about the effect of increased confining stresses upon MSW shear strength at depth. In employing the Zekkos methodology, ARM demonstrated that all static factors of safety were above 1.50 and all seismic factors of safety were above 1.10.

1.3.3 Differential Settlement

Due to the varying waste composition and thicknesses below the MSE berm, differential settlement of the MSE berm was a concern and, therefore, addressed during the design of Cell 2D. Although MSE berms can accommodate relatively large amounts of differential settlement, excessive differential settlement, particularly longitudinal differential settlement or abrupt transverse differential settlement, can jeopardize the integrity and stability of an MSE berm. Accordingly, an extensive settlement analysis was performed to determine the anticipated magnitude of settlement at different points throughout the vertical expansion footprint. The settlement calculations generally followed the procedures outlined by Qian (2002).

ARM’s comprehensive settlement analysis indicated that from approximately Section 2 to 19, the MSE berm was predicted to settle fairly uniformly in a rotational fashion from front to back, with the toe of the MSE berm settling less than the heel. Figure 4 compares and schematically illustrates the predicted pre- and post-settlement...
configuration of the MSE berm in cross-section. The type of settlement illustrated in Figure 4 provides an inherently more stable MSE berm configuration and does not adversely affect the soil-geogrid interaction due to the gradual, uniform (i.e., the MSE berm will settle as a single mass), and rotational nature of the predicted settlement. Only very minimal longitudinal differential settlement was predicted along this segment of the MSE berm, and this could be accommodated by the pliability inherent in the MSE berm design.

**Figure 4** - Cross-section comparing the pre- and post-settlement grades of the MSE berm.

Although differential settlement was not a concern to ARM within this segment of the berm based on its analyses and understanding of the existing and proposed conditions, ARM designed proactive measures to minimize the potential for differential settlement. One of these measures involved subgrade over-excavation and replacement with compacted structural fill. In addition to excavating to the proposed MSE berm subgrade elevations, ARM’s design prescribed over-excavating a minimum of 2 feet below the MSE berm subgrade elevations along the entire length of the Cell 2D MSE berm. Once over-excavation grades were achieved, ARM directed the contractor to “proof-roll” the over-excavated subgrade with a loaded tri-axle dump truck to identify any particularly soft zones within the subgrade. Soft zones that were identified received further over-excavation and replacement with compacted structural fill to minimize the potential for differential settlement. Following the “proof-rolling,” a minimum of 24 inches of compacted coarse aggregate was placed across the entire footprint of the proposed MSE berm. This compacted aggregate provided a stiffening layer beneath the berm that further reduces the potential for detrimental differential settlement and serves to attenuate the magnitude of differential settlements that would otherwise be realized.

**Figure 5** - Contractor installing the geosynthetic reinforcement within the subbase aggregate.

ARM’s settlement analysis indicated that the greatest potential for differential settlement, especially longitudinal differential settlement, was within an area approximately bracketed by Sections 19 to 24. To mitigate the potential for problematic longitudinal differential settlement within this segment of the MSE berm, ARM designed a subgrade reinforcement system consisting of a high strength biaxial geogrid located within the 24-inch thick subgrade aggregate layer, as shown below in Figure 5. Based on post-construction settlement monitoring, this subgrade stiffening technique has been successful in minimizing longitudinal differential settlement with the Cell 2D MSE berm.

Total and differential settlements were also a concern with respect to stormwater and leachate conveyance features. It was necessary for ARM to ensure that both the stormwater channels on top of the MSE berm and leachate collection pipes within the Cell 2D lined area would function satisfactorily under post-settlement conditions. Pre- and post-settlement profiles were created for each of these settlement-sensitive features to ensure that positive drainage would be present in the future. In some cases, grading modifications were necessary to ensure that a regulatory compliant post-settlement slope would exist for suitable leachate and stormwater conveyance.

