Mixed Waste Landfill Cell Construction at Energy*Solutions* LLC: A Regulator's Perspective

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ABSTRACT
A small percentage of the property that Energy*Solutions*' (formerly Envirocare) operates at Clive, Utah is permitted by the State of Utah as a treatment, storage and disposal facility for mixed waste. Mixed Waste is defined as a hazardous waste (Title 40 Code of Federal Regulations Part 261.3) that also has a radioactive component. Typically, the waste Energy*Solutions* receives at its mixed waste facility is contaminated with heavy metals and organic compounds while also contaminated with radioactivity. For Energy*Solutions*, the largest generator of mixed waste is the United States Department of Energy. However, Energy*Solutions* also accepts a wide variety of mixed waste from other generators. For many wastes, Energy*Solutions* goes through the process of characterization and acceptance (if appropriate) of the waste, treating the waste (if necessary), confirmation that the waste meets Land Disposal Restriction, and disposal of the waste in its mixed waste landfill cell (MWLC).

Energy*Solutions* originally received its State-issued Part B (RCRA) permit in 1990. The Permit allows a mixed waste landfill cell footprint that covers roughly 10 hectares and includes 20 individual "sumps." Energy*Solutions* chose to build small segments of the landfill cell as waste receipts dictated. Nearly 16 years later, Energy*Solutions* has just completed its Phase V construction project. 18 of the 20 sumps in the original design have been constructed. The last two sumps are anticipated to be its Phase VI construction project. Further expansion of its mixed waste disposal landfill capacity beyond the current design would require a permit modification request and approval by the Executive Secretary of the Utah Solid and Hazardous Waste Control Board.

Construction of the landfill cell is governed by the Construction Quality Assurance/Quality Control manual of its State-issued Permit. The construction of each sump is made up of (from the bottom up): a foundation; three feet of engineered clay; primary and secondary geosynthetics (60 mil HDPE, geo-fabric and geotextile); a two foot soil protective cover; tertiary geosynthetics (80 mil HDPE, geofabric and geotextile); and a final two foot soil protective cover.

The Utah Department of Environmental Quality Division of Solid and Hazardous Waste (UDEQ/DSHW) oversees the construction process and reviews the documentation after the construction is complete. If all aspects of the construction process are met, the Executive Secretary of the Utah Solid and Hazardous Waste Control Board approves the landfill cell for disposal. It is the role of the regulator to ensure to the stakeholders that the landfill cell has been constructed in accordance with the State-issued permit and that

the cell is protective of human health and the environment. A final determination may require conflict resolution between the agency and the facility.

INTRODUCTION

Energy*Solutions* is permitted and licensed by the State of Utah as a treatment, storage and disposal facility for certain radioactive and mixed wastes. The facility was originally licensed by the Utah Division of Radiation Control (UDEQ/DRC) for receipt of radioactive waste in 1988 and received a State-issued Part B Permit from the UDEQ/DSHW to receive mixed waste in 1990.

Within its MWLC, Energy*Solutions* is permitted to construct 20 sumps. Each sump is designed to capture leachate from the landfill into a sump leachate removal point. The nomenclature for the sumps has been established such that leachate draining to an eastern sump is considered the "A" sump and leachate draining to a western sump is considered the "B" sump. Consequently, the sumps are labeled 1-10 with an "A" and a "B" designation. Since 1990, Energy*Solutions* has constructed 18 of the 20 sumps in five construction projects as follows: Phase IA (sumps 1A and 2A) – 1992; Phase IB (sumps 1B and 2B) – 1996; Phase II (sumps 3A-6A) - 1999; Phase III (sumps 3B-6B) - 2001; Phase IV (Sumps 7 and 8, both A and B) – 2004; Phase V (sump 9, A and B) – constructed and being reviewed.

During the construction process, the UDEQ/DSHW oversees the project for compliance with the Permit. Once the construction process is complete, a detailed set of reports is submitted to the UDEQ/DSHW for review. Energy*Solutions* cannot dispose of waste in the constructed sumps until the construction process is approved.

Many times during construction and many times during review of the construction documentation, conflict resolution is necessary between the facility and the regulatory agency.

CONSTRUCTION PROCESS

The MWLC is constructed in accordance with the requirements of a hazardous waste landfill cell (40 CFR 264 Subpart N – Landfills). The requirements are as follows:

1. Three feet of engineered clay with a hydraulic conductivity of no more than $1X10^{-7}$ cm/sec;
2. two layers of Flexible membrane liner;
3. a leachate removal system immediately above the top (primary) liner;
4. a leachate removal and leak detection system below the top (primary) liner, but above the lower (secondary) Flexible membrane liner liner system. The leak detection system must include a slope of one percent or more, natural or geonet drainage, constructed of material chemically resistant to the waste managed in the landfill cell, constructed with sumps and appropriate removal methods that

provide a method for measuring and recording the volume of liquids present in the sump and of liquids removed.

