Environmental Management Office

Jeff Biddick
Land Protection Division
Oklahoma Department of Environmental Quality
707 North Robinson, P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

REF: Notice of Deficiency – Tier II Permit Modification for Vertical Expansion, McAlester Army Ammunition Plant, New Landfill Pittsburg County, Solid Waste Permit #3551014

Dear Mr. Biddick,

1. McAlester Army Ammunition Plant (MCAAP) has reviewed the comments presented by the Oklahoma Department of Environmental Quality (ODEQ) in the Notice of Deficiency (NOD) letter dated October 18, 2019. We have presented the original ODEQ comments below along with our responses. We hope you find the responses acceptable and that the changes reflected in the revised permit application address the concerns and noted deficiencies presented in the NOD letter to ODEQ’s satisfaction.

   Question. The Application includes a proposed expansion of the permit boundary, but no expansions of the waste boundary are proposed. Oklahoma Administrative Code (OAC) 252:515-1-31 and 51 include restrictions on the location of permit boundaries that were not addresses in the Application. Please provide demonstrations that the proposed permit boundary meets these requirements. Alternatively, MCAAP may reduce the permit boundary to the currently approved state and provide revised drawings and legal description.

   Answer. MCAAP has decided to return to the originally approved landfill permit boundary. All figures and design drawing have been updated to show the original permit boundary and a copy of the original legal description has been incorporated into the revised permit application package.

   Question. The Application proposes final cover consisting of 2.5 feet of compacted clay overlain by 6 inches of topsoil. In accordance with OAC 252:515-19-53(a), the erosion layer must consist of at least 12 inches of soil capable of sustaining plant growth. Alternatively, per OAC 252:515-19-53(c), DEQ may approve the use of an alternative final cover design upon demonstration the alternative provides protection equivalent to the prescriptive design. Please either correct this specification in the Application or provide a demonstration that the proposed design provides equivalent protection.
Answer. The proposed final cover has been revised to consist of a compacted clay layer of 2.0 feet and soil suitable for sustaining vegetative growth to 12 inches. The design drawings have been revised to incorporate this change.

Question. The Application states that the borrow area will be reshaped and revegetated to blend with surrounding terrain within 180 days of the date the area ceased being used in accordance with OAC 252:515-19-55. Appendix 5, Figure 5-1 depicts a proposed borrow area final grading that is below surrounding grade and may result in ponding during rainfall events. Is this area intended to function as a natural pond/depression, or will this area be further reshaped to promote stormwater drainage?

Answer. After final grading, the borrow area will be a low-lying area that will act as a natural pond/depression, supporting a diverse ecosystem. This is intentional.

Question. Appendix 9, Section B states that the barrier layer will have a hydraulic conductivity of no greater than $1.0 \times 10^{-6}$ cm/sec. Please correct this to $1.0 \times 10^{-5}$ cm/sec.

Answer. The typographical error will be corrected and replacement pages provided.

Question. Section 7.1 states that no surface water monitoring program is necessary at the landfill, while an operational plan states that surface water monitoring will be conducted in accordance with MCAAP’s Oklahoma Pollutant Discharge Elimination system (OPDES) permit. Please clarify this discrepancy.

Answer. MCAAP does conduct quarterly monitoring of the landfill stormwater in accordance with the approved OPDES general permit. However, MCAAP is not required to conduct annual numeric effluent monitoring for the landfill. Section 7.1 of the permit application will be revised to agree with the Operational Plan by making this distinction.

2. We look forward to hearing back from you regarding the status of the above referenced permit modification application. In the event that further review indicates the need for additional revision and/or clarifications, we will be happy to work with DEQ to resolve any outstanding issues so the permit modification can be approved as expeditiously as possible.

3. Please address any questions or comments to Mr. Jarrod Thomas, Environmental Engineer, at 918-420-7631 or email jarrod.d.thomas2.civ@mail.mil.

Sincerely,

[Signature]

Darrell L. Elliott
Director, Environmental Management Office

Enclosure
APPLICATION TO MODIFY A SOLID WASTE DISPOSAL FACILITY PERMIT

Date: November 25, 2019
County: Pittsburg

Send to:
Solid Waste Permitting Unit
Waste Management Division
Dept. of Environmental Quality
707 N. Robinson (PO Box 1677)
Oklahoma City, OK 73101-1677

FOR DEQ USE
DEQ Log No.
No. Copies
Date Received:

McAlester Army Ammunition Plant proposes to modify the permit of
(Applicant's Name)
the McAlester AAP Type V Landfill, located at
(Facility Name)
(See attached sheet)
(Exact legal description:

metes & bounds, platted lot, or land survey. Append extra sheets if necessary)

in Pittsburg County, Oklahoma. We hereby make application for a modification
of existing permit number 3561014 as required by the Oklahoma Solid Waste
Management Act and the Rules pursuant thereto.

Remarks & brief description of proposed modification:
The proposed modification is for vertical expansion to allow placement of additional waste
on top of existing waste cells.

Applicant or Authorized Agent:

Signature
Shane M. Upton
Typed Name
Address: McAlester Army Ammunition Plant
City: McAlester State: OK
Date signed: 11/25/19
Phone: (918) 420-6551

Facility Address (if any):
1 C Tree Road
McAlester Army Ammunition Plant
McAlester, OK 74501

Preparing Engineer:

Signature
Gavin James
Typed Name
Address: 1718 South Cheyenne Avenue
City: Tulsa State: OK
Date signed: November 25, 2019
Phone: (918) 382-7581

DEQ USE ONLY

July 2016
DEQ Form #515-020
Corrected Final
RCRA-D Permit Modification Application for the Non-Hazardous Industrial Waste Landfill
McAlester Army Ammunition Plant
McAlester, Pittsburg County, Oklahoma 74501

CONTRACT NUMBER: W912BV-15-D-0017
TASK ORDER NO. W912BV18F0103

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS - TULSA DISTRICT
AND
MCALESTER ARMY AMMUNITION PLANT, OKLAHOMA

November 2019

PREPARED BY:

ALLCONSULTING
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ACRONYMS

ACM Asbestos Containing Material
bgs below ground surface
cm/sec centimeters per second
COD Chemical Oxygen Demand
cy cubic yard(s)
FEMA Federal Emergency Management Administration
Landfill McAlester Army Ammunition Plant Landfill
lbs/cy pounds per cubic yard
MCAAP McAlester Army Ammunition Plant
mg/l milligrams per liter
msl mean sea level
NFIP National Flood Insurance Program
NHIW non-hazardous industrial waste
OAC Oklahoma Administrative Code
ODEQ Oklahoma Department of Environmental Quality
OPDES Oklahoma Pollutant Discharge Elimination System
PE professional engineer
PI plasticity index
PLS professional Land surveyor
PVC polyvinyl chloride
QA quality assurance
QC quality control
RCRA Resource Conservation and Recovery Act
SVOC Semivolatile Organic Compound
SWPPP Storm Water Pollution Prevention Plan
TSCA Toxic Substances Control Act
USGS United States Geological Survey
VOC Volatile Organic Compound
1 General Information

1.1 Ownership

The Landfill site is owned by the U.S. Government and will be operated by McAlester Army Ammunition Plant (MCAAP) personnel. Proof of ownership is included as Appendix 1. Landfill operations will be performed under the direction of the Directorate of Engineering and environmental compliance will be performed under the direction of the Environmental Management office. The mailing address is:

McAlester Army Ammunition Plant
ATTN: Environmental Management Office
1 C Tree Road
McAlester, OK 74501-5000

1.2 Proof of Publication

Proof of publication of Public Notice will be forwarded under separate letterhead for inclusion in the application as Appendix 2.

1.3 Permitted Wastes

The Landfill is designed to handle industrial waste from operations at MCAAP. These wastes typically include:

1) empty cardboard boxes
2) plastic bottles
3) empty crushed cans of paint, paint thinner, etc.
4) metal turnings coated with machine oil
5) inert plastic material
6) small volumes of sandwich wrappings and pop bottles
7) containerized asbestos
8) water treatment plant clarifier sludge/filter backwash
9) sewage sludge

A more inclusive list can be found in Appendix 13.

1.4 Landfill Life and Capacity

The Landfill has received an average 2,204 tons of waste per year for the last five years, as reported by the Oklahoma Department of Environmental Quality (ODEQ). An additional 1,252,326 cubic yards (cy) of capacity will be added through this vertical expansion of the Landfill. The remaining life of the Landfill was estimated at approximately 119 years, considering the added capacity from vertical expansion.
1.5 Location

1) General. The Landfill occupies 49.279 acres more or less in the southwest corner of section 30 T4N R13E and that portion in the southeast corner of section 25 T4N R12E east of Road B as shown on the Site Location Map, Figure 1. Figure 2 presents the Site Layout.

Legal Description. Commencing at the iron pin with coordinates N. 533,255.363 E. 2,604,369.639, based on the Oklahoma South Zone State Plane Coordinates, said pin located at the intersection of Ashland Road and Road B near the corner of Section 25, Township 4 North, Range 12 East, Pittsburg County, Oklahoma:

thence N5°59'01"W a distance of 15.72 feet to the point of beginning;
thence S90°00'00"E a distance of 1600.00 feet;
thence N0°00'00"E a distance of 685.00 feet;
thence N90°00'00"W a distance of 903.00 feet;
thence N0°00'00"E a distance of 500.00 feet;
thence N7°30'00"E a distance of 660.00 feet;
thence N10°30'00"W a distance of 677.60 feet;
thence S74°30'00"W a distance of 705.00 feet;
thence S28°00'00"W a distance of 120 feet;
thence S10°30'00"E a distance of 160.00 feet;
thence S81°00'00"W a distance of 283.00 feet;
thence S18°00'00"W a distance of 51.30 feet;
thence S81°00'00"W a distance of 210.20 feet;
thence S0°00'00"W a distance of 1450.00 feet to the point of beginning;
said tract containing 49.279 acres more or less.

1.6 Current Land Use

The site is currently used by MCAAP as a Non-Hazardous Industrial Waste (NHIW) facility.
MCAAP NHIW LANDFILL
McAlester, OK

Figure 2
Site Layout Map

Legend
- Site Boundary

Project Manager: Charles McComas
Prepared by: ALL Consulting

November 08, 2019
Map Created by: Ben Bockelmann
2 Investigations

2.1 Original Landfill Permit

Field work conducted as part of the original Landfill permitting process consisted of drilling 27 exploratory borings ranging in depth from 20.0 to 100.9 feet below the existing land surface from March 3, to April 8, 1987. One of the core borings was converted to a permanent monitoring well and eight borings were converted to temporary piezometers. Boring locations were located in the field by US Army Corps of Engineers personnel.

Representative soil and rock samples were obtained approximately every 3 feet or change of material. Auger samples were collected in jars and returned to the laboratory for examination, classification, and determination of engineering properties.

The other two borings were augured through the overburden and cored with air to approximately 100 feet with a 4-inch carboloy-tipped core barrel. The core samples were logged and saved in core boxes. Selected core samples were wrapped, sealed in paraffin and stored for examination as necessary. Eight 2-inch polyvinyl chloride (PVC) piezometers were installed at the site in holes encountering water to monitor long-term ground water variation. Three-foot screens were placed at the bottom of the hole and the annular space was backfilled with concrete sand and sealed with bentonite balls to isolate a zone.