Monitoring the settlement of the structure during and following construction was imperative to ensure that berm displacements were within acceptable limits and within the ranges predicted during the design. Settlement was
monitored using settlement plates with vertical rods extending up through the MSE berm. Twelve settlement plates were installed during each stage of construction for a total of 24. Settlement plates were located along the top edge of the MSE berm and along the MSE berm stormwater channel to help determine differential settlement from the front of the berm to the back of the berm (i.e., transverse differential) and to keep them out of the footprint of the access road. As of December 2011, the total settlement under the MSE berm continued to be relatively small (i.e., less than 2 feet) and differential settlements were well within the tolerable range for an MSE berm, and less than predicted during the design, as the settlement parameters (e.g., compression indices) used for analyses were conservative. Figure 6 compares the design elevations at the top of the MSE berm with the observed elevations after settlement based on readings collected from the settlement plates.

**MSE Berm Elevations with Settlement (12/13/11)**

![MSE Berm Elevations with Settlement](image)

**Figure 6** - A comparison of design elevations and post-settlement elevations.

### 1.3.4 Replacement Capping Systems

The existing landfill capping system and portions of the existing waste were removed to prepare the subgrade for MSE berm construction. However, in order to separate the existing waste from the MSE berm geogrid and backfill, a “replacement cap” system was designed and installed, as shown in Figure 7. The replacement cap extended from the toe of the MSE berm to the anchor trench of the contiguous existing lined landfill cell. This cap system consisted of a textured 40-mil high density polyethylene (HDPE) geomembrane sandwiched between 16-ounce per square yard (oz/sy) nonwoven geotextile.

Where waste within the existing lined portion of the landfill would be beneath the MSE berm, a separate cap system was designed and installed. As shown on Figure 8, this cap system, referred to as the “MSE berm cap”, extended from the existing cell anchor trench to the interior limits of the MSE berm fill. The MSE berm cap consisted of 16-oz/sy nonwoven geotextile overlain by a textured 60?-mil HDPE geomembrane overlain by a geocomposite. The geocomposite drainage layer within the MSE berm cap discharges to the aggregate drainage layer overlying the replacement cap.
Based on the predicted settlement pattern beneath the MSE berm, it was apparent that water could potentially impound on top of the replacement cap if no discharge mechanism were to be employed. To prevent the impoundment of water on top of the replacement cap, the MSE berm subgrade was graded such that the surface of the replacement cap would be sloped longitudinally to direct infiltrated stormwater to discrete sump locations. Since the longitudinal drainage pattern had to exist during post-settlement conditions, a relatively complex grading program was employed to ensure that the deflected shape of the stepped MSE berm subgrade would perpetually convey infiltrated stormwater to the sump locations.

At the discrete sump locations, a perforated pipe was installed, which conveyed the accumulated stormwater through a penetration in the replacement cap and then into a custom-designed infiltration trench beyond the toe of the MSE berm. Taking advantage of the native sandy soils at the site, a relatively large volume of water could be infiltrated from a relatively small infiltration trench. Following the completion of Cell 2D construction, stormwater infiltration to the replacement cap sumps was expected to be minimal due to the large amount of impervious surface on top of the MSE berm (i.e., paved roadway and new liner system). Pressure release vents were connected to the infiltration trenches to relieve any excess pore water pressures that could accumulate beneath the MSE berm and to provide a mechanism for assessing the performance of the infiltration trench by allowing for the measurement of the water level within a given trench.

### 1.3.5 Solar Integrated MSE Berm

A unique feature of the MSE berm at the SHL is the photovoltaic (PV) system on the exterior face of an approximately 400-foot segment of the berm. The integrated PV system was custom-designed by ARM with patent-pending technology and was the first PV system designed for installation on the face of an MSE berm. The system consists of 364 rigid panels with a rated capacity of approximately 86 kilowatts (kW). The estimated annual electrical output of the system is approximately 100,000 kWh.

