

ERDF SUPERCELLS 9 & 10
A Case Study/Comparison in Constructability and Cost Reduction through re-design at the Hanford
Reservation, Washington, USA - 11324

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ABSTRACT

In 1996, the U.S. Department of Energy (DOE) opened the Environmental Restoration Disposal Facility (ERDF), which began accepting low-level radioactive soils for disposal recovered from waste sites along the banks of the Columbia River in Washington State.

Intended for expansion as needed, EDRF was originally designed and built with engineered disposal areas, or cells, with baseliner grades that sloped outward from the center of the facility toward the south and north perimeter. This “dual-cell” configuration was used for Cells 1 through 8. In 2009, DOE authorized Washington Closure Hanford (WCH), which manages ERDF for DOE, to expand ERDF by 50 percent and redesign the cell configuration. The expansion of the landfill increased the footprint by 34 acres, while the reconfiguration eliminated nearly half of the infrastructure for the new cells.

A critical feature of the reconfiguration was a design change that created one “super cell” by creating one sump for what used to be a pair of cells. The landfill baseliner now will drain to one side of the landfill instead of from the middle of each “dual cell” to the perimeter. The sumps receive leachate (liquid which leaches off of the waste mass) drainage from the landfill floor. The redesign entailed designing with additional geosynthetics in lieu of traditional construction materials used in the previous Cells 1 through 8. The redesign required half the amount of conveyance piping, pumps, building infrastructure, and electrical and mechanical systems. Because of this, the redesign resulted in cost savings to DOE for material and labor related to construction, as well as for long-term operations and maintenance costs. This “super-cell” configuration not only reduced the site infrastructure, but improved constructability, reduced the construction schedule and significantly reduced construction and operating costs.

INTRODUCTION

The Hanford Nuclear Reservation (Reservation) is located in southeastern Washington, covering an area of approximately 586 square miles (1517.74 square kilometers). The Reservation began in the 1940's with the Manhattan Project. Currently, the Reservation is one of the largest environmental cleanup projects in the world and managed by the DOE. The site comprises of nuclear reactors and associated processing facilities for plutonium production, which left behind millions of gallons of chemical and radioactive waste within underground storage tanks, contaminated buildings, thousands of waste sites, leftover nuclear reactor fuel and contaminated groundwater.

The vision at this site is to reduce the active area of cleanup to less than 75 square miles (194.25 square kilometers) or less by 2015. A part of this vision is the River Corridor Closure Project, managed by the DOE's Richland Operations Office, who also manages the Central Plateau. The River Corridor Closure Project is managed by WCH. The Columbia River Corridor (the Corridor) is approximately 200 square miles (518 square kilometers) along the outer edges of the Hanford site. The Corridor contains portions of the Hanford Reach National Monument and cleanup involves the razing of over 400 buildings, more than 350 waste site cleanups, and placing one nuclear facility and two reactors into interim safe storage, as well as managing the on-site disposal facility known as the ERDF.

ERDF represents the final disposal place for nearly all of the materials recovered from the Columbia River Corridor. ERDF is an engineered, low level radioactive and mixed waste disposal site in the middle of the Reservation that is regulated by the U.S. Environmental Protection Agency (EPA). ERDF was originally

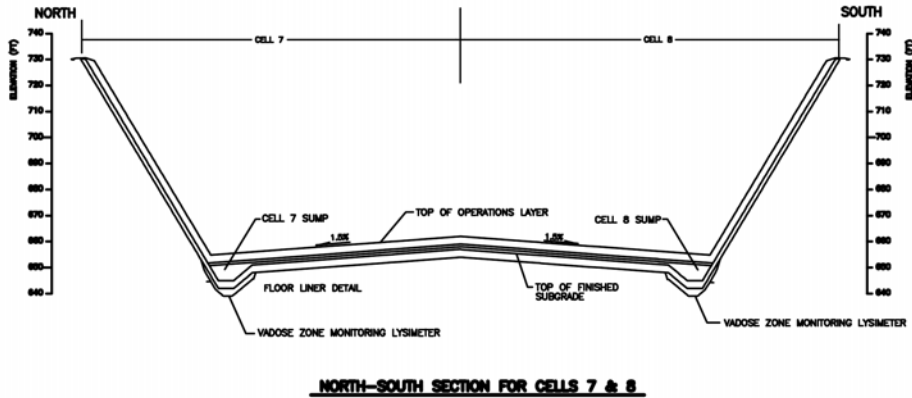
designed and built with engineered disposal areas, or cells, with baseliner grades that sloped outward from the center or highpoint of the facility toward the south and north perimeter. Each cell measured 500 feet square by 70 feet deep (152.4 meters square by 21.336 meters deep). This “dual-cell” configuration was used for Cells 1 through 8. In 2009, WCH was authorized to expand ERDF by 50 percent and redesign the cell configuration. The revised cell configuration created a single “super cell”. The revised cell resulted in a cell 1000 feet by 500 feet by 70 feet deep (304.8 meters by 152.4 meters by 21.336 meters deep).

