CLOSURE OF THE 488-2D ASH BASIN & 488-4D ASH LANDFILL AT THE SAVANNAH RIVER SITE

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CONFERENCE: 2017 World of Coal Ash – (www.worldofcoalash.org)

KEYWORDS: coal ash, compaction, capping, closure

INTRODUCTION

The 488-4D Ash Basin is a sub unit of the D Area Operable Unit (DAOU) within the Department of Energy (DOE) Savannah River Site (SRS) in Barnwell County, South Carolina. The DAOU is located west of Highway 125 approximately 20 miles south of Aiken, SC and contains several coal ash basins associated with the coal-fired power plant operations at SRS (Figure 1). Savannah River Nuclear Solutions (SRNS), the operating contractor for the SRS, contracted with Envirocon to complete the 488-4D Ash Basin Closure Project.

REMEDIAL ACTIVITIES

The primary objective of the 488-4D Ash Basin Closure Project was to remove coal ash from the outside of the boundary of 488-4D and from within the 488-2D Ash Basin, place and compact the removed ash within 488-4D according to the engineered design, install a cap over the 488-4D with an engineered cover system, regrade 488-2D, construct a final storm water control system for both 488-2D and 488-4D and the surrounding area, and revegetate all disturbed areas. The major project tasks associated with the performance of the work are as follows:

- Pre-Mobilization Submittals,
- Mobilization to the Site and Site Preparation,
- Survey Control,
- Storm Water Pollution Prevention and Erosion Control,
- Clearing and Grubbing,
- Dewatering 488-2D,
- Excavate Ash, Place and Compact in 488-4D.
- Grade Ash within 488-4D to Design,
• Install Capping System (Common Fill, Geosynthetic Clay Liner (GCL), Geocomposite Drainage Layer (GDL), Common Fill, and Topsoil) over 488-4D,
• Regrade and Place Common Fill in the bottom of 488-2D to Design,
• Construct Permanent Storm Water Conveyance System,
• Stabilize the Site by Seeding, Sodding, and Placement of Crushed Stone Surfacing, and
• Demobilization.

Pre-Mobilization Submittals
Pre-mobilization activities commenced upon receipt of the Notice-to-Proceed (NTP) from SRNS and the contract execution. The Worker Protection Plan (WPP), complete with a list of identified Task Specific Plans (TSPs) and the Quality Assurance Project Plan were submitted for review, comments, and acceptance prior to mobilizing to the jobsite. During the pre-mobilization activities, Envirocon submitted the following for SRNS approval:

• Cost Loaded Schedule,
• Construction Field Engineer Resume,
• Professional Land Surveyor Registration/License,
• Testing Laboratory Information,
• GPS Model(s),
• Contractor Certification Form(s),
• GCL/GDL Installer/Field Crew and Supervisor Qualifications and Resumes,
• QC Inspector Resume, and
• Material Information and Certifications for Materials that are used early in the project cycle.

Prior to mobilization, the Envirocon Project Manager, Superintendent, Safety Professional, and the Construction Field Engineer participated in a pre-construction meeting with SRNS. At the meeting, the Envirocon team provided a detailed schedule, discussed the operational requirements of the work, and together with SRNS personnel, reviewed the safety requirements and site pre-construction requirements necessary to start work.

Additionally, Envirocon, with SRNS participation, attended a pre-construction meeting with the local building trades unions to discuss the upcoming project. During the meeting, Envirocon provided a description of the project to the union representatives and an estimate of the number and type of building trades employees to be employed during the execution of the project.

Mobilization and Site Preparation
Project personnel began mobilization to the 488-4D Basin Closure project site upon approval of required pre-construction submittals. The WPP was available onsite, reviewed and signed by all persons working on the project prior to any set-up and preparation activities. The project management team performed additional submittal preparation and managed equipment mobilization during this time frame.
All initial equipment, materials and supplies required in the performance of the Project were mobilized to the Site and staged at the temporary laydown area, shown in Figure 2.

All regular on-site Envirocon personnel obtained a security badge from SRNS. Prerequisites for issuance of security badges included General Employee Training (GET) and Substance Abuse Program (SAP) testing. In addition, SRNS provided several site-specific training courses to site employees.