A set of two falling head permeability tests was performed at each of five borings. Separate 6-inch diameter auger holes were drilled for each test to different depths. All the test holes were above the water table. The holes were filled with clean, clear water. Water level drop versus time was measured and recorded. The readings were plotted on graph paper and connected by a smooth line. Two points were then taken off the steep straight portion of the graph to be used in permeability calculations. The resulting calculated permeability was 3.78E-07 centimeters per second (cm/sec).

2.2 Vertical Landfill Expansion

A geotechnical survey was conducted by Belongia Consultants, Inc. in December of 2018. During the geotechnical survey, a total of 15 borings were placed around the perimeter of the existing Landfill, with depths ranging from 19 to 34 feet below ground surface (bgs). Four samples were collected in the upper 10 feet of each boring and one sample was collected every 5 feet thereafter to boring termination. Blow counts were recorded during progression of each boring to determine the standard penetration resistance. No geotechnical sampling within existing cells was conducted due to the potential for contact with asbestos.

All samples were analyzed for moisture content and unit dry weight. Unconfined compression tests were conducted on cohesive soil (clay) samples and moisture content and/or hand penetrometer analysis were conducted on granular soil (silty or sandy soils, miscellaneous fills, weathered bedrock, or other hard material) samples when applicable. Atterberg limits analyses were conducted for selected samples.
Results of the geotechnical survey indicated low- to moderate-strength fat clay soil to depths ranging from approximately 5 to 12 feet bgs. The fat clay was underlain by moderate- to high-strength shaley fat clay to depths ranging from 9 to 19.5 feet. This intermixed clay and shale unit was generally underlain by shale bedrock to the bottoms of the borings. The geotechnical survey analysis estimated the long-term consolidation of the load from the vertical expansion of the Landfill would be less than 6 inches. No groundwater was encountered in any of the 15 borings. Geotechnical survey results are presented in Appendix 3.
3 Site Conditions

3.1 Cultural Features

2) The current Landfill site is within the boundaries of MCAAP. The closest residence is 10,100 feet from the Landfill (Figure 3). The closest normally occupied building, Ashland Ammunition Transfer Depot, is 6,800 feet away. There are three ammunition storage bunkers approximately 715 feet from the active portion of the Landfill. There are no public or private wells within 8,700 feet of the Landfill.

3) The closest airport is McAlester Field, approximately 11.5 air miles away (Figure 3).

4) There are two roads fronting the site, Ashland Road and Road B. Both are improved hard-surface asphalt roads. The roads are owned and maintained by MCAAP.

5) There are no utility lines, transmission lines or pipelines that impinge on the permitted area.

3.2 Geology

1) Regional Geology. The area is located to the west of the frontal margin of the Ouachita Mountains. MCAAP is located in the broad Krebs Syncline between the Savanna and McAlester anticlines. The Krebs Syncline plunges 4 to 10 degrees southwestward and becomes a topographic basin in T4N R13E. The Pennsylvanian Thurman Sandstone and Boggy Shale are the principal formations that outcrop in the MCAAP area. The Boggy Shale consists of thin sandstone beds alternating with thick shale beds. The sandstone seams are variable in thickness and character and often contain fossils. The shale beds are generally dark, platy to blocky, carbonaceous and fossiliferous. The Thurman Sandstone is medium- to fine-grained, light brown and moderately cemented. A detailed description of the area is found in U.S. Geological Survey (USGS) Bulletins 874A and 874B. Detailed geologic logs of the Landfill area are presented in Appendix 11.

2) Site Geology

a) Soils. The soil at the site is a residual clay formed from the weathering of the underlying Boggy Shale. The soil/rock interface is gradational and averages 6.5 feet deep. The upper soil horizon down to about 2.5 feet is classified by the Unified Soil Classification System as a low plasticity clay with a plasticity index (PI) of 14. It is a brown to brownish-gray, soft, damp to wet soil with organic material which becomes hard when dried. The portion passing the 200 mesh screen exceeds 80%. The lower horizon is classified as a clay with moderate plasticity, PI 30-35. It is a gray to tan-green, moderately stiff to hard, damp soil that grades into the shale below. The portion passing the 200 mesh screen generally exceeds 90%.
b) **Bedrock.** The formation underlying the Landfill is the Boggy Shale. As described in the geologic logs for core holes 117 and 118, it is a blocky, brown-gray to greenish black, slightly silty, moderately jointed, moderately soft to soft shale with some bedding evident in slightly more silty zones. The shale slakes rapidly when exposed to air. When treated like a soil and classified according to the Unified Soil Classification System, the shale is a clay with a PI of 19 to 35 with greater than 95% passing the 200 mesh screen. The upper shale zone, down to 27 or 28 feet, is slightly weathered as evidenced by some iron staining and softer strata. The shale below 27 to 28 feet is unweathered and similar to the weathered zone except for the presence of sub-rounded cemented siltstone nodules. A third shale zone containing pyritized plant fossils and brachiopoda fossils extends to 84 or 86 feet. Beneath the third zone, in the lowest zone, is a dark shale with a few tight joints. However, in core hole 118 from 85 feet, a discontinuous light gray siltstone grades at 90 feet into a 1.8-foot thick seam of fine- to medium-grained sandstone. The formation appears to be flat lying or with a small dip to the west, southwest. No faults or major structural features were encountered during the explorations. The permeability of the shale in the upper zones as measured in situ at five locations over the area varies from $4 \times 10^{-9}$ to $1 \times 10^{-6}$ cm/sec. A summary of the permeabilities is given in Table 1.

c) **Trench Cover.** The soil and shale excavated from the borrow area will have properties suitable for trench cover or backfill. The upper 2 1/2 feet of soil will be suitable for topsoil and capable of supporting plant growth within the first season.

<table>
<thead>
<tr>
<th>Table 1: Summary of Permeability Measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEPTH (feet)</td>
</tr>
<tr>
<td>HOLE 93</td>
</tr>
<tr>
<td>4.6 - 14.1</td>
</tr>
<tr>
<td>9.2 - 37.7</td>
</tr>
<tr>
<td>HOLE 113</td>
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<tr>
<td>3.5 - 15.5</td>
</tr>
<tr>
<td>5.3 - 19.1</td>
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<tr>
<td>HOLE 121</td>
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<tr>
<td>5.1 - 15.6</td>
</tr>
<tr>
<td>7.7 - 24.5</td>
</tr>
<tr>
<td>HOLE 104</td>
</tr>
<tr>
<td>3.1 - 15.5</td>
</tr>
<tr>
<td>4.9 - 21.5</td>
</tr>
<tr>
<td>HOLE 109</td>
</tr>
<tr>
<td>4.6 - 15.2</td>
</tr>
<tr>
<td>5.9 - 38.7</td>
</tr>
</tbody>
</table>

Permeability measurements were originally presented in the 1988 MCAAP Type V Permit Application.
3.3 Surface Water

1) Stream Flow. The general topography of the Landfill area can be seen in Figure 1. The site is near the top of a gentle hill. Sheet flow accounts for most of the water movement across the area. Three small intermittent streams collect the water and drain the area to the east. Figure 4 shows the drainage areas and watershed boundaries. A small pond is located immediately upstream from the Landfill on the south side of Ashland Road. There are no other ponds or lakes on the stream before its confluence with the unnamed intermittent east fork of Hominy Creek. The Zone A or 100-year flood for this unnamed creek can be seen on the National Flood Insurance Program (NFIP) Flood Hazard Boundary Map, Figure 5.

2) Water Quality. There are no specific water quality studies in Hominy Creek or further downstream in Coal Creek. The water should be considered good quality. Stream quality measured in Gaines Creek north of McAlester and in McGee Creek near Stringtown south of McAlester varies in sulphates from 7.8 to 239 milligrams per liter (mg/l), in chlorides from 2 to 24 mg/l, in dissolved solids from 30 to 470 mg/l, in hardness (as CaCO3) from 15 to 188 mg/l, and in specific conductance from 57 to 690 microhms/cm.

3.4 Groundwater

1) Water-Bearing Strata. The groundwater source is a permeable layer which apparently dips across the nearly flat lying strata to the northwest from a high in the southeast corner of the Landfill. Groundwater elevation data was collected during well sampling on February 8, 2017. During sampling, the highest water encountered was in MW-124B at an elevation of 753.79 feet, while the lowest water encountered was in MW-117 at an elevation of 722 feet. The recharge area for the first groundwater zone under the Landfill is immediately to the south and east of the Landfill along Ashland Road. The plane of the water bearing strata outcrops in the stream valley and surface water percolates through the overburden into the groundwater system. A map of the depth contour of water bearing strata is presented with the historical landfill plates in Appendix 10.

2) Potentiometric Surface. The groundwater is confined below a thick low-permeability shale. The potentiometric surface dips to the northwest at an increasing gradient which averages 0.014. The steeper gradient to the northwest indicates a decreasing permeability within the water-bearing strata. A potentiometric surface map is presented with the historical landfill plates in Appendix 10.

3) Groundwater Quality and Use. Groundwater in three monitoring wells at MCAAP Sediment Retention Basin in Section 23, T4N, R13E from a similar strata of the Boggy Shale has from 210 to 300 mg/l chloride, 1,800 to 2,800 mg/l sulfate, and a specific conductance of 4.3 to 7.1 microhms/cm. There are no domestic or private water supply
wells within 1/2 mile or municipal or public water supply wells within 1 mile of the proposed site boundary. The closest to the Landfill that a public or private well could be drilled without permission of MCAAP is 8,700 feet.
Figure 3
Cultural Features Map

Legend
- ★ MCAAP NHIW Landfill
- Airport
- Nearest Residence

MCAPP Site Boundary

Map Created by: Ben Bockelmann
Prepared by:

June 10, 2019

MCAAP NHIW LANDFILL
McAlester, OK

Project Manager: Charles McComas

June 10, 2019
Map Created by: Ben Bockelmann
Prepared by:

ALLCONSULTING
Figure 4
Watershed Boundary Map
Figure 5
FEMA Flood Map

Legend
- Site Boundary
- Flood Zone A

MCAAP NHIW LANDFILL
McAlester, OK

Project Manager: Charles McComas
November 08, 2019

Map Created by: Ben Bockelmann
4 Vertical Expansion Development

4.1 Construction Sequence

The Landfill will be developed in six phases, with each phase located on top of the current Landfill. The six phases will progress from the northern side of the Landfill, with each subsequent phase expanding to the south (Figure 2). The phases will be constructed for the purpose of managing and maintaining the waste disposal operations within the smallest practical area. This will aid in diverting storm water away from the active working face. Detailed description of the vertical expansion construction sequence is presented in Appendix 7.

Additional soil will be sourced from the on-site borrow area. The location of the borrow area is shown in Figure 1 and Figure 2. The on-site soil borrow area shall be reshaped and revegetated, or otherwise reclaimed, to blend with surrounding terrain within 180 days of the date the area ceased being used in accordance with Oklahoma Administrative Code (OAC) 252:515-19-55.

The process of closing the Landfill will occur in stages as designed final elevations for each phase are reached. Most of the closure activities including maintenance and care will be completed during standard operation of the Landfill. The full Landfill Closure Plan is provided in Appendix 9.

4.2 Volume Calculations

Volume calculations are provided with the Life and Design Calculations in Appendix 5.