Energy*Solutions* decided to build its landfill cell with an extra layer of geosynthetic protection. Consequently, requirements for installation of the third (tertiary) layer of geosynthetics are included in its Permit.

Construction of the MWLC sumps is done in accordance with the Construction Quality Assurance/Quality Control Plan (CQA/QC) within Energy*Solutions*' State-issued Part B Permit (Permit). The CQA/QC defines acceptable standards for each construction element and typically requires following ASTM Methods for testing protocols. A summary of the work elements is as follows:

- Test pad construction
- Foundation
- Clay liner construction
- Secondary geosynthetics
- Primary geosynthetics
- Soil protective cover
- Tertiary geosynthetics
- Soil protective cover

The Permit defines all aspects of Energy*Solutions*' mixed waste management including landfill cell construction. Although some of the conditions in the Permit that apply to landfill construction may be considered tedious and unnecessary by the facility, the process has proved to result in satisfactory sump construction. The regulatory agency is always open to permit modifications that might improve the quality of the landfill cell. However, the modification process is time consuming and facilities typically have time constraints. Any modification of the CQA/QC requires a Class 2 Permit Modification Request. The requirements for a Class 2 Modification Request include a 60 day public comment period and a Public Meeting held by the facility within the 60 day period. After the required 60 days, additional time may be needed for the regulatory agency to further evaluate the request. If comments are received, the regulatory body must consider the comments and provide a written response. Consequently, in addition to the time consuming process and the nature of the public input, the modification may not be approved. The result is that facilities usually choose to leave the Permit unmodified. However, the facilities may also consider some of the conditions within the Permit unnecessarily stringent.

Materials of Construction

Clay is the primary material of construction between the foundation and the geosynthetic liner system. Stockpiles of clay are processed with a deflocculant added to aid in the hydraulic conductivity requirement. The clay requirements are as follows:

- CL, ML or CL-ML solids based on the Unified Soil Classification
- Plasticity index between 10 and 25
- A liquid limit between 30 and 50
- Dry clod size less than 1"

Laboratory and standard proctor tests are performed in an offsite laboratory. The independent laboratory helps to minimize conflicts between the facility and the regulatory agency.

Test Pad Construction

A test pad is required to prove that a satisfactory construction method has been developed. Energy*Solutions'* Permit requires that before actual landfill construction can begin, a test pad must be successfully constructed in three lifts. The first lift can be no greater than 12" and the next two can be no greater than 9" before compaction. After compaction, each lift must be tested in three spots for hydraulic conductivity, in nine spots for moisture and compaction, and one sample is sent to a laboratory to conduct hydraulic conductivity tests as well. The moisture requirement is that the clay must contain water at a level of optimum to five percent above optimum. The compacted clay must be greater than 95% of a standard proctor. The Permit requires that the process and equipment used to construct the test pad must be identical to the process and equipment used for landfill construction.

Conflict generally arises if tests fail or if a regulator, overseeing the process, questions a test procedure. If a test fails, the facility can start over or add more passes to further compact the clay. However, both scenarios are time consuming and don't necessarily guarantee success. Extra passes by a compactor on the test pad also means extra passes in the actual landfill cell during construction. During conflict or when tests fail, the regulatory agency considers the alternatives posed by the facility and then discusses with the facility which alternatives are acceptable based on the Conditions in the Permit. Sometimes, the facility and the regulatory agency have a different interpretation of the Permit language, which can make conflict resolution more difficult. Unfortunately, the easy answer is to start a new test pad. However, starting over is costly, time consuming and frustrating. Consequently, conflict resolution with regard to Permit interpretation or test results becomes an option.

Foundation

The landfill must have an adequate foundation to support the clay liner, the geosynthetics, the waste and the landfill cap. Otherwise, settlement may occur and various failures can take place e.g. geosynthetic tears, cap fails, etc.

The foundation is required to be compacted to 95% of a standard proctor, to have elevations at key control points less than or equal to the design engineer's elevations, and to be free of "soft spots." Conflict generally arises from the subjectivity of how big of a soft spot and how deep a soft spot (usually in the form of sandy material) can be. Typically, the facility will argue that if the lot tested (10,000 ft^2) passes the compaction requirement, the foundation is ready for clay liner placement. The regulatory agency will argue that sand lenses (soft spots) are detrimental at any size and do not meet the requirements of the Permit. Conflict resolution is required to find a solution that protects the environment and the stakeholder, but doesn't put an unnecessary financial burden or time constraint on the facility. The resolution can be to remove the sand lense and replace it with compacted clay or to demonstrate why the area meets the conditions of the Permit with respect to soft spots.