The Envirocon Project Manager, Site Superintendent, and Safety Professional were trained in excavation and trench safety and are designated competent persons by Envirocon.

Upon arrival, all equipment delivered to the site was inspected for cleanliness, operability and compliance with OSHA standards. Delivery and service vehicles, as well as all tools and equipment entering the site, were subject to the same inspection requirements. All equipment delivered to the site had up-to-date maintenance logs and was in properly functioning condition. Fuel powered equipment was equipped with a fire extinguisher and arrived onsite with a current monthly inspection. A Major Equipment Declaration (MED) was provided to, and approved by, the Subcontract Technical Representative (STR) prior to equipment being placed into service. The STR coordinated an incoming equipment radiological survey, performed by SRNS personnel.

Temporary facilities, including an office trailer, equipment storage, parking, and portable sanitary units, were set up at the lay down area on existing concrete or asphalt pads. The office trailer was equipped with proper signage marking emergency exit points and met all NFPA Life Safety Code requirements. Envirocon utilized a portable diesel powered generator to power the office trailer. As the generator was less than 150KW no air operating permit was needed. The configuration of temporary facilities was in accordance with the size limitations of the Storm Water Pollution Prevention Plan (SWPPP).

As practicable, all equipment maintenance was performed within the laydown/storage area. Equipment maintenance areas were designed to minimize storm-water run-on and run-off. To prevent soil contamination from fluids dripping from equipment, plastic liners, drip-pans and/or containers were placed under equipment requiring maintenance. If equipment required a major repair and could not be moved prior to repair, a work zone was set up around the equipment for the safety of maintenance personnel. Maintenance personnel were required to use the proper PPE and engage spill-prevention measures for maintenance and repairs performed under these conditions.

Envirocon established a fueling station within the equipment maintenance area. The fueling station was established on an existing asphalt area. Two (2) double-walled tanks were brought in by the fuel supplier for diesel and regular fuel. The fueling station
was inspected and approved by SRNS Safety and Fire Protection representatives prior to use.

Prior to the start of ground disturbance activities, Envirocon constructed a temporary water fill station for water trucks to facilitate dust suppression at the site. Envirocon used irrigation piping to transfer water from well 631-3G to an area north of 488-4D. At the termination of the irrigation pipe, a J-stand was erected to allow water truck filling activities. Upon completion of earth moving activities, the pipe was repurposed for irrigation of revegetated areas.

Project Surveying
Survey control points had been established by others and were provided to Envirocon by SRNS prior to the start of work. Established project control point or benchmark/monument positions (x, y, and z coordinates) were used to maintain vertical and horizontal limits during the excavation and backfill process. Envirocon provided protection for control points and survey monuments during construction activities. In high traffic areas, benchmarks were demarcated by three guard posts with reflective paint striping.

A Global Positioning System (GPS) was utilized to perform the site construction layout by Envirocon’s Grade Checker and Project Engineer. GPS utilized Digital Terrain Models (DTMs) and electronic background maps to ensure continuous control of all excavation grades, limits of excavation and backfill soil placement, and to minimize the possibility of induced error by limiting the number of field calculations needed to conduct layout operations. GPS DTM models were provided to SRNS for review and approval 14 days prior to use.

Envirocon utilized the services of a South Carolina licensed Professional Land Surveyor (PLS) throughout the duration of the project. They set additional project control monuments where needed, performed initial pre-excavation topographic surveys, ash placement surveys, bottom of excavation topographic surveys, cover material topographic surveys, storm water system as-built surveys and provided spot checks during construction layout staking. As-built survey data was provided to SRNS periodically throughout the project and complete project as-builts were submitted at the end of the project.

Storm Water Pollution Prevention and Erosion Control
Envirocon performed all of the 488-4D Ash Basin Closure project work in accordance with SRNS’s existing SWPPP. Water, erosion and/or sediment control measures were constructed and maintained to control potential releases during activities associated with this project. The primary objectives of the storm water/erosion controls (SW/EC) to be used for this project were to:

- Control the spread of ash during remediation activities,
- Maintain storm-water run-on/run-off within the project site boundaries,
- Provide storm water/erosion control inspection and reporting, and
• Prevent loss of sediments and ash from site.