The Super Cell design resulted in the expansion of the landfill footprint by 34 acres, while the reconfiguration eliminated nearly half of the infrastructure for the new cells.

EXISTING DESIGN

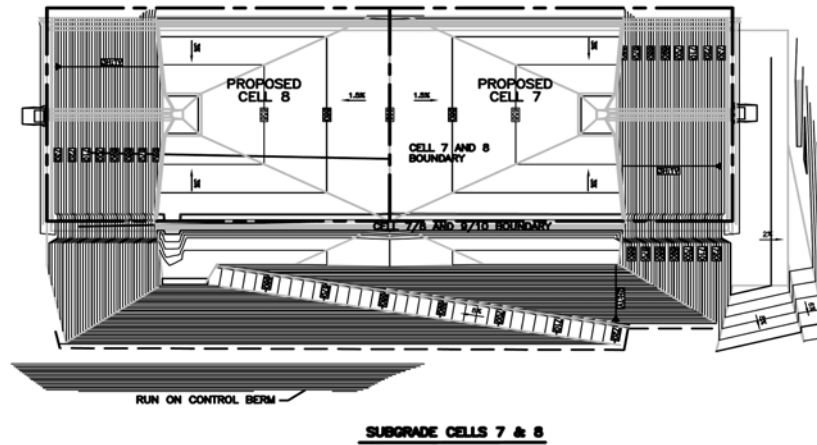
ERDF’s existing design comprised of a landfill with a mirror image when divided through the center. This design allowed for the landfill to be built in 8-acre phases. In reality it was only practical to build these cells as one single 16-acre footprint, due to the logistics of construction related activities. A cross-section of the existing design (Cells 7 & 8) is shown in Figure 1 [1].

Figure 1



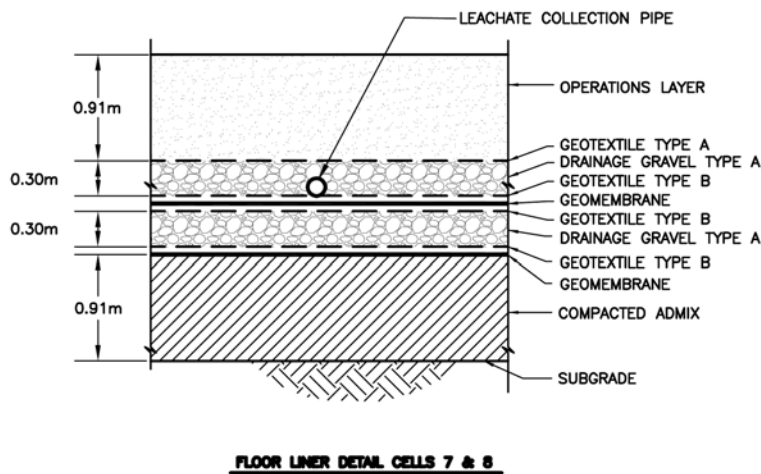
As seen in Figure 1, the sumps on either end of the cell required related monitoring, pumping and mechanical and electrical equipment at either end of the cell. The infrastructure on either end with the related conveyance piping around facility resulted in high initial capital costs, and higher long term operations and maintenance costs. The plan view of one of the dual sump existing cell designs is presented in Figure 2 [1].

Figure 2



This design was in part a function of the need to meet engineering parameters associated with its design and the EPA’s Record of Decision (ROD). The most significant parameter is that the design of this landfill, and in general all landfills, is based on the principle that the transfer of leachate should occur in an unconfined manner. To travel in an unconfined manner means that the leachate is to travel above the primary liner system of High Density Polyethylene (HDPE) through a leachate collection system, without constraints (e.g. pressure) from material above it. Typically, to achieve this, the leachate collection system is comprised of conventional construction materials like sands or larger aggregates. By allowing the liquid to travel through the drainage media in an unconfined manner, the liner’s ability to transfer leachate through the primary liner system is reduced. The liner cross-section is presented in Figure 3 [1].