Clay Liner Placement

Once a test pad has been successfully built, clay material has been stockpiled and tested, and a foundation has been adequately prepared, clay liner placement can begin. The engineer that designs the landfill is required to include at least 1% grade so that leachate can be collected in the sump leachate removal point. The top of clay liner has elevation requirements in the design that

ensure three feet of clay have been placed and also to fulfill the 1% grade within the landfill. The design engineer for Energy*Solutions* has established key control points for elevation on grids of about 50 feet except in the sump leachate removal areas. The sump leachate removal area has many more control points and is specially designed to ensure leachate is captured and can be removed from the landfill cell.

Clay placement on the first lift begins at not greater than 12" loose. Each successive lift can be placed at not greater than 9" loose. Grade stakes are placed at key control points (roughly every 50 feet, except in the sump area). A Quality Control (QC) technician prepares grade stakes with ribbons (at 9" or 12" depending on the lift) to depict the loose lift height. Rock trucks deliver the clay and dozers grade it. Once the QC technician verifies the lift height, the stakes are removed and the clay is compacted. The QC technician observes the compactor operator to ensure that the process is done with the same equipment and in the same manner as was accomplished on the test pad. Once compaction is complete, testing begins. Testing consists of clay moisture content, percent compaction and hydraulic conductivity.

Hydraulic conductivity can be measured by an ASTM Method using double rings. The Method will produce an accurate value, but can take months to perform. EnergySolutions and the DSHW agreed to accept a single ring permeameter method, developed by a local consulting firm, to determine hydraulic conductivity. However, the compromise was to test smaller lots and at a higher frequency.

Conflict arises when construction in the landfill cell isn't exactly as it was on the test pad, when deviations from ASTM Methods are observed, when field conditions dictate construction changes or when Permit Conditions are not met. In addition, the single ring permeameter is very sensitive to climate changes and sometimes, the results may be questioned by the regulatory agency. If the conflict is complicated, meetings are held with the facility, the landfill contractor and the regulatory agency to work out solutions. Sometimes, in extreme situations, the only correct solution is to remove the clay and start over. This can be costly and time consuming. In these types of situations, conflict is usually stressful and time consuming for all parties involved.

Geosynthetic Installation

Once the clay liner has been placed, the surface of the liner must be adequate to provide continuous support for the plastic liner system. Permit Conditions exist that limit the size of desiccation cracks, surface ridging and surface protrusions. The facility works to provide a surface that is smooth and firm. When the surface is ready, a 24 hour notice is given to the regulatory agency so that a surface inspection can be done. Conflict resolution is typically minimal.

The secondary geosynthetic liner system is placed first. 60 mil high density polyethylene (HDPE) is placed in panels based on a panel placement plan. The panel placement plan is required to minimize seams and connections near the sump area. The large area between the two sump leachate removal areas is covered first and fusion welding is done to connect the panels. Welding technicians are required to perform pre-weld tests with the machine they anticipate using at the beginning of the shift, after lunch and anytime a machine has been turned off. Pre-weld test coupons are taken and subject to peel and shear stresses. If the coupons pass, the technician can use that machine at the temperature and speed used for the test. Pre-test welding is also required for extrusion welding. Extrusion welding is a technique for patches, caps, repairs, etc.

After successful pre-weld testing, the HDPE panels are fusion welded in the landfill cell. Destructive testing of the seams is done at a rate of one test for every 500 linear feet of welding. Non-destructive testing (air pressure between the seams) is done on each seam. Patches and other non-fusion seams are done by extrusion welding. These welds are tested by vacuum box testing.

Once the secondary HDPE is placed, geonet is installed to minimize channeling of the leachate. The geonet is sewn together with quick connect ties. The ties are required to be of the same material as the HDPE.

The sump leachate removal areas require special attention. There are sharper angles and specialized seams. In addition, a leachate collection and removal system must be installed within the sump leachate removal points. Within the sump leachate removal area, the area is filled with a material that has a hydraulic conductivity greater than $1X10^{-2}$ cm/sec. The facilities usually use -2.5" gravel. In order to protect the flexible membrane liner from the gravel, a rub sheet is extrusion welded to the sump and the gravel is "burrito" wrapped in filter fabric. PVC piping is placed in the sump in an "H" configuration. The piping has holes drilled (staggered on each side) to collect the leachate. At the lowest point of the SLRP and just at the point where the slope changes to 3:1, a 10" pipe is then placed over the 3" PVC pipe and is used as the pump casing for removal of leachate. A pipe trench is prepared that goes up a 3:1 slope on the end of the landfill. When landfill construction is complete, the three 10" pipes from the secondary, primary and tertiary sumps are extended away from the landfill for access and to pump any leachate in the buried sumps. Naturally, leachate should only be present above the tertiary liner. If leachate is found above the primary or secondary liner, a leak may be present in the tertiary liner system.