All storm water/erosion control features were installed in the locations identified in the Project Drawings, Specifications, and SRNS’s SWPPP in accordance with the project permits and allowances. SW/EC measures were installed prior to the start of any excavation or other soil-disturbing activities. During field operations, each site work area was evaluated weekly, and after rain events, to determine whether additional SW/EC measures were necessary. Envirocon’s Field Engineer and Site Superintendent, along with the STR and SRNS Design Personnel, participated in the SWPPP inspections. Additional run-on/run-off controls were installed if/when needed or deemed appropriate.

One week prior to the start of construction activities, Envirocon provided notification to the STR of intent to start surface disturbance to construct perimeter controls. The STR provided an excavation sketch for the affected areas and approval to start land disturbance activities. Initial land disturbance activities were limited to:

• Installation of construction entrance(s),
• Inlet protection for 3 existing storm water inlets,
• Clearing and grubbing to allow installation of silt fence,
• Installation of silt fence and J-Trap east of 488-4D,
• Installation of silt fence and rock check dams west of 488-4D,
• Demolition and removal of an existing 96-inch diameter corrugated metal pipe trash rack and concrete piers,
• Removal of existing 18-inch diameter cast iron discharge pipes,
• Excavation of ash to allow construction of rock filter ring and outlet structure,
• Construction of a rock filter ring and outlet structure, including a 24-inch reinforced concrete pipe (RCP) and headwall,
• Demolition and removal of a wood bridge, abandoned monitoring well and catch basin, and
• Grouting of a 24-inch diameter existing corrugated polyethylene pipe to be abandoned in place.

Envirocon utilized a combination of sediment control Best Management Practices (BMPs) during earth disturbance activities. As practicable, Envirocon continued to utilize the existing infiltration basin located within 488-4D as a collection point for storm water runoff from the landfill surface. However, the infiltration basin was located within the ash placement area so directing storm water to the basin was limited to the period of time prior to ash placement in the existing infiltration basin. As ash placement was ready to begin in the infiltration basin, Envirocon installed extensive temporary erosion control BMPs to direct storm water to the existing storm water drainage ditch around 488-4D. Envirocon used a combination of run-off berms, check dams, straw waddles, slope drains and silt fence to minimize the transport of sediment through the drainage ditch system. Temporary controls were inspected weekly and after rain events to ensure compliance with the SWPPP. BMPs that collected sediment were evaluated for effectiveness and cleaned or replaced, as appropriate. Sediment removed from BMPs was placed on the 488-4D landfill.
At the completion of ash placement activities and during installation of geotextile cap materials, storm water catch basins were installed as part of the storm water conveyance system. Geotextiles were attached to the catch basins as they were installed across the cover of the landfill. Immediately following installation of the catch basins, the downstream CPP and riprap aprons were installed. Construction of these features allowed storm water from the 488-4D landfill to be discharged into the 488-2D settling basin. After settling in the basin, storm water was discharged through one of the 488-2D outlet structures. Envirocon protected all existing storm water catch basins with inlet protection BMPs. Inlet protection devices were inspected weekly and cleaned or replaced as necessary.

During construction activities Envirocon used a range of erosion prevention BMPs to stabilize non-vegetated areas. Erosion prevention BMPs included surface roughening; temporary seeding; permanent seeding for completed areas; and riprap. Erosion prevention BMPs were installed and maintained in accordance with the SRNS SWPPP.

Clearing and Grubbing
The existing wooded area west of 488-4D required clearing and grubbing of trees and vegetation to allow excavation of ash material that had migrated down the slope. Materials were size reduced to meet the waste acceptance criteria, loaded into trucks and disposed of at the Three Rivers Landfill. SRNS provided and signed waste manifests for the CERCLA sanitary waste materials that were transported to the landfill.