The facing of the MSE berm behind the PV panels was modified to accommodate the solar installation. Typically, the MSE berm facing consists of vegetation; however, sunlight would not reach the facing of the MSE berm behind the solar panels. Therefore, vegetation had to be replaced with a rock facing. Additionally, a dual layer of biaxial geogrid and a sacrificial geotextile were installed at the face of the PV-covered MSE berm to provide additional ultraviolet (UV) radiation resistance for the UV-stabilized geosynthetics.
The horizontal support anchors for the PV system were installed within the MSE berm during construction of the berm with the use of a custom form designed by the contractor in order to meet the installation tolerances. The system is fully cantilevered to allow it to accommodate the predicted total and differential settlement of the MSE berm. Figure 9 is a cross-section displaying a schematic of the solar panel anchor system. Figure 10 displays the installation of the embedded horizontal solar panel anchors.

The value of the electricity produced by the PV system will be donated to the Town of South Hadley’s Department of Public Works (DPW).

1.4 Overall Planning

The overall planning of the Cell 2D expansion was critical to the success of the project and the landfill. Because the facility is spatially constrained, the only option for an economically viable expansion involved the use of an MSE berm. The use of an MSE berm allowed the landfill to maximize airspace while avoiding impacts to surrounding wetlands and minimizing the overall disturbance footprint. However, in order to permit an MSE berm for a waste containment application in a State that had never allowed such a use, numerous original design elements and planning documents had to be developed and publicly accepted. Some examples of original planning documents that were prepared specifically for this project include the following:

- MSE berm Remedial Contingency Plan
- Comprehensive Cold Weather Construction Plan
- MSE Berm Maintenance and Inspection Plan

Additionally, with the goal of integrating sustainability into the expansion design, solar panels were placed on a portion of the exterior face of the MSE berm. To ARM’s knowledge, solar panels had never previously been fastened to the face of an MSE berm at a landfill site or elsewhere. The use of solar panels provided an economic benefit to the local community while enhancing the environmental attributes of the overall project.
Section 2: Environmental Controls

2.1 Groundwater

Due to historic waste disposal practices at the SHL, groundwater contamination is a legacy issue at the site. Because the historic waste was disposed of with no liner beneath the waste, chemicals in the waste infiltrated into the groundwater. With the most recent expansion at the SHL (i.e., 2003- to present) several double lined cells as well as a capping system were constructed over the existing waste as a way to limit water from infiltrating into the historic waste mass thereby decreasing the production of leachate and attenuating groundwater contamination.

In addition to several double lined cells being constructed over the historic landfill, the SHL also has a groundwater treatment system. The groundwater treatment system consists of several down gradient recovery wells that extract groundwater and transport it to the on-site pretreatment facility. The contaminated groundwater receives advanced oxidation treatment and then is discharged to the sanitary sewer system.

As part of the Cell 2D expansion at the SHL, new cap systems were installed beneath the MSE berm to prevent water from infiltrating into the historic waste. Additionally, 1.6 acres of a double composite liner system were installed over existing waste.

2.2 Leachate Monitoring

The Cell 2D expansion at the SHL did not require the construction of any new leachate sumps. Instead, all leachate was diverted into existing cells, where it is directed to existing leachate collection sumps. At each sump location, there are safeguards in place that monitor the leachate level within the sump to prevent large amounts of head from accumulating on the liner system. When leachate is removed from the discrete sump locations, it is transported to the local sewer authority where it is treated. In addition to monitoring the leachate levels on top of the liner system, leachate samples are collected quarterly and analyzed to determine the composition.

2.3 Landfill Gas Control

Prior to construction, several landfill gas (LFG) control devices existed within the footprint of the Cell 2D expansion. These devices, which included a LFG header, condensate knockout, and existing gas vents, had to be retrofitted or relocated to accommodate the Cell 2D MSE berm. After Cell 2D has reached final grade, additional landfill gas wells will be installed within the new waste mass. These gas wells will be connected to the existing gas collection system. All LFG is transported to an on-site flare where it is ignited to reduce methane emissions. Future plans at the SHL include installing a LFG to energy plant.

2.4 Overall Impact

The Cell 2D expansion at the SHL provides a net positive overall impact on human health, environmental quality, and resource conservation. In addition to a share of the tipping fees, which reduce the overall tax burden to Town residents, the new geomembranes associated with the Cell 2D project provide added protection from groundwater contamination by minimizing surface water infiltration into the historic waste. The combination of additional lined areas coupled with the continued operation of a groundwater pump and treat system have resulted in improvements to the localized groundwater quality.