4.3 Drainage

Drainage from the Landfill will be designed, constructed, and maintained to conform to the requirements of OAC 252:515-17-2. This includes a run-on control system to prevent flow onto active portions of the facility during the peak discharge from a 24-hr, 25-year storm; and a run-off control system with sufficient capacity to collect and control all contaminated storm water resulting from a 24-hr, 25-year storm.

Storm water runoff within the waste disposal boundary is captured within the Landfill’s storm water system. The storm water system is made up of diversion ditches, down chutes and perimeter storm water channels. The perimeter channels will be reconstructed in accordance with the new design to accommodate increased flows from the vertical expansion as the expansion is constructed. Run-off calculations and graphs for diversion ditches are proved in Appendix 4.

4.4 Construction Equipment

Construction equipment is covered in Section 5.2.
5 Site Operations

The Landfill Operation Plan is included as Appendix 7 and includes general Landfill operation considerations for litter control, asbestos handling, erosion control for the soil borrow area, and descriptions of daily cover and lift construction procedures.

The Landfill will be environmentally safe and will not be a nuisance to adjacent areas when the procedures listed below are properly followed. It will also reduce hazards caused by vectors such as rats, flies, skunks and other scavengers.

5.1 Operating Hours

The normal operating hours for the Landfill are from 0730 to 1500 hours, Monday through Thursday except on holidays. The operating hours may change during times when specific high-priority projects conducted within MCAAP are needed. Asbestos will be disposed of by appointment only.

5.2 Personnel and Equipment

An equipment operator/attendant will be on duty anytime wastes are delivered to the Landfill.

1) A portable building and sanitary facilities will be provided for employee office, shelter and comfort. A telephone or other means of communication will be provided for emergency communication.

2) The following equipment or equal will be used for excavation of the soil borrow area, daily operations, and site maintenance:
   a) Crawler/dragger
   b) Scrapper
   c) D-7 dozer
   d) Compactor/Dozer

   The crawler/dragger, scrapper, and D-7 dozer will be used for daily soil cover excavation and earth movement. The compactor/dozer will be used primarily for the day-to-day operations of spreading, compacting and covering the daily fill. The D-7 dozer will be used as a backup for the compactor/dozer.

3) Health and safety equipment will be available on site in accordance with MCAAP safety regulations to include fire extinguishers and first aid supplies.

5.3 Public Access Control

Public access is to the Landfill is not allowed by the MCAAP. Access to the Landfill is controlled by the MCAAP, which is a secured military facility. Artificial and/or natural barriers shall be used to discourage unauthorized traffic and uncontrolled dumping. Vehicular access will be restricted by a locked gate.
5.4 Solid Waste Acceptance

The Landfill is permitted to handle NHIW and asbestos from operations at the MCAAP. All waste delivered to the Landfill will be measured using the facility’s scale that is tested and certified annually in accordance with OAC 252:515-19-33(a)(2). If the scale is inoperative, tonnage shall be estimated on a volume basis where 1 cy of waste shall be calculated to weigh 1/3 ton.

Fees and monthly reports are to be submitted to the ODEQ and filed in the operating record. Copies of the monthly and quarterly reporting forms to be submitted to the ODEQ are included in Appendix 7. Monthly reports shall be filed in the operating record and submitted to the ODEQ no later than the 15th of the month following the reporting period.

5.5 Operating Procedures

1) Progression. The Landfill will continue with the progression of the trench landfilling until the footprint of the proposed vertical expansion area is complete. The vertical expansion of the Landfill will occur in a sequence of six phases as described in Appendix 7. Phase I will begin at the northern side of the Landfill, with each subsequent phase expanding to the south. As maximum slopes of 4 feet horizontal to 1 foot vertical are achieved, the landfilling will move to the south.

   Waste Placement. Waste material will be deposited in the area identified as the working face. The slope of the working face will be no more than 4:1. The spreading and compaction operations are performed using a waste compactor with a push blade. The height of waste will generally not exceed 10 feet in height and is referred to as a lift. The width of the working face will be kept as small as practical. The waste will be placed next to the previous day's waste as described in Appendix 7.

2) Asbestos Management. Asbestos Containing Material (ACM) is regulated under 40 CFR Part 61, Subpart M and 29 CFR 1826.1101 and requires special handling and disposal practices. Disposition of asbestos will be in accordance with MCAAP’s EM Plan 55. Asbestos will be disposed of in the Landfill "by appointment" only; that is, the date and time for placing asbestos in the Landfill will be arranged with the Landfill operator in advance. The asbestos disposition area is separate from the industrial waste area. Only asbestos certified personnel will be allowed in the asbestos disposition area while an active burial is being conducted. During ACM activities, no other types of waste will be accepted; the Landfill will be closed until the ACM is placed in the disposition area and ready for covering.

3) Daily and Intermediate Cover. Daily and intermediate cover will be applied in accordance with OAC 252:515-19-51(c)(1) and OAC 252:515-19-52. Each working day, 6 inches of daily cover material will be applied over solid waste disposed at the facility. This material shall consist of earthen material that is free of garbage, trash, or other unsuitable materials. Waste disposal areas that are not protected by final cover or managed with runoff control structures must receive intermediate cover consisting of an additional 12 inches of compacted earthen material capable of sustaining
vegetation. This earthen material shall also be free of garbage, trash, or unsuitable material. Vegetative cover (or ODEQ-approved alternate material) will be established and maintained at the Landfill for areas that remain inactive for a period of more than 1 year.

4) **Final Cover.** The final cover vegetation must be effective, long-lasting, and capable of self-regeneration and plant succession. Vegetation shall consist of species that are equal or superior to native vegetation during each season of the year. Permanent or interim vegetation shall be established in areas that have been undisturbed for 90 days or more.

The final cover will be constructed when or as the final elevations of waste placement are achieved and will consist of a uniform layer of low shrink-swell clay equivalent to the natural liner material and will be compacted in no more than 8-inch lifts to a depth of 2 feet over the entire surface of the Landfill. A 12-inch layer of soil suitable for topsoil and capable of sustaining plant growth will be placed on the clay cover and vegetated.

5) **Borrow Source.** The on-site soil borrow area shall be reshaped and revegetated, or otherwise reclaimed, to blend with surrounding terrain within 180 days of the date the area ceased being used in accordance with OAC 252:515-19-55.

5.6 **Storm Water Management**

The storm water management plan for the Landfill includes provisions for control of storm water run-on and run-off associated with a 24-hour, 25-year storm event. During operations, storm water from the landfill area will be diverted to temporary ditches which will be routed to the perimeter storm water channels. The perimeter storm water channels then route the run-off to the proposed storm water pond. The storm water pond is designed to control the runoff from a 24-hour, 25-year storm event. During storm events less than a 24-hour, 25-year storm, the pond is designed with a skimmer to reduce total suspended solids before releasing them downstream to the existing pond. Stormwater management also includes controlling rainfall from outside permit boundary. This run-on is diverted around the landfill by perimeter berms and drainage channels. The Storm Water Run-on/Run-off Plan is included as Appendix 8.

5.7 **Leachate Management**

Storm water that interfaces with waste in the working face of the Landfill will be contained by temporary run-off ditches. The leachate will be allowed to be evaporated or absorbed by the underlying waste/earthen daily cover material. If the leachate does not evaporate or becomes an issue to contain, the Landfill will haul the leachate offsite for disposal.
6 Maintenance and Safety

6.1 Fire Safety
Fire extinguishers are provided for fire protection purposes on all equipment. MCAAP maintains an emergency response plan for the entire installation including the Landfill. The facility emergency response plan will be regularly updated to consider current Landfill operations. All employees will be familiar with emergency response and evacuation procedures.

6.2 Vectors
In general, vectors will not find suitable harborage in the Landfill due to the compaction and covering of the waste. However, if a vector problem should arise, an assessment of the operating conditions will be made and necessary corrective actions will be taken. If the vector problem persists after initial corrective action, a professional exterminator will be hired to mitigate the problem.

6.3 Litter Control
Blowing litter will be controlled in accordance with OAC 252:515-19-35. The Landfill will conduct unloading of waste in such a manner to reduce the blowing of waste from outside the working face. The working face will be covered at the end of each day as well as when necessary during the operational day to help minimize the scattering of waste. In addition, mobile litter fencing will be placed downwind of the active area during windy weather periods.

6.4 Dust Control
Dust resulting from vehicular traffic, construction activity, and Landfill operations will be kept to a minimum within the property through the utilization of a water truck, road base material, and/or vegetation establishment. If necessary, a water truck is utilized throughout the day to apply water to various haul roads throughout the site. During the life of the Landfill, water will be applied to the access roads to control dust on as-needed basis.
7 Monitoring

7.1 Surface Water

There are no perennial streams within 1/2 mile of the Landfill. There are no receiving lakes or impoundments within 1 mile downstream of the Landfill. Surface water quarterly monitoring will be conducted to comply with the facility’s approved Oklahoma Pollutant Discharge Elimination System (OPDES) general permit. The facility is not required to conduct annual numeric effluent monitoring for the landfill. Figure 4 is a watershed map of the Landfill area.

7.2 Groundwater

1) **Groundwater Monitoring Program.** The groundwater monitoring program is included as Appendix 6.

2) **Monitoring Well Installation.** One upgradient (MW-125) and three downgradient wells (MW-123, MW-124, and MW-117) were initially installed in 1987 to monitor the groundwater at the Landfill. Three of the four monitoring wells, MW-123, MW-124, and MW-125 were air drilled to the first water zone with a 7 7/8-inch rock bit. The fourth monitoring well, MW-117, was installed in core boring 117 which was reamed out with air to 7 7/8-inches. Core boring 117 was air cored to 100 feet. It encountered minor water at about 80 feet and no additional water zones were encountered below the first. Four-inch poly-vinyl-chloride (PVC) Schedule 40 pipe well casing with a 10-foot, 0.010-inch slotted screen was placed in each well. A 5-foot sump was placed in each downgradient well and a 2 1/2-foot sump was placed on the upgradient well. From experience in other wells in the Boggy Shale, the sump aids in preventing the screen from being clogged with clay particles. In the three downgradient wells, a sand filter was placed in the annular space to about 30 feet in order to provide reservoir capacity for very slowly recovering wells. In the upgradient well, the sand filter was brought up to 22.5 feet. Bentonite balls were hydrated with water and allowed to swell before the remainder of the hole was filled with cement/bentonite grout. A locking protective cover and three protective bollards were cemented into a 4-foot square concrete pad for each well.

MW-124 monitored a very low permeability zone that was initially thought to be dry. As a result, MW-126 was installed in 1987 as a backup for MW-124 in the event it could not be sampled. MW-126 was drilled with a 5 5/8-inch drag bit by the USGS and set with 2-inch screw joint casing to the next lower water zone. The well was bottomed at 120 feet with a 10-foot, 0.010-inch slotted screen from 119 to 109 feet, a sand filter to 102 feet, and bentonite balls to 89 feet with the remainder of the annulus backfilled with cement/bentonite grout.