Dewatering of 488-2D Ash Material
Upon mobilization to site, the 488-2D basin had significant surface water that needed to be removed. Two (2) 4 inch electric pumps, provided by SRNS, were installed and began dewatering immediately. After the surface water was removed to the extent practicable, the ash material in the basin was still substantially saturated when it was to be excavated and placed in the 488-4D basin. Since the saturated ash material had little bearing capacity and was unable to support heavy equipment, it was necessary to construct temporary access roads into the 488-2D basin. These roads were constructed of approximately 9,000 cubic yards of common fill material. To the extent allowable, Envirocon utilized excess clay berm material from the 488-4D landfill in order to reduce the amount of fill used from the Borrow Pit. Common fill was placed directly into the 2D basin, spread by a dozer and compacted by truck traffic and/or vibratory drum compactor. Lift thickness was sufficient so that heavy equipment could travel on the access roads without breaking through the fill and the basin bottom clay layer. As the ash was later excavated, the temporary roads were removed.

To facilitate dewatering of the saturated ash material, Envirocon used a combination of the following techniques:

**Excavation of drainage ditches in the bottom of 488-2D**: Excavation of small drainage ditches through the ash assisted in ash dewatering by allowing impounded water an area to drain into the ditches. Ditches were excavated through the ash and graded to
allow collection near either the west or east end of 488-2D (Figure 3). Once collected, water in the ditches was pumped to the neighboring basins and/or used for on-site dust suppression. Temporary erosion control measures were installed at any discharge points and BMPs used to prevent discharge of sediment laden water.

**Temporarily stockpiling ash within 488-2D to facilitate drainage** - Excavation and placement of ash material in stockpiles also assisted in dewatering of ash material. Excavators were used to excavate ash and place in stockpiles. Stockpiles were then allowed to gravity drain for a period of time prior to hauling and placement on the 488-4D landfill surface (Figure 4).

**Over-excavation and construction of a sump dewatering system** - Sumps excavated through ash material into the underlying soil provided collection for water, which was pumped from the 488-2D basin into the neighboring basins (Figure 5). The pumping points were constructed from a perforated HDPE pipe wrapped in filter fabric and supported by riprap. The filter fabric reduced sediment load while the riprap retained the shape of the sump during repeated drawdown due to pumping.

**Ash Excavation, Placement, and Grading**

Excavation was performed using 40-metric ton excavators equipped with GPS. The GPS model was developed from the excavation surface for the 488-2D Basin (Figure 6). Prior to the start of excavation, the model was provided to SRNS for approval.

A tracked excavator excavated ash and placed the material in 40-ton articulated haul trucks (Figure 7). The trucks utilized the temporary access roads to haul material from the 488-2D Basin to the 488-4D Landfill. Trucks were loaded to minimize spilling of material during transport between the areas. The ash excavation was started at the east end of 488-2D and proceed westward. When excavation within 488-2D was interrupted by ash conditions and/or rain events, Envirocon relocated the excavators and trucks to excavate the relatively dry ash material east and west of 488-4D.

Approximately 80,000 cubic yards of ash material was hauled in articulated off-road trucks from the 488-2D basin to the top of the 488-4D landfill. It was then dumped onto the existing ash surface in 488-4D and spread into 6-inch to 12-inch thick loose layers by a D-6 dozer equipped with GPS (Figure 8). Lift thicknesses were dependent on moisture content of ash; ash with higher moisture content was spread in thinner lifts to facilitate drying.

Envirocon’s production rate for ash placement in 488-4D allowed five working days of drying time prior to a new lift being placed over ash material. During the five working days, placed ash was conditioned to allow drying. A disc was used to turn ash material that was too wet to allow compaction, to facilitate its drying (Figure 9). When available, dry ash material from the perimeter of 488-4D was mixed using a disc with wetter ash material to reduce overall moisture content. When rain was forecast, the ash surface was sealed by compacting with a smooth drum compactor to minimize impacts of precipitation.
In addition to the ash material from 488-2D, approximately 34,300 cubic yards of the existing ash located in 488-4D required regrading to achieve lines and grades presented in the construction drawings. Dozers equipped with GPS cut the ash surface to design grade, while front end loaders moved the ash to fill area locations. In some areas, the cuts to grade were so extensive that excavators and haul trucks were used to relocate the material. Ash that was cut from within 488-4D was drier than the material located in 488-2D, so some of this drier material was incorporated into wetter ash material to facilitate drying and compaction.