Primary liner is installed above the secondary geonet. Primary liner is also 60 mil HDPE. Once all of the QC and QA testing is complete, geonet is installed and then a filter fabric is put on top of the geonet to reduce clogging from the soil protective cover. Panels of filter fabric are sewn together.

Soil protective cover is then placed on top of the filter fabric. The cover process is described in the next Section. The facility works to provide a surface that is equivalent to the top of clay surface described for the secondary clay liner. However, since the tertiary liner system is supplemental, a Permit Condition is not included for a top of clay 24 hour inspection. Once the facility and flexible membrane liner manufacturer representative are satisfied that the surface is adequate for liner installation, an 80 mil HDPE flexible membrane liner is placed. All of the pre-weld testing each day of welding is required for the tertiary liner welding. Geonet and filter fabric are installed above the tertiary flexible membrane liner. Finally, a soil protective cover is installed above the 80 mil geomebrane liner system to protect the liner system from possible damage.

Conflict generally arises with situations such as rapid ambient air temperatures and Flexible membrane liner surface temperature changes, cleanliness of panels before welding, machine calibration etc. One Permit Condition that helps to avoid conflict is that in addition to the coupons that are tested in the field, additional coupons are sent to an off-site laboratory and a third set is archived at the facility if future testing is needed for conflict resolution. Conflict resolution is typically minimal due to the nature of testing. If tests have been inadvertently overlooked, archived samples can be tested.

Soil Protective Cover

Once geosynthetics have been installed, a soil protective cover is placed to minimize possible damage to the plastic liner system. The requirements are that the soil passes 100% less than 3.5" screen and 85% passing the 1" screen.

While the current CQA/QC Plan addresses acceptable soil cover material, outdated Plans were not specific enough. Conflict could arise when the regulatory agency observed material that appeared to be inappropriate for use as soil protective cover. The burden then rests on the facility to demonstrate whether or not the material meets the Permit Conditions. If the material does not meet the Permit Conditions, the facility must propose a solution to provide soil protective cover that is acceptable. The basic conflict typically involved an analysis that focused on soil determination versus particle determination. If conflict arises before installation, the remedy is much easier. The facility and the agency can resolve what is and what isn't acceptable. However, if the facility has already begun placing the cover and the cover is deemed as unacceptable, the facility may be required to replace the cover. Replacing the cover is a delicate, expensive and time consuming process. For this specific reason, Permit Conditions were developed that make soil protective cover material acceptable by employing unified soil classification and screening requirements.

Final As-built Reports

As-built reports are submitted that detail the Permit requirements for each work element. The reports document the quality control and quality assurance work that is required within the CQA/QC. The regulatory agency reviews the documentation to confirm that the construction documentation meets the Conditions of the Permit.

Inevitably, the documentation will have problems. Conflict resolution can be minimal or difficult based on the problems with the documentation. If the documentation problems are simply typographical errors or numbers read incorrectly, the facility can typically resubmit the documentation with the corrections. If the submittal has errors with things such as compaction, permeability, geosynthetics not meeting shear or peel requirements, cover material not meeting specifications, etc., then conflict resolution becomes more difficult. The facility is then required to either explain why the construction results are in compliance with the Permit or the regulatory agency has to make the difficult decisions. Sometimes, work elements are required to be redone even though the landfill cell has been completed.

CONCLUSION

All of the written correspondence between the facility and the regulatory agency is in the public record. The public record is available to anyone making a request under Government Records Access Management Act (GRAMA) of Utah. Consequently, when the regulatory agency reviews landfill construction documentation, if any element does not meet the Conditions of the Permit, the regulatory agency must be able to explain why it is or is not acceptable to any entity making a GRAMA request and questioning the approval to use the landfill cell.

Conflict Resolution can become difficult at times because the facility answers to a Corporate Board whose focus is on the bottom line. The regulatory agency answers to the stakeholders and must ensure that the landfill cell meets all Conditions of the Permit and is protective of human health and the environment. Consequently, the regulatory agency must ask, "If a question arises with regard to the construction, can the agency answer that the work element meets the Conditions within the Permit?"

Fortunately, the UDEQ/DSHW and Energy*Solutions* have developed a professional relationship wherein each understands how the other must operate. Under the circumstances, such a professional relationship makes conflict resolution easier to address even under difficult situations.