Monitoring wells MW-123A and MW-124A were installed in 2004 as replacements to monitoring wells MW-123 and MW-124, respectively. Monitoring wells MW-123 and MW-124 were decommissioned by USACE in 2005. In November of 2006, monitoring well MW-124B was installed as a replacement of monitoring well MW-124A, which
demonstrated consistent elevated turbidity levels and a decrease in groundwater elevation of approximately 40 feet since its installation in September 2005. In August of 2013, monitoring well MW-LF-1 was installed to provide additional hydraulically downgradient coverage along the Landfill’s north-northwest boundary. Monitoring well MW-126 was decommissioned in August 2013.

In February 2015, monitoring well MW-LF-2 was constructed approximately 300 feet south of the landfill’s northeast corner boundary. The monitoring well was installed due to the potential for northeast groundwater flow identified in previous reports. The well borehole was drilled using a Mobile Drill B-80 air drilling rig equipped with an air rotary bit. Well boreholes were advanced with a 7 3/4-inch roller cone bit attached to API air rod. Rod flights of 10 feet were utilized for borehole advancement to a total depth of approximately 37 feet. After the final depth of the borehole was achieved, drilling rods and roller cone drill bit were removed from the borehole. The monitoring well was constructed inside the open borehole. The well was constructed with 4-inch Schedule 40 PVC pipe connected by screw threads to a 10-foot section of 4-inch Schedule 40 PVC screen with 0.01-inch slotted openings. The screened interval of the borehole was packed with a commercial fine to medium sand and sealed with bentonite. The well was constructed in accordance with standard procedures for the construction of groundwater monitoring well. The protective casing was set in a 36-inch square concrete pad and surrounded by three protective bollards.

Monitoring well schematics are presented in Appendix 12.

7.3 Gas

Explosive gas is not considered a problem due to the remote area and the absence of permanent structures within 700 feet of the Landfill. No formal gas monitoring programs are proposed. Explosive gas may, however, collect in low areas and in unventilated temporary structures. A portable explosive gas monitor will be used in the temporary workers building to detect the presence of explosive gas.
8 Landfill Expansion Design Sheets

Landfill expansion design drawings are presented in this Section.
NOTES:
1. EXISTING GRADES BASED ON SURVEY PERFORMED ON NOVEMBER 22, 2018 BY BENCHMARK SURVEYING.
2. CROSS-SECTION LOCATION PROVIDED ON SHEET C-5.
3. FINAL COVER, ACCESS ROAD AND STORM WATER CHANNEL DETAILS PROVIDED ON SHEET C-11.
NOTES:
1. EXISTING GRADES BASED ON SURVEY PERFORMED ON NOVEMBER 28, 2018 BY BENCHMARK SURVEYING.
2. CROSS-SECTION LOCATION PROVIDED ON SHEET C-5.
3. FINAL COVER, ACCESS ROAD AND STORM WATER CHANNEL DETAILS PROVIDED ON SHEET C-11.
NOTES:
1. EXISTING GRADES BASED ON SURVEY PERFORMED ON NOVEMBER 28, 2016 BY BENCHMARK SURVEYING.
2. CROSS-SECTION LOCATION PROVIDED ON SHEET C-5.
3. FINAL COVER, ACCESS ROAD AND STORM WATER CHANNEL DETAILS PROVIDED ON SHEET C-12.
NOTES:
1. EXISTING GRADES BASED ON SURVEY PERFORMED ON NOVEMBER 29, 2018 BY BENCHMARK SURVEYING.
2. CROSS-SECTION LOCATION PROVIDED ON SHEET C-6.
3. FINAL COVER, ACCESS ROAD AND STORM WATER CHANNEL DETAILS PROVIDED ON SHEET C-12.
Appendix 1
Proof of Ownership
Honorable Robert S. Kerr,
Governor of Oklahoma,
Oklahoma City, Oklahoma.

Dear Governor Kerr:

The laws of the State of Oklahoma (sections 1, 2, 3, and 4, title 60, Oklahoma Statutes, 1941) permit the assumption of exclusive Federal jurisdiction over lands within the State, acquired by the United States for military and certain other purposes.

Under section 366, Revised Statutes, as amended by the act of February 1, 1940 (54 Stat. 10), and by the act of October 9, 1940 (64 Stat. 1053; 40 U.S.C. 255), it is provided in effect that unless and until the United States has accepted jurisdiction over lands acquired or in which any interest shall have been acquired after February 1, 1940, it shall be conclusively presumed that no such jurisdiction has been accepted.

Accordingly, notice is hereby given that the United States accepts exclusive jurisdiction over all lands acquired by it for military purposes within the State of Oklahoma, title to which has heretofore vested in the United States, and over which exclusive jurisdiction has not heretofore been obtained.

It is requested that you return the enclosed copy of this letter, with an endorsement thereon over your signature stating the date of your receipt of this notice.

Sincerely yours,

HENRY L. STILSON
Secretary of War.

The original of this letter of acceptance was received in the office of the Governor on the 1st day of April, 1943.

[Signature]
Governor of the State of Oklahoma
From: Chief of Naval Operations

Subject: Disestablishment of the Naval Ammunition Depots Located at Bartow, Savanna and Holalest, Georgia

1. Authority. The Secretary of the Navy, effective 24 September 1977, has approved the disestablishment of the following three activities, assigned to the Chief of Naval Operations for command and support:

   a. Commanding Officer
      Naval Ammunition Depot
      Bartow, GA 39823
      (Ext: 2012) (Short Title: NAD BARTOW GA)
      (Activity Code: 1314-44) (IC): 34238

   b. Commanding Officer
      Naval Ammunition Depot
      Holalest, GA 73501
      (Ext: 7391) (Short Title: NAD HOLALEST GA)
      (Activity Code: 1314-44) (IC): 34162

2. Implementation. Commanders, billets, and actions concerned are requested to take necessary action.

3. Information. The subject three activities being disestablished are not under headquarters activities.

4. Cancellation (Endorsement). This notice may be retained for reference purposes.

Distribution:

[Signature]

[Title]

[Department of the Navy]
DEPARTMENT OF THE ARMY
HEADQUARTERS US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
5001 Eisenhower Ave, Alexandria, VA 22333

PERMANENT ORDERS 57-1

1. Hawthorne Army Ammunition Plant XQ (W39YAA) CCNUM X10178 Hawthorne, Nevada 89415

Following organization/unit action directed.

Action: Unit reorganized
Assigned to: US Army Armament Materiel Readiness Command (ARRCOM)
Mission: As stated in Section I, TDA XQW39YAA.
Effective date: 1 October 1977
Military structure strength: 9 officers, 9 aggregate
Military authorized strength: 9 officers, 9 aggregate
Civilian structure strength: 778 DHUS, 778 aggregate
Civilian authorized strength: 758 DHUS, 758 aggregate
Accounting classification: N/A
Additional instructions: None
Format: 740

2. McAlester Army Ammunition Plant XQ (W390AA) CCNUM X10178 McAlester, Oklahoma 74501

Following organization/unit action directed.

Assigned to: US Army Armament Materiel Readiness Command (ARRCOM)
Mission: As stated in Section I, TDA XQW390AA.
Effective date: 1 October 1977
Military structure strength: 7 officers, 7 aggregate
Military authorized strength: 7 officers, 7 aggregate
Civilian structure strength: 808 DHUS, 808 aggregate
Civilian authorized strength: 778 DHUS, 778 aggregate
Accounting classification: N/A
Additional instructions: None
Format: 740
PERMANENT ORDERS 57-1, HQ DARCOM, 18 Jul 1977

3. Crane Army Ammunition Activity XQ (W39ZAA) CCNUM X10173
Crane, Indiana 47522

Following organization/unit action directed.

Action: Unit reorganized
Assigned to: US Army Armament Materiel Readiness Command (ARRCOM)
Mission: As stated in Section I, TDA XQW39ZAA
Effective date: 1 October 1977
Military structure strength: 2 officers, 2 aggregate
Military authorized strength: 2 officers, 2 aggregate
Civilian structure strength: 751 DHUS, 751 aggregate
Civilian authorized strength: 749 DHUS, 749 aggregate
Accounting classification: N/A
Authority: DOD Directive 5160.65, 26 November 1975, subject: Single
Manager Assignment for Conventional Ammunition
Additional instructions: None
Former: 740

FOR THE COMMANDER:

DISTRIBUTION
A and B
6--DRCCP
2--DRCCG-S
3--DRCIG
1--DRCIN
3--DRCIS-ER
1--DRCFA-M
4--DRCFA-O
1--DRCFA-P
2--DRCP-T-ME
2--DRCP-T-MT
2--DRCP-T-S
2--DRCP-T-SA
2--DRCP-T-SP
2--DRCP-T-SR
1--DRCA-AR
14--HQDA (12-DAAG-OPR); (2-DAAG-HDA), Forrestal Bldg, WASH DC 20314
1--HQDA (DADE-FDA), Pentagon, WASH DC 20310
1--Cdr, DARCOM M11 Pers Mgt Det, Edgewood Activity, MD 21010
20--DRCM-TM
1--Cdr, TRADOC, ATTN: ATLOG-NAT-PM, Fort Monroe, VA 23651
1--DRCM-TS
5--Cdr, Crane Army Ammunition Activity, Crane, IN 47522
5--Cdr, Hawthorne Army Ammunition Plant, Hawthorne, NV 89415
5--Cdr, McAlester Army Ammunition Plant, McAlester, OK 74501
5--Cdr, HQ ARRCOM, Rock Island, IL 61201
Appendix 2
Proof of Publication
TITLE
U. S. ARMY AMMUNITION PLANT

STATE OF OKLAHOMA,
COUNTY OF TULSA } ss.

AFFIDAVIT:

I, Teri Forman, of lawful age, being duly sworn, upon oath deposes
and says that he is the clerk of Tulsa World, a daily newspaper printed in
the City of Tulsa, County of Tulsa, State of Oklahoma, and of a bona fide paid general circulation therein,
printed in the English language, and that the notice by publication, a copy of which is hereto attached, was
published in said newspaper for one days, the first publication being on
the 20th day of April 1988, and the last day of publication being on the
20th day of April 1988,

The advertisement above referred to, a true and printed copy of which is hereto attached, was published in
newspaper on the following dates, to wit:

April 20, 1988

Said notice was published in the regular edition of said newspaper and not in a supplement thereof.

Signature

Publishing Fee $47.00
Notary fee $47.00
TOTAL $47.00

Subscribed and sworn to before me this 20th day of April A. D. 1988.
PROOF OF PUBLICATION

TITLE . . . U.S. ARMY AMMUNITION PLANT

STATE OF OKLAHOMA,
COUNTY OF TULSA

AFFIDAVIT:

I, Teri Forman, of lawful age, being duly sworn, upon oath deposes and says that he is the clerk of Tulsa Tribune, a daily newspaper printed in the City of Tulsa, County of Tulsa, State of Oklahoma, and of a bona fide paid general circulation therein, published in the English language, and that the notice by publication, a copy of which is hereto attached, was published in said newspaper for one day, the first publication being on the 20th day of April, 1988, and the last day of publication being on the 20th day of April, 1988, and that said newspaper has been continuously and uninterruptedly published in said county during the period of more than One Hundred and Four (104) weeks consecutively, prior to the first publication of said notice, or advertisement, as required by Section one, Chapter four, Title 25 Oklahoma Session Laws, 1943, as amended by House Bill No. 496, 22d Legislature, and thereafter, and complies with all of the prescriptions and requirements of the laws of Oklahoma. (The advertisement above referred to is a true and printed copy. Said notice was published in all editions of said newspaper and not in a supplement thereof.)