Once the ash had dried to the extent needed to successfully compact, a minimum of five passes with a vibratory smooth drum compactor was used to compact the loose lift (Figures 10 and 11). Though initially the vibratory action of the compactor was utilized, Envirocon eventually discontinued the use of the vibrator action. Envirocon and SRNS together, discovered that the vibratory action of the roller caused the ash to release moisture content, making the lift unsuitable. After four lifts had been placed and compacted, the surface of the ash was proof rolled to demonstrate successful compaction. SRNS was notified a minimum of 48 hours prior to any proof rolling activities and the proof rolling was performed in the presence of the Testing Laboratory Technician, STR and SRNS Engineer. A four-wheeled (minimum) pneumatic tired piece of heavy equipment not weighing less than 25 tons was used to proof roll the ash surface (Figure 12). Areas that exhibited pumping or softness (Figure 13) were excavated a minimum of 18-inches and reconditioned until material characteristics allowed for successful proof rolling. All proof rolling reports were submitted to SRNS.

As discussed above, the existing 488-4D infiltration basin was utilized as long as practicable to manage storm water discharge from 488-4D. Toward the end of the ash placement, the infiltration basin was dewatered and the basin surface was prepared to accept ash placement to meet the compaction requirements. As this material was saturated, it was conditioned by discing and by mixing with existing drier ash. However, wicking of water from the infiltration basin materials quickly became a problem for placement of ash over it. Envirocon used a compacted layer of fill material from the on-site borrow area to bridge the infiltration basin material and to allow other ash material to be placed and compacted on top of it.

Once all ash had been placed in the 488-4D landfill, SRNS performed a visual inspection of the site to confirm that all ash had been placed in the landfill in accordance with the subcontract documents. Following the inspection and approval, Envirocon performed a topographic survey of the finished ash surface. Data from the topographic survey was provided to SRNS for evaluation against the existing cap design. SRNS revised the cap design accordingly and provided a final cap design to Envirocon.

Installation of Capping System
Directly over the final graded ash surface, Envirocon constructed a 6-inch thick layer of compacted common fill to serve as a base for GCL and GDL placement. The common fill was sourced from the on-site borrow pit, located approximately 1.5 miles east of 488-
4D landfill. The borrow area was cleared, grubbed and partially excavated by SRNS prior to the start of excavation by Envirocon. Erosion control BMPs installed by SRNS were maintained by Envirocon while performing work in the borrow area.

Envirocon excavated 23,000 cubic yards of common fill material from the borrow area for the 6 inch common fill layer in accordance with the borrow area excavation plan. A tracked excavator or wheel loader excavated the fill material and loaded it into haul trucks. The material was hauled to 488-4D landfill where it was dumped and spread by a dozer, equipped with GPS, into a loose lift approximately 7- to 8-inches thick. Moisture content of the fill material was adjusted as necessary and the material compacted with a minimum of five passes with a vibratory compactor.

Following construction of the 6-inch common fill layer, Envirocon surveyed the finished surface. The survey data was provided to SRNS for approval prior to the start of GCL and GDL installation.

Procurement of GCL and GDL started in early May of 2015, shortly after excavation began. Following purchase, SRNS was notified of delivery 24 hours in advance. As the GCL and GDL arrived onsite, the rolls were inspected by the QC Inspector. Rolls were unloaded and placed into storage with minimal handling. Cloth chokers and spreader bars were used to handle rolls of GCL and GDL. The spreader bar was attached to a steel bar inserted through the center core of the roll to pick and move GCL and GDL. Spreader bars were certified and marked with maximum load capacity. Damaged rolls were separated from undamaged rolls and any damage was reported to SRNS.

GCL and GDL were stored off the ground in the material laydown yard. Original packaging material remained on the rolls until immediately prior to installation. Polyethylene sheeting was placed over the rolls to minimize the impact of rain events during storage.

Immediately prior to installation, the 6-inch common fill layer was fine graded and rolled with a drum roller. Rocks and sticks were removed or pushed into the surface. GCL was deployed using all terrain forklifts in the orientation recommended by the manufacturer (Figure 14). The amount installed was limited to the amount that can be covered with common fill or protected by tarps at the end of the day.