Figure 12 - Protection of wetlands surrounding the site both during and after construction were of paramount importance.
Furthermore, because the Cell 2D expansion only minimally increased the lateral footprint of the SHL, environmental resources (e.g., surrounding wetlands) were conserved. Additional capacity was provided while the disturbance footprint was minimized, which vastly improves overall environmental quality when compared to other expansion options. Not only was space conserved due to the construction of a MSE berm, several thousand cubic yards of soil were also conserved. The soil conservation is due to the fact that the MSE berm has a steeper face slope (i.e., 0.5H:1V) than an unreinforced berm (i.e., 2H:1V or greater).

2.5 Compatibility with Environment

The Cell 2D expansion at the SHL was designed to be compatible with both the environment and the surrounding community. The SHL is compatible with the environment in the sense that it provides the local community a safe place to dispose of waste while preventing groundwater and surface water pollution. In addition to being a safe place to dispose of waste, the SHL along with the Town, also provide both a recycling center and a composting area for town residents. Furthermore, the SHL is compatible with the nearby Westover Metropolitan Airport and Air Reserve Base by limiting the height of the landfill to not disrupt any air traffic.

Figure 13 – Cell 2D MSE berm with exposed solar anchors.

Section 3: Implementation of Sustainability

3.1 Sustainable Design

Incorporating sustainability into the design of the Cell 2D expansion at the SHL was essential for the success of the project. Because the design of the expansion increased the capacity of the SHL while minimizing lateral expansion, resources were conserved. In addition to protecting the surrounding wetlands from disturbance, several thousand cubic yards of soil were conserved due to the construction of an MSE berm instead of an unreinforced earthen berm. Because the soil was obtained from an off-site source, the emissions caused by transporting the soil to the site were also greatly decreased due to the smaller volume required to construct an MSE berm.

Another aspect of the Cell 2D expansion that focuses on sustainability is the implementation of the solar panel array on the face of the MSE berm. Solar panels had never been placed on the face of a MSE berm before, so a unique, patent-pending, system was designed by ARM to make this application feasible. The value of the electricity from the solar installation is returned to the local community by offsetting electrical costs at the adjacent DPW facility.

3.2 Financially Sustainable Reuse of SHL/Generation of Revenue

The Cell 2D expansion at SHL is financially sustainable. The expansion allowed for the landfilling operations to continue, whereas if the expansion would not have been constructed, the landfill would have reached its maximum capacity and have been forced to close. By extending the life of the facility, the Cell 2D expansion has provided funding to support the local recycle center and compost facility and provided substantial funding in the form of tipping fees that are used by the Town to pay for a host of community services. By maximizing the capacity of the facility, the SHL is extending the life of the facility and the economic benefits that it provides to the local community.
In addition to generating revenue through waste disposal, the value of the electricity from the solar installation is returned to the local community by offsetting electrical costs at the adjacent DPW facility. Overall, the revenue generated by the additional disposal capacity and the solar array has made the Cell 2D expansion a financially sustainable reuse of SHL.

Aside from the revenue generating disposal capacity and solar energy revenues, South Hadley Landfill, LLC is required to escrow a portion of the tipping fees to sustain a financial assurance mechanism (FAM) to provide funding for the long-term operation and maintenance of the facility during the post-closure period.

Section 4: Public Acceptance, Appearance and Aesthetics

4.1 Site Aesthetics

As depicted in Figure 14, the Cell 2D expansion provides the SHL with a “clean and green” look. The face of the MSE berm is vegetated, except for where the solar panels are installed. The steep, vegetated face of the MSE berm provides an appealing visual barrier between the active disposal area and the surrounding community.

Figure 14 – The aesthetically pleasing vegetated facing of the MSE berm is shown in the foreground.

4.2 Public Relations

Public acceptance and public relations were vital to both the design and the permitting process for the Cell 2D expansion at the SHL. Because the landfill is owned by the town of South Hadley, town officials were involved throughout the design and permitting process. As part of the local permitting process, the project required approval of elected local officials. Accordingly, following multiple presentations by the SHL and the Engineer, the Cell 2D expansion was unanimously approved by the Town Selectboard. The Town Selectboard is a group of elected officials who represent the public’s opinion and act in the public’s best interest.