The advertisement above referred to, a true and printed copy of which is hereto attached, was published in said newspaper on the following dates, to wit:

April 20, 1988

Said notice was published in the regular edition of said newspaper and not in a supplement thereof.

Publishing Fee . . . . $47.00

Notary fee . . . . $ .

TOTAL . . . . $47.00

Subscribed and sworn to before me this 20th day of April, 1988

Signature

ATTACHMENT (HERE) 1. Empty cardboard boxes
2. Plastic bottles
3. Empty crushed cans of paint, paint thinner, etc.
4. Metal furnishings coated with materials
5. Inert plastic material
6. Small volumes of sandwich wrappings and pop bottles
7. Contaminated asbestos
8. Water treatment plant clarifier sludge/filter backwash
9. Sewage sludge
10. Surplus, assembling and packing of munitions and the operations, and maintenance of the facility. If more specific information is desired, it may obtained by contacting the director, or his designated representative at the U.S. Army Ammunition Plant, ATTN: SMECENS OCP, McAlester, Oklahoma 74501-5000, (918) 421-255 or by contacting the Director of the Solid Waste Division, OGD at 4601-711-525, 400 N. E. 7th Street, P.O. Box 5515, Oklahoma City, Oklahoma 73105.

Any person residing or doing business in Oklahoma may, within thirty (30) days of the date of the publication of this notice, submit written notice of opposition and request for a formal public meeting shall be mailed to the Solid Waste Division of the Oklahoma State Department of
Affidavit of Publication

State of Oklahoma  
County of Pittsburg  

_________________________, of lawful age, being duly sworn and authorized, says that he

is General Manager of the McAlester News-Capital and Democrat, a daily newspaper printed in the City of McAlester, Pittsburg County, Oklahoma, a newspaper qualified to publish legal notice, advertisements and publications as provided in Section 106 of title 25, Oklahoma Statutes 1961, as amended, and complies with all other requirements of the laws of Oklahoma with reference to legal publications.

That said notice, a true copy of which is attached hereto, was published in the regular edition of said newspaper during the period and time of publication and not in a supplement, on

the following dates:

April 20, 1988

__________________________
Owen Jones

Subscribed and sworn to before me this 20 day of April, 1988

__________________________
Kathie Casey
Notary Public

My commission expires:

Nov. 19, 1989

Publication Fees, $62.23
feet; thence 57°43'00"W a distance of 705.00 feet; thence 52°80'00"W a distance of 120 feet; thence 10°30'00"E a distance of 160.00 feet; thence 58°10'00"W a distance of 283.00 feet; thence 10°00'00"W a distance of 51.30 feet; thence 58°10'00"W a distance of 1450.00 feet to the point of beginning; said tract containing 49.279 acres more or less.

This would be a Type I solid waste disposal site or facility for the disposal of:

1. Empty cardboard boxes
2. Plastic bottles
3. Empty crushed cans of paint, paint thinner, etc.
4. Metal turnings coated with machine oil
5. Inert plastic material
6. Small volumes of sandwich wrappings and pop bottles
7. Containerized asbestos
8. Water treatment plant clarifier sludge/filtered backwash
9. Sewage sludge from load-assembling and packing of munitions and the operations and maintenance of the facility.

If more specific information is desired, it may be obtained by contacting the applicant, or his designated representative at Commander, McAlester Army Ammunition Plant, ATTN: SMCMC-DEM, McAlester, Oklahoma 74501-9500, (918) 241-2551, or by contacting the Director of the Solid Waste Division, OSDH at (405) 271-5338, 1000 N.E. 10th Street, P.O. Box 53551, Oklahoma City, Oklahoma 73152.

Comments and requests for a formal public meeting should be mailed to the Solid Waste Division of the Oklahoma State Department of Health, P.O. Box 53551, Oklahoma City, Oklahoma 73152.
Appendix 3
Copies of Soil Test Results
SUBSURFACE EXPLORATION REPORT

PROPOSED LANDFILL MODIFICATIONS
McALESTER ARMY AMMUNITION PLANT
McALESTER, OKLAHOMA

Project No. 1185060
December 21, 2018

Prepared for:
ALL CONSULTING
Tulsa, Oklahoma

Prepared by:
BELONGIA CONSULTANTS INC.
Broken Arrow, Oklahoma
December 21, 2018

ALL Consulting
1718 South Cheyenne Ave
Tulsa, Oklahoma 74119

Attention: Mr. Gavin James, PE

Re: Subsurface Exploration
    Proposed Landfill Modifications
    McAlester Army Ammunition Plant
    McAlester, Oklahoma
    Project No. 1185060

Dear Mr. James:

We are submitting, herewith, the results of the subsurface exploration performed for the
proposed landfill modifications at the McAlester Army Ammunition Plant in McAlester,
Oklahoma.

The borings generally encountered low to moderate strength, fat clay soil to depths
ranging from about 5 to 12 feet. The fat clay was underlain by moderate to high strength
shaley fat clay to depths ranging from 9 to 19.5 feet. The overburden soils were underlain
by shale bedrock to the bottom of the borings. General comments regarding potential
consolidation of the soils supporting the new landfill are presented in the following report.

If you have any questions regarding the contents of this report or if we can be of further
service, please do not hesitate to contact us.

Sincerely,

Belongia Consultants Inc.

David L. Belongia, PE
Oklahoma No. 12908

DLB:PS
Enclosure
Copies To: Addresssee (1)
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INTRODUCTION

This report presents the results of the subsurface exploration and geotechnical engineering services for the proposed landfill modifications at the McAlester Army Ammunition Plant in McAlester, Oklahoma. Fifteen soil borings extending to depths ranging from about 19 to 34 feet were drilled as part of the exploration. The results of the borings and a boring location diagram are attached.

We understand the project involves converting a trench type landfill to a pyramid type landfill. As part of this conversion, it is proposed to add about 75 feet of landfill material to the existing landfill.

The purpose of this report is to describe the subsurface conditions encountered in the borings; analyze the data obtained and provide general comments regarding potential consolidation of the soils supporting the new landfill.

SUBSURFACE EXPLORATION PROCEDURES

Fifteen soil borings were drilled for the project. The borings were staked in the field by ALL Consulting personnel. The boring locations should be considered accurate only to the degree implied by the methods used to locate them.

The borings were drilled with a truck mounted drill rig using continuous hollow stem augers to advance the borings. Representative soil samples were obtained using the split-barrel and thin wall tube sampling procedure in general accordance with the appropriate ASTM procedure.

Disturbed samples are obtained in the split-barrel sampling procedure by driving a 2-inch O.D. split-barrel sampler into the ground using a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler were recorded in the field and are shown on the boring logs as the standard penetration resistance (SPT-N) value. The number of blows required to advance the sampler the final 12 inches or less of a standard 18-inch sampling interval indicate the in-place relative density of granular soils
and, to a lesser degree of accuracy, the consistency of cohesive soils, and the hardness of weathered bedrock. A greater efficiency is achieved with the automatic hammer, compared to the conventional safety hammer operated with a cathead and rope. The effect of this increased efficiency has been considered in interpreting the standard penetration resistance values for this project.

In the thin wall tube sampling procedure, a thin wall steel tube is hydraulically pushed into the soil to obtain a relatively undisturbed soil sample.

The soil samples obtained in the field were sealed and returned to our laboratory for further examination, testing and classification.

During the drilling operation, field boring logs were prepared by the drill crew. These logs report drilling and sampling methods, sampling intervals, soil and groundwater conditions encountered, and the driller’s visual evaluation of the conditions between samples. The final boring logs, included in this report, has been prepared based on the driller’s field logs and has been modified, where appropriate, based on the results of the laboratory observation and testing.

LABORATORY TESTING PROGRAM

Moisture content and, where applicable, calibrated hand penetrometer tests were performed on the split-barrel samples. The calibrated penetrometer test provides an indication of the unconfined compressive strength of a cohesive soil. In addition, unconfined compressive strength and dry unit weight tests were performed on selected portions of the thin wall tube samples.

In addition, Atterberg limits tests were performed on selected soil samples. The Atterberg limits indicate the plasticity of a cohesive soil and are used to approximate the soil’s potential for volume change with variation in moisture content. The laboratory test results are reported on the boring logs.

The soil samples were examined in our laboratory by an experienced geotechnical engineer and were classified based on the soil’s texture and plasticity in accordance with the attached General Notes and Unified Soil Classification System. The estimated Unified System group symbols are shown on the boring log. A brief description of the Unified Soil Classification System is attached. Disturbed samples of the bedrock materials were classified in accordance with the General Notes and described using commonly accepted geotechnical terminology. Petrographic analysis may reveal other rock types.
SUBSURFACE CONDITIONS

The subsurface conditions encountered at the boring locations are shown on the attached boring logs and are briefly described below. The stratification lines on the boring logs represent the approximate boundary between soil and rock types; in-situ, the transition between materials may be gradual and indistinct.

Three to four inches of surface vegetation and topsoil was encountered at some of the boring locations. Fill material consisting of brown and dark brown, lean and lean to fat clay with varying amounts of gravel was encountered at boring locations B-1, B-4, B-5 and B-7, to depths of about 2 feet. The surface materials, where encountered, were underlain by dark brown, brown, reddish brown and gray, fat clay, trace gravel to depths ranging from about 5 to 12 feet. The fat clay was underlain by olive brown and gray, shaley fat clay to depths ranging from about 9 to 19.5 feet. The clay was underlain by olive gray to gray, highly weathered shale, trace sandstone, which extended to the bottom of the borings.

GROUNDWATER CONDITIONS

Groundwater level observations were made while drilling and immediately after completing the borings to evaluate groundwater conditions. As shown in the lower left corner of the boring logs, no groundwater was encountered in the borings at these times.

The groundwater level observations made during our exploration provide an indication of the groundwater conditions at the time the boring was performed. Longer monitoring in piezometers or cased holes would be required to evaluate longer-term groundwater conditions. Fluctuations in the amount of perched water, if any, and groundwater levels should be expected throughout the years depending upon variations in the amount of rainfall, runoff, evaporation, and other hydrological factors not apparent at the time of our exploration.

ANALYSIS AND RECOMMENDATIONS

Geotechnical Considerations

We understand the existing landfill consists of 45 to 50 foot wide trenches that extend to depths ranging from about 7 to 20 feet below existing grade. There is an approximate 7 foot wide buffer between each trench.

The borings generally encountered low to moderate strength, fat clay soil to depths ranging from about 5 to 12 feet. The fat clay was underlain by moderate to high strength
shaley fat clay to depths ranging from 9 to 19.5 feet. The overburden soils were underlain by shale bedrock to the bottom of the borings.

Based on the results of the borings, it is assumed that the trenches extend into the moderate to high strength, shaley fat clay. Based on estimated weights for the waste material and daily cover, the maximum stress that would be transferred to the underlying soil would be about 3800 pounds per square foot.

Assuming the bottom of trenches are extended into the shaley clay, we estimate the long term consolidation of the shaley clay, due to the above load, would be less than 6 inches. Of course, some long term consolidation of the waste material and daily cover would also occur.