GDL installation was performed concurrently with GCL installation. Loads placed on the GCL during GDL installation could not exceed the manufacturer’s recommendations in order to prevent damage to the GDL (Figure 15). The GDL was installed in accordance with the manufacturer’s recommendations and project specifications.

GDL and GCL were installed starting at the west side of 488-4D progressing westward. Installation in this orientation facilitated daily placement of common fill over the GDL. As GDL/GCL was placed, the anchor trench was excavated and prepared for liner installation. Temporary ditches, swales, and or sandbags were used to divert water from the surface of the GDL. If damage occurred during installation, repairs were made in
accordance with the manufacturer’s recommendations. The Envirocon QC Inspector monitored and documented the GCL and GDL installation.

Following installation of GDL/GCL, Envirocon constructed a 20-inch common fill layer over the Geosynthetic materials. The common fill was again sourced from the on-site borrow pit. Envirocon performed the following tests on borrow material; soil particle size (ASTM D 422); modified Proctor compaction (ASTM D 1557); and moisture content (ASTM D 2216) at a frequency of one test for every 5,000 cubic yards of material excavated or if material changes in texture or color.

Common fill hauled from the borrow pit was spread over the GDL by a D-6 size low ground pressure (LGP) dozer, equipped with GPS, in an initial 12 to 15-inch loose lift. Fill was pushed out over the GDL in an upward tumbling motion so that wrinkles in the GDL were not created. Fill was not allowed to be dropped or dumped on the GDL from higher than three feet. On slopes, fill was placed from the bottom of the slope upward (Figure 16). Equipment used to place fill could not operate directly on the GDL. Compaction of the initial lift of material above the GDL/GCL was accomplished by equipment traffic with ground pressure less than seven pounds per square inch (psi) making at least two passes over the area. Envirocon sequenced placement of cover material over GDL/GCL such that minimal GDL/GCL was exposed at any time in the event of rain and to ensure all GDL/GCL that had been deployed was covered by the end of the shift. In transition areas that could not be covered with fill material until an adjacent panel of GDL/GCL was installed, rain tarps were deployed to cover the working edge of the GDL/GCL at the end of the day to protect it from precipitation.

The remaining fill was placed in a lift thickness that resulted in an overall common fill layer of 20-inches. Fill was placed with a D-6 LGP dozer and compacted to 90 percent maximum density. A vibratory compactor was utilized to ensure material was compacted to the specification. Compaction was measured with a nuclear densitometer at a frequency of one test for every 50,000 square feet per lift, or one per day, whichever was greater. Because the traffic on the initial 12 to 15-inch lift was limited to low ground pressure equipment, the second common fill lift was placed as soon as practicable after the first lift was compacted. Placing fill in this sequence and fashion allowed truck traffic relatively close access to the working edge of GDL/GCL, which enabled maximum coverage of GDL daily.

Following completion of the 20-inch common fill layer, a 4-inch thick layer of topsoil was placed over all areas of the 488-4D Landfill. Topsoil was sourced from a local offsite location. 60 days prior to use of topsoil, Envirocon supplied SRNS with the topsoil test reports. SRNS performed verification testing of the topsoil source to confirm its suitability.

Prior to topsoil placement, the surface was scarified to a depth of 2 inches. Topsoil was delivered to the site by dump trucks and either dumped on the scarified surface or staged elsewhere in the area of disturbance until needed. A D-6 dozer equipped with GPS placed the topsoil in a uniform layer (Figure 17). Topsoil was compacted by the
weight of the dozer or other equipment operating on the surface; no other compaction was required. Lime and fertilizer was applied to the topsoil within 72 hours of topsoil placement and mixed into soil. A John Deere farm tractor with fertilizer spreader placed nutrients on the soil.

The surface of the topsoil was smoothed by raking or using a drag mat to achieve a uniform surface. If present, large rocks were removed prior to sodding. An as-built topographic survey of the finished topsoil surface was taken and provided to SRNS for approval.