Figure 3



CHALLENGE

Additional clean up funds were released through the American Recovery and Reinvestment Act (ARRA). In an effort to allow the acceptance of contaminated materials from the Corridor at an accelerated rate, with these increased funds WCH was authorized by DOE to expand the landfill and thereby incorporate new technologies, using more efficient and cost effective construction and operation methods.

SOLUTION

To minimize the construction effort and reduce the construction timeline, various design changes were incorporated into the original design. These changes included the following:

- Replace the double sump design with a single sump located on the north end of the disposal site. The base grades of the landfill shall utilize a single V-shape down the centerline of the floor, sloped 1.0% along the centerline with a 2.0% perpendicular cross slope.
- Replace the network of 4-inch and 6-inch (10.16-centimeter and 15.24-centimeter) diameter leachate collection pipes used on previous projects with a single leachate collection pipe located in the flow line of the V-shaped subgrade.
- Revise the primary drainage layer and secondary leak detection drainage layer to incorporate a geocomposite.

REVISED DESIGN

The first challenge was to incorporate the single sump design. The purpose of moving toward a single sump design was to reduce the construction time allotted for constructing dual sumps and reduce the required infrastructure for landfill expansion. Sump construction is typically one of the more challenging portions of landfill construction due to the need of the steep slopes within a limited and enclosed area. By reducing the sumps by one-half, this would also reduce the total sump construction time required for one 16-acre landfill portion by one-half. Additionally, by implementing this design the landfill would be able to eliminate the need to have two crest pad buildings per 16-acre portion. The crest pad building is the term used for the buildings at the crest of the landfill slopes on the north and south ends of each 16-acre landfill portion. These buildings contain the various mechanical and detection monitoring equipment necessary for the required environmental monitoring at the landfill. A plan view (Figure 4) [2] and cross-section (Figure 5) [2] of the single sump design is presented below.

Figure 4

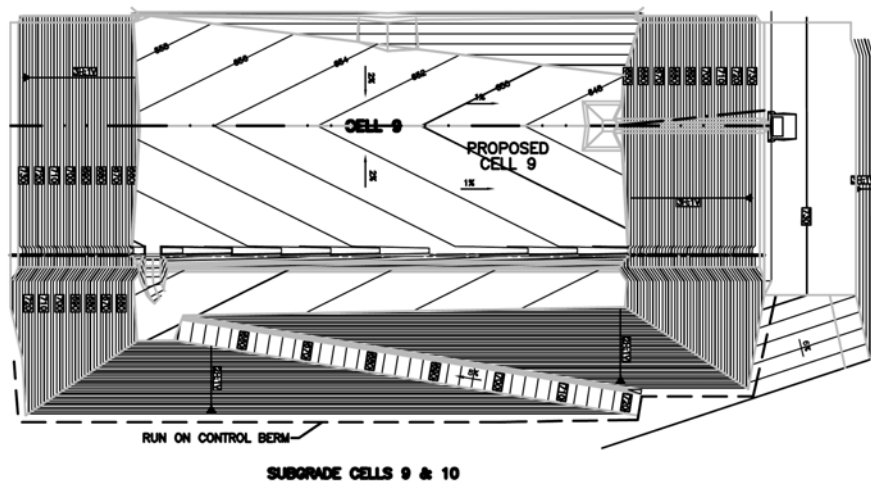
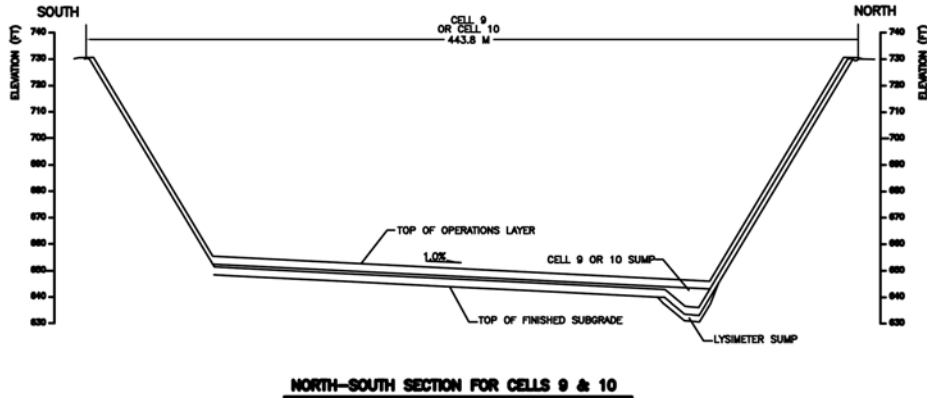