GENERAL COMMENTS

The general comments presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations which may occur away from the borings or across the site. The nature and extent of such variations may not become evident until construction.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Belongia Consultants reviews the changes, and either verifies or modifies the conclusions of this report in writing.
# LOG OF BORING NO. B-1

## SITE
McAlester Army Ammunition Plant
McAlester, Oklahoma

## PROJECT
Proposed Landfill Modifications

### GRAPHIC LOG

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<th>RECOVERY, %</th>
<th>SPT BLOWS / ft</th>
<th>WATER CONTENT, %</th>
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The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

### WATER LEVEL OBSERVATIONS, ft

- WL: None WD

### Belongia Consultants, Inc.

- BORING STARTED: 11-14-18
- BORING COMPLETED: 11-14-18
- RIG: CME 45
- FOREMAN: TB
- APPROVED: DLB
- JOB #: 1185060
# LOG OF BORING NO. B-2

## CLIENT
McAlester Army Ammunition Plant
McAlester, Oklahoma

## ENGINEER
ALL Consulting

## SITE

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The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

## WATER LEVEL OBSERVATIONS, ft

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<tr>
<th>WL</th>
<th>None WD</th>
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## BORING OBSERVATIONS

| BORING STARTED | 11-14-18 |
| BORING COMPLETED | 11-14-18 |

## Equipment

| RIG | CME-45 |
| FOREMAN | TB |

## APPROVALS

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| JOB # | 1185060 |</p>
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The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft
WL None WD
WL
WL

Belongia Consultants, Inc.

BORING STARTED 11-14-18
BORING COMPLETED 11-14-18
RIG CME-45 FOREMAN TB
APPROVED DLB JOB # 1185060
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**Continued Next Page**

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**

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<tr>
<th>WL</th>
<th>None WD</th>
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Belongia Consultants, Inc.

**BORING STARTED** 11-14-18

**BORING COMPLETED** 11-14-18

**RIG** CME-45 FOREMAN TB

**APPROVED** DLB JOB # 1185060
# LOG OF BORING NO. B-4

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**WATER LEVEL OBSERVATIONS, ft**

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**Belongia Consultants, Inc.**

BORING STARTED | 11-14-18
BORING COMPLETED | 11-14-18
RIG | CME-45
FOREMAN | TB
APPROVED | DLB
JOB # | 1185060

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The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.
# Log of Boring No. B-5

**Client:** McAlester Army Ammunition Plant  
**Engineer:** ALL Consulting  
**project:** Proposed Landfill Modifications  

### Description

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The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

**Water Level Observations, ft**  
- WL: None  
- WD:  

**Belongia Consultants, Inc.**  
**BoRiNg Started:** 11-14-18  
**BoRiNg Completed:** 11-14-18  
**Rig:** CME-45  
**Foreman:** TB  
**Approved:** DBL  
**Job #:** 1185060
# Log of Boring No. B-6

**Client**: McAlester Army Ammunition Plant  
McAlester, Oklahoma  

**Engineer**: ALL Consulting

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</table>

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

**Water Level Observations, ft**  
WL: None  

**Belongia Consultants, Inc.**  

**BORING STARTED**: 11-14-18  
**BORING COMPLETED**: 11-14-18  
**RIG**: CME-45  
**FOREMAN**: TB  
**APPROVED**: DLB  
**JOB #: 1185060**
# LOG OF BORING NO. B-7

## Site
McAlester Army Ammunition Plant  
McAlester, Oklahoma

## Proposed Landfill Modifications

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>TESTS</th>
</tr>
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<tbody>
<tr>
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## Graphic Log

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<th>Water Content, %</th>
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The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

## Water Level Observations

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## Boring Details

- **BORING STARTED**: 11-14-18  
- **BORING COMPLETED**: 11-14-18  
- **RIG**: CME-45  
- **FOREMAN**: TB  
- **APPROVED**: DLB  
- **JOB #**: 1185060
### LOG OF BORING NO. B-8

**CLIENT**

McAlester Army Ammunition Plant
McAlester, Oklahoma

**ENGINEER**

ALL Consulting

**SITE**

McAlester Army Ammunition Plant
McAlester, Oklahoma

**PROJECT**

Proposed Landfill Modifications

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>TESTS</th>
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#### DESCRIPTION

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<th>SPT - N BLOWS / ft</th>
<th>WATER CONTENT, %</th>
<th>DRY UNIT WT, pcf</th>
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The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**

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<th>WL</th>
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| BORING STARTED | 11-14-18 |
| BORING COMPLETED | 11-14-18 |

Belongia Consultants, Inc.

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<th>RIG</th>
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<tr>
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| APPROVED | DLB |
| JOB #    | 1185060 |
# Log of Boring No. B-9

**Client:** McAlester Army Ammunition Plant  
**Location:** McAlester, Oklahoma  

## Graphic Log

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<th>Water Content, %</th>
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The stratification lines represent the approximate boundary lines between soil and rock types; in-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft:** None

**Belongia Consultants, Inc.**

**Boaring Started:** 11-14-18  
**Boaring Completed:** 11-14-18  
**RIG:** CME-45  
**Foreman:** TB  
**Approved by:** DLB  
**Job #:** 1185060
## LOG OF BORING NO. B-10

### SITE
- McAlester Army Ammunition Plant
- McAlester, Oklahoma

### PROJECT
- Proposed Landfill Modifications

### CLIENT
- All Consulting

### ENGINEER
- None

### DESCRIPTION

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**Notes:**
- The stratification lines represent the approximate boundary lines between soil and rock types. *In-situ*, the transition may be gradual.
- WATER LEVEL OBSERVATIONS, ft
  - WL: None WD
  - WL: None

**Approval Details:**
- BORING STARTED: 11-14-18
- BORING COMPLETED: 11-14-18
- RIG: CME-45
- FOREMAN: TB
- APPROVED: DLB
- JOB #: 1185060

Belongia Consultants, Inc.
# LOG OF BORING NO. B-11

## CLIENT

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## ENGINEER

| ALL Consulting |

## PROJECT

### Proposed Landfill Modifications

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<td>6</td>
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### DESCRIPTION

- 4" Topsoil
- **FAT CLAY**
  - brown
- **FAT CLAY, TRACE GRAVEL**
  - brown and olive brown
- **SHALEY FAT CLAY**
  - olive gray
- **HIGHLY WEATHERED SHALE**
  - gray

### WATER LEVEL OBSERVATIONS, ft

<table>
<thead>
<tr>
<th>WL</th>
<th>None WD</th>
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**Belongia Consultants, Inc.**

**BORING STARTED** 11-14-18

**BORING COMPLETED** 11-14-18

**RIG** CME-45  **FOREMAN** TB  **APPROVED** DLB  **JOB #** 1185060
# LOG OF BORING NO. B-12

## CLIENT

### SITE
- McAlester Army Ammunition Plant
- McAlester, Oklahoma

## ENGINEER

### ALL Consulting

## PROJECT

### Proposed Landfill Modifications

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### Graphic Log

- **4" Topsoil**
  - **FAT CLAY**
  - brown
- **FAT CLAY, TRACE GRAVEL**
  - brown and olive brown
- **SHEALY FAT CLAY**
  - olive gray and reddish brown
- **HIGHLY WEATHERED SHALE**
  - olive gray to gray

---

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**
- **WL**: None WD

**Belongia Consultants, Inc.**

**BORING STARTED**: 11-14-18
**BORING COMPLETED**: 11-14-18

**RIG**: CME-45
**FOREMAN**: TB
**APPROVED**: DLB **JOB #:** 1185060
The stratification lines represent the approximate boundary lines between soil and rock types: in-situ, the transition may be gradual.

**WATER LEVEL OBSERVATIONS, ft**

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**Belongia Consultants, Inc.**

**RIG** CME-45  **FOREMAN** TB  **APPROVED** DLB  **JOB #** 1185060
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<th>WATER CONTENT, %</th>
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<td>HS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>SHALEY FAT CLAY, TRACE GRAVEL</strong></td>
<td></td>
<td>CH 3</td>
<td>SS</td>
<td>15 37</td>
<td>17.3</td>
<td>*4000</td>
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<tr>
<td></td>
<td>olive gray</td>
<td></td>
<td>CH 4</td>
<td>SS</td>
<td>16 43</td>
<td>16.7</td>
<td>HS</td>
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</tr>
<tr>
<td></td>
<td><strong>HIGHLY WEATHERED SHALE</strong></td>
<td></td>
<td>CH 5</td>
<td>SS</td>
<td>10 27/6&quot; 50/6&quot;</td>
<td>16.5</td>
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<td>HS</td>
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<tr>
<td></td>
<td>gray</td>
<td></td>
<td>CH 6</td>
<td>SS</td>
<td>6 50/6&quot;</td>
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</table>

The stratification lines represent the approximate boundary lines between soil and rock types. In-situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft
- WL: None WD

Belongia Consultants, Inc.

BORING STARTED: 11-14-18
BORING COMPLETED: 11-14-18
RIG: CME-45
FOREMAN: TB
APPROVED: DLB
JOB #: 1185060
<table>
<thead>
<tr>
<th>Depth, ft</th>
<th>DESCRIPTION</th>
<th>USCS SYMBOL</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>RECOVERY, %</th>
<th>SPT BLOWS / ft.</th>
<th>WATER CONTENT, %</th>
<th>DRY UNIT Wt, lb/ft³</th>
<th>UNCONFINED, STRENGTH, psi</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4&quot; Topsoil</td>
<td>HS</td>
<td>1</td>
<td>SS</td>
<td>12</td>
<td>4</td>
<td>23.5</td>
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<td>FAT CLAY</td>
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<td>FAT CLAY</td>
<td>HS</td>
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<td>SS</td>
<td>14</td>
<td>18</td>
<td>22.9</td>
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<td></td>
<td>olive brown and gray</td>
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<td>10</td>
<td>SHALEY FAT CLAY</td>
<td>HS</td>
<td>3</td>
<td>ST</td>
<td>12</td>
<td>19.5</td>
<td>114</td>
<td>*3000</td>
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<tr>
<td></td>
<td>olive brown and gray</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>HS</td>
<td>4</td>
<td>SS</td>
<td>14</td>
<td>27</td>
<td>17.6</td>
<td></td>
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<tr>
<td>19.5</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>HIGHLY WEATHERED SHALE</td>
<td>HS</td>
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<td>SS</td>
<td>15</td>
<td>47</td>
<td>17.3</td>
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</tr>
</tbody>
</table>

The stratification lines represent the approximate boundary lines between soil and rock types; in situ, the transition may be gradual.

WATER LEVEL OBSERVATIONS, ft:
- WL: None

Belongia Consultants, Inc.

BORING STARTED: 11-14-18
BORING COMPLETED: 11-14-18
RIG: CME-45
FOREMAN: TB
APPROVED: DLB
JOB #: 1185060
RESULTS OF UNCONFINED COMpressive STRENGTH TEST
B-2, S-3  3.5-5'
RESULTS OF UNCONFINED COMPRESSIVE STRENGTH TEST
B-5, S-3  3.5-5'
RESULTS OF UNCONFINED COMPRESSION STRENGTH TEST
B-7, S-3  3.5-5'
RESULTS OF UNCONFINED COMPRESSIVE STRENGTH TEST
B-9, S-3  3.5-5'
GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:
SS: Split Spoon - 1-3/8” I.D., 2” O.D., unless otherwise noted
ST: Thin-Walled Tube - 2” O.D., unless otherwise noted
RS: Ring Sampler - 2.42” I.D., 3” O.D., unless otherwise noted
DB: Diamond Bit Coring - 4”, N. B
BS: Bulk Sample or Auger Sample

HS: Hollow Stem Auger
PA: Power Auger
HA: Hand Auger
RB: Rock Bit
WB: Wash Boring or Mud Rotary

The number of blows required to advance a standard 2-inch O.D. split-spoon sampler (SS) the last 12 inches of the total 18-inch penetration with a 140-pound hammer falling 30 inches is considered the “Standard Penetration” or “N-value”.