488-2D Regrading and Common Fill Placement in 488-2D
Following removal of ash material from the 488-2D basin, the bottom surface of the basin was regraded and filled with common fill to achieve the final design grades provided by SRNS (Figure 18). A dozer equipped with GPS was used to cut and place material in 488-2D. Envirocon excavated and hauled approximately 60,000 cubic yards of common fill from the borrow area. The material was placed in areas that needed additional fill to achieve the final grade. A vibratory smooth drum compactor was used to compact the fill to 85% maximum density in non-traffic areas. As with the 4D Landfill, a 4-inch layer of topsoil was placed into the basin bottom and along the side slopes. An as-built topographic survey of the finished topsoil surface was taken and provided to SRNS for approval. After receiving approval, the entire surface area was covered with sod.

Construction of Permanent Storm Water Conveyance System
Envirocon installed a permanent Storm Water Conveyance System involving trenches, catch basins, manholes, subsurface piping around the 488-4D and 488-2D, along with two outlet structures in 488-2D (Figure 19). The construction of the catch basins was tied into the GCL to capture storm water infiltration.

Installation of Final Vegetative Cover and Crushed Stone Surfacing
All surfaces disturbed by construction activities received one of the listed surface treatments for project completion:

**Sod Installation** The water line installed by Envirocon during mobilization was repurposed for irrigation of sod and seed. The topsoil was wetted prior to laying sod. Sod was transported from delivery trucks to topsoil with track loaders. The sod installers placed sod on topsoil so that sod to soil contact was maintained over the entire area and joints were staggered. Laborers used rakes and machetes to tighten seams and to trim and patch areas. After installation, sod was rolled with a lawn roller perpendicular to the direction the sod was laid. Newly installed sod was watered to wet the soil to a three-inch depth (Figure 20).

**Seed Installation** Seed was planted by mechanical spreader at the rate and mixture specified for the time of year the seed was planted. Seeded areas were lightly dragged to cover seeds and to maintain a surface free of ridges and depressions. Straw mulch was placed at a rate of 4,000 pounds per acre within 24 hours of seed placement.
Mulch was anchored three inches into soil with a disc. Soil was maintained in a moist condition until acceptance was received by SRNS.

**Crushed Stone** Crushed stone surfacing was placed on areas of compacted common fill that serve as roads on the project site. Envirocon constructed a 30-foot wide access road east of 488-2D, a 13-foot wide road east of 488-4D and 15-foot wide roads around 488-4D. Access roads consisted of 4-inches of crushed stone surfacing placed over existing road fill or compacted common fill. A vibratory compactor was used to construct a dense uniform surface. Water was applied as necessary to aid compaction.

**Demobilization**
All temporary erosion control features installed during construction activities were removed following completion of the site storm drainage system and installation of surface treatments. Erosion control features were disposed in accordance with the Waste Management Plan.

Upon completion of all construction activities, Envirocon was scheduled to remove equipment, excess materials, temporary office trailers, personnel, and any other materials from the site. However, Envirocon was awarded a second contract to remediate an additional ash basin and coal fine area, so demobilization was not necessary.

Envirocon’s Construction Field Engineer submitted an Engineer’s Certification Letter stating the work was completed in accordance with the Subcontract Documents and the STR approved the certification.

**LESSONS LEARNED**

Though the 488-4D Ash Basin Closure Project was not the first time Envirocon had handled coal ash or other similar silty, potentially thixotropic materials, there were several lessons that we learned during this project. These lessons learned included:

**Dewatering/Excavation** – Envirocon found that the most of the coal ash in 488-2D basin could be dewatered by trenches and sumps. This dewatering of the first 3-5 feet of coal ash proved adequate structural support for low ground pressure dozers to push out native soils on top of geomembranes for the construction of access/haul roads. Envirocon quickly learned that the access/hauling roads needed to have dewatering ditches on each side of them to allow any water brought up from below the dewatered levels by vibration of equipment operating on these roadways. This prevented the saturation of the coal ash directly under the roadways, as saturated ash had little to no structural support.