Figure 15 – The prismatic blue hue of the solar panels gives the landfill an attractive and modern appearance.

The town receives a percentage of the tipping fee associated with the disposal of waste and the SHL provides other services to town residents that are widely used. The Town of South Hadley operates a recycling center and a composting area for town residents in conjunction with SHL as shown on Figure 16. Both areas, which are open two days per week, offer residents alternatives to placing waste in the landfill. Many residents take advantage of these services as these areas are highly trafficked on their days of business.

In 2011, South Hadley, Massachusetts experienced three extreme weather events: a tornado; a flood; and an...
October snow storm. Each of these extreme weather events caused significant damage to various features and facilities within the community. As a result, there was a significant amount of debris that required disposal. The SHL played a pivotal role in the clean-up efforts as much of the debris was disposed of in the newly constructed Cell 2D and within the compost area. Due to increased demands as a result of the clean-up efforts, MassDEP granted SHL a temporary increase in the maximum daily tonnage that could be accepted at the landfill. The increase in maximum daily tonnage allowed the SHL to further assist the community with the disposal of damaged materials (e.g., household goods, infrastructure), while the compost area provided an area for natural debris (e.g., downed tree limbs) to be relocated.

Section 5: Innovation and Creativity

5.1 Unique, Innovative Aspects of the Cell 2D Expansion

The Cell 2D expansion at the SHL involved many “firsts” within the Commonwealth of Massachusetts and within the industry. Prior to the Cell 2D expansion at the SHL, MassDEP had never permitted the construction of an MSE berm for a waste containment application. The permitting process involved with this project was unique, as there was no precedent or regulatory guidelines or policies that governed the use of an MSE berm for a landfill. Ultimately, with policies developed through the collective efforts of the MassDEP, SHL, and its Engineer, the Cell 2D expansion has facilitated the use of MSE technology to enable the efficient use of land and earthen resources for landfill expansions elsewhere in Massachusetts.

Aside from its “newness” in Massachusetts, to the authors’ knowledge, the Cell 2D MSE berm was the first MSE berm to be built on top of existing municipal solid waste. Due to the limited space at the site, the only option for expansion was with the use of a MSE berm above existing waste. In order to successfully design and construct the Cell 2D MSE berm, innovative solutions and complex analyses were required to address issues that had not previously been encountered in landfill design. Among these solutions that were previously described include the replacement cap drainage system and the extensive settlement monitoring plan.

Figure 16 - The aerial image shows the location of the on-site recycling center and compost area.

Figure 17 - Settlement plates were installed within the berm as an innovative way to monitor the movement of the MSE berm.
Another unique and innovative aspect of the Cell 2D expansion that had never been accomplished before was the installation of a solar panel array on the face of the MSE berm. The installation of the solar panel array on the face of the MSE berm required a unique (patent pending) design that enables an additional revenue stream to the town of South Hadley.

Due to the need for capacity facilitated by the Cell 2D expansion, the construction of the project had to occur under a compressed schedule, during unfavorable months of the year (northeast U.S.). The SHL received the MassDEP permit approval in October of 2010. At that point, the SHL had less than 6 months of capacity remaining. Therefore, it was necessary to begin construction as soon as the permit approval was received. As a result, the Cell 2D MSE berm was constructed in two stages. The first stage was constructed from October to December of 2010. The second stage was constructed from April to July of 2011. Because of the timing of the first stage of construction, ARM was required to create a cold-weather construction plan due to the expected subfreezing temperatures in Massachusetts during October through December. With the cold-weather construction plan, the construction was able to proceed, enabling timely completion and continued operation of the SHL due to the increase in capacity.

Overall, the Cell 2D expansion at SHL was a successful project that incorporated multiple sustainability concepts and innovations while navigating through policies and permitting procedures that evolved through the course of the project to ensure environmental protection and financial responsibility. The project included many firsts that are likely to contribute to the continually evolving waste management industry.
Solar • Continued from Page 1

landfill. "It's certainly a unique design. We're excited about it."