WATER LEVEL MEASUREMENT SYMBOLS:
WL: Water Level
WCI: Wet Cave in
DCI: Dry Cave in
AB: After Boring
WS: While Sampling
WD: While Drilling
BCR: Before Casing Removal
ACR: After Casing Removal

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwat. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIONAL SOIL CLASSIFICATION: Soil classification is based on the Unified Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

### CONSISTENCY OF FINE-GRAINED SOILS

<table>
<thead>
<tr>
<th>Unconfined Compressive Strength, Qu, psf</th>
<th>Standard Penetration or N-value (SS) Blows/ Ft.</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 500</td>
<td>&lt;2</td>
<td>Very Soft</td>
</tr>
<tr>
<td>500 - 1,000</td>
<td>2 - 3</td>
<td>Soft</td>
</tr>
<tr>
<td>1,001 - 2,000</td>
<td>4 - 6</td>
<td>Medium Stiff</td>
</tr>
<tr>
<td>2,001 - 4,000</td>
<td>7 - 12</td>
<td>Stiff</td>
</tr>
<tr>
<td>4,001 - 8,000</td>
<td>13 - 26</td>
<td>Very Stiff</td>
</tr>
<tr>
<td>8,000+</td>
<td>26+</td>
<td>Hard</td>
</tr>
</tbody>
</table>

### RELATIVE DENSITY OF COARSE-GRAINED SOILS

<table>
<thead>
<tr>
<th>Standard Penetration or N-value (SS) Blows/Ft.</th>
<th>Relative Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 3</td>
<td>Very Loose</td>
</tr>
<tr>
<td>4 - 9</td>
<td>Loose</td>
</tr>
<tr>
<td>10 - 29</td>
<td>Medium Dense</td>
</tr>
<tr>
<td>30 - 49</td>
<td>Dense</td>
</tr>
<tr>
<td>50+</td>
<td>Very Dense</td>
</tr>
</tbody>
</table>

### RELATIVE PROPORTIONS OF SAND AND GRAVEL

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>With</td>
<td>15 - 29</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 30</td>
</tr>
</tbody>
</table>

### GRAIN SIZE TERMINOLOGY

<table>
<thead>
<tr>
<th>Major Component of Sample</th>
<th>Particle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Over 12 in. (300mm)</td>
</tr>
<tr>
<td>Cobbles</td>
<td>12 in. to 3 in. (300mm to 75 mm)</td>
</tr>
<tr>
<td>Gravel</td>
<td>3 in. to #4 sieve (75mm to 4.75 mm)</td>
</tr>
<tr>
<td>Sand</td>
<td>#4 to #200 sieve (4.75mm to 0.075mm)</td>
</tr>
<tr>
<td>Silt or Clay</td>
<td>Passing #200 Sieve (0.075mm)</td>
</tr>
</tbody>
</table>

### RELATIVE PROPORTIONS OF FINES

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 5</td>
</tr>
<tr>
<td>With</td>
<td>5 - 12</td>
</tr>
<tr>
<td>Modifiers</td>
<td>&gt; 12</td>
</tr>
</tbody>
</table>

### PLASTICITY DESCRIPTION

<table>
<thead>
<tr>
<th>Term</th>
<th>Plasticity Index</th>
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<tbody>
<tr>
<td>Non-plastic</td>
<td>0</td>
</tr>
<tr>
<td>Low</td>
<td>1-10</td>
</tr>
<tr>
<td>Medium</td>
<td>11-30</td>
</tr>
<tr>
<td>High</td>
<td>30+</td>
</tr>
</tbody>
</table>
GENERAL NOTES
Sedimentary Rock Classification

DESCRIPTIVE ROCK CLASSIFICATION:

Sedimentary rocks are composed of cemented clay, silt and sand sized particles. The most common minerals are clay, quartz and calcite. Rock composed primarily of calcite is called limestone; rock of sand size grains is called sandstone, and rock of clay and silt size grains is called mudstone or claystone, siltstone, or shale. Modifiers such as shaly, sandy, dolomitic, calcareous, carbonaceous, etc. are used to describe various constituents. Examples: sandy shale; calcareous sandstone.

LIMESTONE
Light to dark colored, crystalline to fine-grained texture, composed of CaCO₃, reacts readily with HCl.

DOLOMITE
Light to dark colored, crystalline to fine-grained texture, composed of CaMg(CO₃)₂, harder than limestone, reacts with HCl when powdered.

CHERT
Light to dark colored, very fine-grained texture, composed of micro-crystalline quartz (SiO₂), brittle, breaks into angular fragments, will scratch glass.

SANDSTONE
Very fine-grained texture, composed of consolidated silt or clay, bedded in thin layers. The un laminated equivalent is frequently referred to as siltstone, claystone or mudstone.

SANDSTONE
Usually light colored, coarse to fine texture, composed of cemented sand size grains of quartz, feldspar, etc. Cement usually is silica but may be such minerals as calcite, iron-oxide, or some other carbonate.

CONGLOMERATE
Rounded rock fragments of variable mineralogy varying in size from near sand to boulder size but usually pebble to cobble size (1/2 inch to 6 inches). Cemented together with various cementing agents. Breccia is similar but composed of angular, fractured rock particles cemented together.

PHYSICAL PROPERTIES:

DEGREE OF WEATHERING

Slight
Slight decomposition of parent material on joints. May be color change.

Moderate
Some decomposition and color change throughout.

High
Rock highly decomposed, may be extremely broken.

BEDDING AND JOINT CHARACTERISTICS

<table>
<thead>
<tr>
<th>Bed Thickness</th>
<th>Joint Spacing</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Thick</td>
<td>Very Wide</td>
<td>&gt;10'</td>
</tr>
<tr>
<td>Thick</td>
<td>Wide</td>
<td>3'-10'</td>
</tr>
<tr>
<td>Medium</td>
<td>Moderately Close</td>
<td>1'-3'</td>
</tr>
<tr>
<td>Thin</td>
<td>Close</td>
<td>2'-1'</td>
</tr>
<tr>
<td>Very Thin</td>
<td>Very Close</td>
<td>4'-2'</td>
</tr>
<tr>
<td>Laminated</td>
<td></td>
<td>.1'- .4'</td>
</tr>
</tbody>
</table>

Bedding Plane
A plane dividing sedimentary rocks of the same or different lithology.

Joint
Fracture in rock, generally more or less vertical or transverse to bedding, along which no appreciable movement has occurred.

Seam
Generally applies to bedding plane with an unspecified degree of weathering.

SOLUTION AND VOID CONDITIONS

Solid
Contains no voids.

Vuggy (Pitted)
Rock having small solution pits or cavities up to ½ inch diameter, frequently with a mineral lining.

Porous
Containing numerous voids, pores, or other openings, which may or may not interconnect.

Cavernous
Containing cavities or caverns, sometimes quite large.
### UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests

<table>
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<tr>
<th>Group Symbol</th>
<th>Group Name</th>
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<tbody>
<tr>
<td>GW</td>
<td>Well-graded gravelF</td>
</tr>
<tr>
<td>GP</td>
<td>Poorly graded gravelF</td>
</tr>
<tr>
<td>GM</td>
<td>Silty gravelF,G,H</td>
</tr>
<tr>
<td>GC</td>
<td>Clayey gravelF,G,H</td>
</tr>
<tr>
<td>SW</td>
<td>Well-graded sandI</td>
</tr>
<tr>
<td>SP</td>
<td>Poorly graded sandI</td>
</tr>
<tr>
<td>SM</td>
<td>Silty sandG,H,I</td>
</tr>
<tr>
<td>SC</td>
<td>Clayey sandG,H,I</td>
</tr>
<tr>
<td>CL</td>
<td>Lean clayK,L,M</td>
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<tr>
<td>ML</td>
<td>SiltK,L,M</td>
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<tr>
<td>OL</td>
<td>Organic clayK,L,M,N</td>
</tr>
<tr>
<td>OM</td>
<td>Organic siltK,L,M,O</td>
</tr>
<tr>
<td>CH</td>
<td>Fat clayK,L,M</td>
</tr>
<tr>
<td>MH</td>
<td>Elastic SiltK,L,M</td>
</tr>
<tr>
<td>OH</td>
<td>Organic clayK,L,M,P</td>
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<tr>
<td>PT</td>
<td>Peat</td>
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<table>
<thead>
<tr>
<th>Coarse Grained Soils</th>
<th>Gravels</th>
<th>More than 50% of coarse fraction retained on No. 4 sieve</th>
<th>Clean Gravels</th>
<th>More than 5% finesC</th>
<th>Cu ≥ 4 and 1 ≤ Cc ≤ 3E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clean Gravels</td>
<td>More than 12% finesC</td>
<td>Cu &lt; 4 and/or 1 &gt; Cc &gt; 3E</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Gravels with Fines</td>
<td>More than 12% finesC</td>
<td>Fines classify as ML or MH</td>
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<tr>
<td>Sands</td>
<td>50% or more of coarse fraction passes No. 4 sieve</td>
<td>Clean Sands</td>
<td>Less than 5% finesC</td>
<td>Cu ≥ 8 and 1 ≤ Cc ≤ 3E</td>
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<tr>
<td></td>
<td>Sands with Fines</td>
<td>More than 12% finesC</td>
<td>Cu &lt; 4 and/or 1 &gt; Cc &gt; 3E</td>
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<td></td>
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<tr>
<td></td>
<td>Fines classify as ML or MH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fines classify as CL or CH</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

Fine-Grained Soils

50% or more passes the No. 200 sieve

- **Silt and Clay**: Liquid limit less than 50
  - **Inorganic**: PI > 7 and plots on or above "A" lineI,
    - ML: SiltK,L,M
  - **Organic**: Liquid limit - oven dried ≤ 0.75
    - OL: Organic clayK,L,M,N
    - OM: Organic siltK,L,M,O
- **Silt and Clay**: Liquid limit 50 or more
  - **Inorganic**: PI plots on or above "A" lineI,
    - CH: Fat clayK,L,M
  - **Organic**: Liquid limit - oven dried < 0.75
    - OH: Organic clayK,L,M,P
    - OM: Organic siltK,L,M,O
- **Highly Organic Soils**: Primarily organic matter, dark in color, and organic odor
  - PT: Peat

---

**Notes:**

1. Based on the material passing the 3-in. (75-mm) sieve
2. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
3. Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
4. Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
5. Cu = D60/D10, Cc = (D50)^2 / D60 x D10
6. If soil contains ≥ 15% sand, add "with sand" to group name.
7. If fines classify as CL-ML, use dual symbol GC-GM, or SC-SCM.
8. If fines are organic, add "with organic fines" to group name.
9. If field sample contains ≥ 15% gravel, add "with gravel" to group name.
10. If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
11. If soil contains 15 to 25% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
12. If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
13. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravely" to group name.
14. PI ≥ 4 and plots on or above "A" line.
15. PI < 4 or plots below "A" line.
16. PI plots on or above "A" line.
17. PI plots below "A" line.