Figure 5



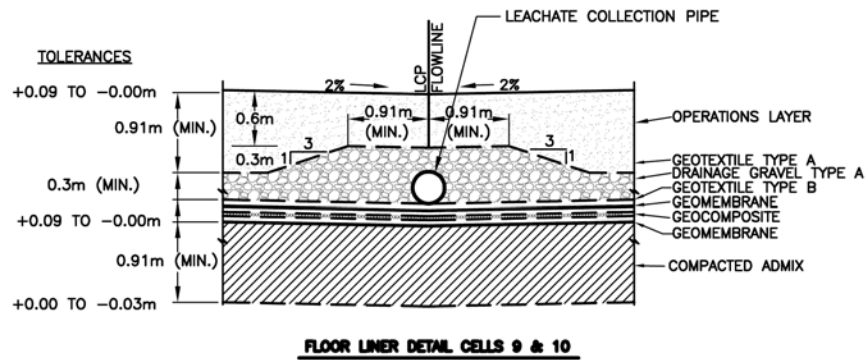
The second challenge was to remove the network of 4- and 6-inch (10.16- and 15.24-centimeter) piping. The existing design utilized an extensive piping network within the leachate collection system in an effort to route leachate to the collection sump on either end of each 16-acre landfill portion. The removal of the network was a function of the single sump design in that the grading directed the flow of leachate from the south through the center of the landfill to the sump on the north end. This removal of the network necessitated the use of an alternative product/material to allow the same or greater transmissivity than the existing leachate collection system.

The third challenge, and a result of the second challenge, was to utilize a synthetic drainage component in both the secondary leak detection layer and the leachate collection layer. The use of a synthetic drainage layer was not only sought after as a means to accelerate the construction process, but was also a necessity to facilitate the longer drainage flow paths through the implementation of a single sump.

The drainage components used in the existing design utilized a granular material, which was manufactured or crushed on-site within 1 mile (1.6 kilometers) of the ERDF construction site. The material was manufactured according to the specifications; however, this required crushing equipment and associated time to manufacture the required product. Additionally, a contractor needed to have the required trucks to mobilize and facilitate the transport of the product. The combination of these items required time and resources which needed to be maximized in order to meet the project constraints.

The longer flow path in the leachate collection layer dictated a material which could carry the leachate in an unconfined manner to the single leachate collection sump. The granular media as manufactured on-site could not meet the engineering requirements. The result was the use of a geocomposite material. The geocomposite, a geonet placed between two geotextiles, provided a means to meet the transmissivity requirements needed and, additionally, the geocomposite allowed the elimination of the need to manufacture the granular drainage layer and the various time constraints associated with manufacturing and transporting the granular media. The geocomposite completely replaced the granular media in the secondary leachate detection layer and provided the ability for the primary leachate collection layer to transmit higher volumes of leachate over longer distances and from larger contributing areas. Figure 6 [2] shows the improved cross-section using geosynthetic components.

Figure 6



By successfully addressing these challenges individually, ERDF was not only able to reduce the overall construction time related to each 16-acre unit, but ERDF was also able to reduce capital costs associated with the electrical and mechanical equipment required for the support of these 16-acre units by one-half. Although the full cost savings have not been finalized, it is apparent that these changes will result in the reduction of capital costs and what will eventually be reduced long term operations and maintenance costs.

CONCLUSIONS

The use of geocomposite was a critical component in allowing ERDF to make the changes required for incorporating a single sump design. The use of geocomposite allowed for design changes in both the secondary leak detection layer and leachate collection layer by exceeding the engineering properties of the materials used previously in each of these layers. In addition, the construction time allotted for construction of each 16-acre unit was reduced due to the single sump design and the geocomposite allowed for a quicker installation of the entire liner system. The result is that the construction time allotted was reduced by nearly nine months. Lastly, WCH was able to reduce the capital costs associated with mechanical, electrical and facility conveyance piping by over one-half. The long term operations and maintenance costs have not been realized at this point since the supercells are not in operation; however, it is apparent that the reduction in site infrastructure will result in a reduction of these costs also. All of these measures, when fully implemented, will result in significant costs savings for the DOE.

ACKNOWLEDGEMENTS

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REFERENCES

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- 2) Environmental Restoration Disposal Facility (ERDF) Cells 9 and 10, Revision 0 Drawings 0600X-DD-C0452, 0600X-DD-C0456, 0600X-DD-C0458; 2009.