**Compaction** – As Envirocon knew from the placement and compaction of gypsum, the compaction of coal ash is not similar to that of soils. Envirocon and SRNS personnel realized that the moisture-density curves (Proctor curves) for the coal ash material varied widely over the 488-2D and 488-4D impoundments. Therefore, proof-rolling was
selected as performance criterion for the placed and compacted ash. As the compaction of the coal ash material seemed to wick moisture up from previous lifts, Envirocon found that it was best to disc the coal ash until it appeared to be slightly drier than required before compaction. In some instances, it took multiple days of reworking lifts until they were sufficiently dry. Envirocon also learned to not utilize the vibratory capacity of the smooth drum roller when compacting the coal ash, as even low frequency and low amplitude vibrations appeared to wick moisture up from previous lifts.

Weather – With over 25 years’ experience in capping landfills and impoundments, Envirocon was well aware of the impact of rain events on placement and compaction of materials and the installations of capping and cover systems. Envirocon learned that sloped surfaces of coal ash sealed with a smooth drum roller were still highly erodible by even moderate rain events and could be quickly eroded by thunderstorms. These slopes needed to dry before equipment could operate on them and start repairing the surface. Therefore, several days following rain events were lost to repairing the side slopes and cleaning out perimeter ditches. This affected the overall schedule along with our project costs. While Envirocon included weather days in our schedule and our budget, these weather days were not completely sufficient from what we encountered during the project.

CONCLUSIONS

Though lessons were learned, Envirocon successfully closed and capped the 37 acres of coal ash impoundments during the 488-4D Ash Basin Closure Project at the SRS. We dewatered, excavated and hauled 76,236 cubic yards of saturated ash material from the 488-2D basin to the 488-4D. 60,782 cubic yards of common fill was placed in the 488-2D basin, along with 2 outlet structures.

The ash material from 488-2D, along with 28,508 cubic yards of coal ash from outside the 488-4D landfill ash and 34,292 cubic yards of coal ash regraded within 488-4D was placed and compacted in 488-4D. The compacted ash was graded to final elevations and covered with 6 inches of common fill.

To cap the 488-4D landfill, Envirocon installed 948,433 square feet of GCL and 929,514 square feet of GDL on the 488-4D landfill. An additional 20 inches of common fill (57,553 cubic yards) was placed, along with 4 inches (13,553 cubic yards) of topsoil and 24 acres feet of sod to complete the capping structure. An additional 13 acres of sod was installed on disturbed areas outside of the landfill cover limits. Envirocon obtained all the common fill from on-site borrow areas.

Envirocon constructed permanent Storm water Conveyance System around the 488-4D landfill. This system consisted of 5 catch basins, 1 manhole, and 5,400 feet of subsurface piping around 488-4D landfill and was integrated with the GDL to capture and remove all storm water falling on the capped 488-4D landfill.
SRNS was satisfied with the quality of Envirocon’s work on the 488-4D Ash Basin Closure Project, to the extent that they awarded the next phase, closure of the 488-1D Basin, to Envirocon.
Figure 1. Location of the 488-4D and 488-2D Ash Basins
Figure 2. Temporary Laydown and Staging Area
Figure 3. Dewatering using Ditches

Figure 4. Stockpiles of Saturated Ash for Gravity Dewatering
Figure 5. Typical Dewatering Sump

Figure 6. GPS Model for the Excavation Surface of 488-2D Basin
Figure 7. Hauling of Saturated Ash to the 488-4D Basin

Figure 8. Spreading of Ash in Loose Lifts for Moisture Conditioning
Figure 9. Discing of the Ash for Moisture Conditioning

Figure 10. Compacting Lifts of the Moisture-Conditioned Ash
Figure 11. Rolling the Compacted Ash Lifts

Figure 12. Proof-Rolling the Compacted Ash Surface
Figure 13. Evaluation of a Proof-rolled Surface

Figure 14. Placement of the Geosynthetic Clay Layer (GCL)
Figure 15. Covering of the Geosynthetic Drainage Layer (GDL)

Figure 16. Placement of the Common Fill Layer
Figure 17. Covering the Common Fill Layer with Topsoil

Figure 18. Filling and Regrading of the 488-2D Basin
Figure 19. Installation of the Permanent Storm water Conveyance System

Figure 20. Placement of the Sod