Planning Board Member Mark Cavanaugh asked of any noise associated with the solar panels. It was explained the panels have an inverter with a fan creating noise a little louder than a residential refrigerator.

Energy produced by the panels will cover 50 percent of the landfill's current on-site demand. When asked by a Planning Board member why Interstate Waste Services (IWS) managers of the landfill, were not aiming for 100 percent, Wheeler said, "Cost, mainly," adding the panels are expensive to fabricate and install, as they're much more intricate than typical rooftop solar panels. After the landfill is capped, however, its energy expenditure would obviously decrease, allowing the town to harness some of that previously used power.

Absorbing much energy at the moment is the treatment of contaminated groundwater running beneath the site. The landfill sits atop old waste placed in the ground ages ago and an ancient system treats the contaminated groundwater, directing it to a sewage plant. IWS oversees the treatment of this water, despite it having existed prior to their ownership. "Once it's removed, it's removed," said Tom Fields, director of landfill operations, of the contamination. He projects over time, the contamination will cease, thanks to the treatment, and the town - which will resume care of the treatment and ownership of the solar panels when the landfill is capped within the next five to eight years - will no longer need to expend power in that area.

Installation of the panels will take between three to four weeks on-site. IWS and ARM hope to do the necessary groundwork before the next frost. Further installation will resume in the spring. "We try to avoid doing this work in the heart of winter," said Wheeler. A March installation is scheduled.

It was expected the solar panel installation would be completed this fall, however due to project delays, IWS and ARM requested from the Department of Environmental Protection an extension. One was granted until April 15.

South Hadley Electric Light (SHEL) will coordinate with IWS and ARM for the installation of a transformer to transfer energy from the panels.

"It's a no-brainer," said Planning Board Associate Member Jeremy King. "Let's do it."

Unanimously, the Planning Board voted to approve a special permit to alter/expand a pre-existing nonconforming use (the landfill) for installation of solar panels.

South Hadley goes solar

Town's landfill first in state to install solar panels

By Kristin Will

Staff Writer, kwill@turley.com

SOUTH HADLEY - South Hadley's landfill will be the first in the state to affix solar panels to its sides.

Approved last Monday by the Planning Board, a total of 372 solar panels will be installed on the south-facing side of Cell 2D. Their total length extends 200 feet and the panels, comprised of rigid crystalline, will be stacked nine high.

Cell 2D wraps around the southern perimeter of the landfill. It can contain 230,000 cubic yards of waste. The cell does not surpass 405 in elevation.

Each solar panel generates 230 kilowatts per year. In total, the collection of panels will generate 100,000 kilowatts per year. The panels are a fixed orientation, anchored to four-inch-thick steel stabilizers embedded within Mechanically Stabilized Earthen (MSE) Berms. They are expected to last at least 25 years.
2012 LANDFILL RE-USE EXCELLENCE AWARD
CHECKLIST AND RELEASE

2012 Applications must be submitted to SWANA no later than Friday, April 13, 2012

*** PLEASE NOTE THAT ENTRY REQUIREMENTS HAVE CHANGED ***

Application Checklist (Please make sure the following items are included in your submittal packet)

- Completed release statement (this page), to be scanned and included in digital submission
- Check (made payable to SWANA) or credit card payment for nomination fee (in U.S. dollars) via Excellence Award Nominations
- At least 2 pictures of your operation (may be included in nomination text)
- One copy of your award submittal uploaded using your purchased 2012 SWANA Excellence Awards Application Uploading Instructions
- If you would like to mail your submission, please contact Jesse Maxwell, Program Coordinator, at jmaxwell@swana.org or (240) 494-2237.

Release Statement:  I certify that the information provided in this application is accurate and correct to the best of my knowledge. SWANA reserves the right to publish the enclosed information. Nominations become the property of SWANA. My signature gives SWANA the right to reprint or make available for purchase any portion of this submittal.

Signature: [Signature] Date: 4/12/12