---

**Diagrams:**

- For classification of fine-grained soils and fine-grained fraction of coarse-grained soils
- Classification criteria: PI ≥ 4 and LL ≤ 25.5.
- PI plots on or above "A" line.
- PI < 4 or plots below "A" line.
- For classification of CL-ML, ML-OL, and OL-CL.
Appendix 4
Drainage Calculations
Downspout Rv3

Trapezoidal
- Bottom Width (ft) = 6.00
- Side Slopes (z:1) = 2.00, 2.00
- Total Depth (ft) = 1.50
- Invert Elev (ft) = 763.00
- Slope (%) = 25.00
- N-Value = 0.100

Highlighted
- Depth (ft) = 0.95
- Q (cfs) = 45.00
- Area (sqft) = 7.50
- Velocity (ft/s) = 6.00
- Wetted Perim (ft) = 10.25
- Crit Depth, Yc (ft) = 1.07
- Top Width (ft) = 9.80
- EGL (ft) = 1.51

Calculations
- Known Q
- Known Q (cfs) = 45.00

Graph showing Elev (ft) and Depth (ft) with sections marked at 762.50, 763.00, 763.50, 764.00, 764.50, 765.00 with corresponding depths ranging from 0.00 to 2.00 ft.
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2018 by Autodesk, Inc. v12

Hyd. No. 2

MCAAP Downspout WCS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<td>Hydrograph type</td>
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<td>Storm frequency</td>
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<td>Time interval</td>
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<tr>
<td>Drainage area</td>
<td>5.360 ac</td>
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<tr>
<td>Basin Slope</td>
<td>0.0 %</td>
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<td>Tc method</td>
<td>TR55</td>
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<tr>
<td>Total precip.</td>
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<td>Storm duration</td>
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<td>Peak discharge</td>
<td>40.16 cfs</td>
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<td>Time to peak</td>
<td>12.05 hrs</td>
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<tr>
<td>Hyd. volume</td>
<td>127,953 cuft</td>
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<td>Curve number</td>
<td>94</td>
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<td>Hydraulic length</td>
<td>0 ft</td>
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<td>Time of conc. (Tc)</td>
<td>4.00 min</td>
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<td>Distribution</td>
<td>Type III</td>
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<tr>
<td>Shape factor</td>
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</table>

MCAAP Downspout WCS

Hyd. No. 2 -- 25 Year

Hyd No. 2
Hyd. No. 2
MCAAP Downspout WCS

<table>
<thead>
<tr>
<th>Description</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Totals</th>
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<tbody>
<tr>
<td><strong>Sheet Flow</strong></td>
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<tr>
<td>Manning’s n-value</td>
<td>0.05</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Flow length (ft)</td>
<td>70.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Two-year 24-hr precip. (in)</td>
<td>4.19</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Land slope (%)</td>
<td>25.00</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Travel Time (min)</td>
<td>0.97</td>
<td>+</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Shallow Concentrated Flow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow length (ft)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Watercourse slope (%)</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Surface description</td>
<td>Paved</td>
<td>Paved</td>
<td>Paved</td>
<td></td>
</tr>
<tr>
<td>Average velocity (ft/s)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Travel Time (min)</td>
<td>0.00</td>
<td>+</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Channel Flow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X sectional flow area (sqft)</td>
<td>6.75</td>
<td>3.40</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Wetted perimeter (ft)</td>
<td>7.12</td>
<td>8.20</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Channel slope (%)</td>
<td>1.00</td>
<td>25.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Manning's n-value</td>
<td>0.030</td>
<td>0.100</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>Velocity (ft/s)</td>
<td>4.79</td>
<td>4.13</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Flow length (ft) ([0])</td>
<td>583.0</td>
<td>250.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Travel Time (min)</td>
<td>2.03</td>
<td>+</td>
<td>1.01</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total Travel Time, Tc</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Travel Time, Tc: 4.01 min
Terrace Berm WCS

**Triangular**
- Side Slopes (z:1) = 2.00, 4.00
- Total Depth (ft) = 1.50

**Invert Elev (ft)** = 763.00
**Slope (%)** = 1.00
**N-Value** = 0.030

**Calculations**
- Compute by: Known Q
- Known Q (cfs) = 12.00

**Highlighted**
- Depth (ft) = 1.12
- Q (cfs) = 12.00
- Area (sqft) = 3.76
- Velocity (ft/s) = 3.19
- Wetted Perim (ft) = 7.12
- Crit Depth, Yc (ft) = 1.00
- Top Width (ft) = 6.72
- EGL (ft) = 1.28
Hyd. No. 1
MCAAP Terrace Berm WCS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrograph type</td>
<td>SCS Runoff</td>
</tr>
<tr>
<td>Storm frequency</td>
<td>25 yrs</td>
</tr>
<tr>
<td>Time interval</td>
<td>1 min</td>
</tr>
<tr>
<td>Drainage area</td>
<td>1.500 ac</td>
</tr>
<tr>
<td>Basin Slope</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Tc method</td>
<td>TR55</td>
</tr>
<tr>
<td>Total precip.</td>
<td>7.29 in</td>
</tr>
<tr>
<td>Storm duration</td>
<td>24 hrs</td>
</tr>
<tr>
<td>Peak discharge</td>
<td>11.24 cfs</td>
</tr>
<tr>
<td>Time to peak</td>
<td>12.05 hrs</td>
</tr>
<tr>
<td>Hyd. volume</td>
<td>35,808 cuft</td>
</tr>
<tr>
<td>Curve number</td>
<td>94</td>
</tr>
<tr>
<td>Hydraulic length</td>
<td>0 ft</td>
</tr>
<tr>
<td>Time of conc. (Tc)</td>
<td>3.80 min</td>
</tr>
<tr>
<td>Distribution</td>
<td>Type III</td>
</tr>
<tr>
<td>Shape factor</td>
<td>484</td>
</tr>
</tbody>
</table>

![Graph of MCAAP Terrace Berm WCS Hydrograph No. 1 - 25 Year](image-url)
**TR55 Tc Worksheet**

Hydraulic No. 1
MCAAP Terrace Berm WCS

<table>
<thead>
<tr>
<th>Description</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sheet Flow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manning's n-value</td>
<td>0.050</td>
<td>0.011</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>Flow length (ft)</td>
<td>200.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Two-year 24-hr precip. (in)</td>
<td>4.19</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Land slope (%)</td>
<td>25.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Travel Time (min)</td>
<td>2.25</td>
<td>0.00</td>
<td>0.00</td>
<td>2.25</td>
</tr>
</tbody>
</table>

| **Shallow Concentrated Flow**               |       |       |       |        |
| Flow length (ft)                           | 0.00  | 0.00  | 0.00  |        |
| Watercourse slope (%)                      | 0.00  | 0.00  | 0.00  |        |
| Surface description                        | Unpaved | Paved | Paved |        |
| Average velocity (ft/s)                    | 0.00  | 0.00  | 0.00  |        |
| Travel Time (min)                          | 0.00  | 0.00  | 0.00  | 0.00   |

| **Channel Flow**                           |       |       |       |        |
| X sectional flow area (sqft)               | 6.75  | 0.00  | 0.00  |        |
| Wetted perimeter (ft)                      | 7.12  | 0.00  | 0.00  |        |
| Channel slope (%)                          | 1.00  | 0.00  | 0.00  |        |
| Manning's n-value                          | 0.030 | 0.015 | 0.015 |        |
| Velocity (ft/s)                            | 4.79  | 0.00  | 0.00  |        |
| Flow length (ft)                           | 440.0 | 0.0   | 0.0   |        |
| Travel Time (min)                          | 1.53  | 0.00  | 0.00  | 1.53   |

**Total Travel Time, Tc** 3.78 min
Hyd. No. 15
MD1 (Outfall)

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 1 min
Inflow hyds. = 12, 14

Peak discharge = 121.92 cfs
Time to peak = 12.05 hrs
Hyd. volume = 388,425 cuft
Contrib. drain. area = 0.000 ac
Hyd. No. 33

MD2 ALT

Hydrograph type = Combine  
Storm frequency = 25 yrs  
Time interval = 1 min  
Inflow hyds. = 20, 29, 32

Peak discharge = 100.12 cfs  
Time to peak = 12.03 hrs  
Hyd. volume = 311,886 cuft  
Contrib. drain. area = 3.610 ac
**Channel Report**

Hydraflo Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

**North Channel**

### Trapezoidal
- Bottom Width (ft) = 8.00
- Side Slopes (z:1) = 2.00, 2.00
- Total Depth (ft) = 3.00
- Invert Elev (ft) = 750.00
- Slope (%) = 0.50
- N-Value = 0.030

### Calculations
- Compute by: Known Q
- Known Q (cfs) = 76.50

<table>
<thead>
<tr>
<th>Elev (ft)</th>
<th>Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>749.00</td>
<td></td>
</tr>
<tr>
<td>750.00</td>
<td>0.00</td>
</tr>
<tr>
<td>751.00</td>
<td>1.00</td>
</tr>
<tr>
<td>752.00</td>
<td>2.00</td>
</tr>
<tr>
<td>753.00</td>
<td>3.00</td>
</tr>
<tr>
<td>754.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>

### Highlighted
- Depth (ft) = 1.68
- Q (cfs) = 76.50
- Area (sqft) = 19.08
- Velocity (ft/s) = 4.01
- Wetted Perim (ft) = 15.51
- Crit Depth, Yc (ft) = 1.27
- Top Width (ft) = 14.72
- EGL (ft) = 1.93
North Outfall

Trapezoidal
Bottom Width (ft) = 8.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 750.00
Slope (%) = 0.50
N-Value = 0.030

Highlighted
Depth (ft) = 1.94
Q (cfs) = 100.12
Area (sqft) = 23.05
Velocity (ft/s) = 4.34
Wetted Perim (ft) = 16.68
Crit Depth, Yc (ft) = 1.49
Top Width (ft) = 15.76
EGL (ft) = 2.23

Calculations
Compute by: Known Q
Known Q (cfs) = 100.12

Elev (ft)  Section  Depth (ft)
754.00  753.00  752.00  751.00  750.00  749.00
-1.00  0.00  1.00  2.00  3.00  4.00
0  2  4  6  8  10  12  14  16  18  20  22  24
Reach (ft)
Hyd. No. 38
To Pond (MD1,2ALT and MDC1,2)

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 1 min
Inflow hyds. = 15, 33, 35, 36

Peak discharge = 223.55 cfs
Time to peak = 12.05 hrs
Hyd. volume = 711,292 cuft
Contrib. drain. area = 0.460 ac
South Channel

Trapezoidal
Bottom Width (ft) = 6.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 750.00
Slope (%) = 1.00
N-Value = 0.030

Highlighted
Depth (ft) = 1.35
Q (cfs) = 57.14
Area (sqft) = 11.74
Velocity (ft/s) = 4.87
Wetted Perim (ft) = 12.04
Crit Depth, Yc (ft) = 1.23
Top Width (ft) = 11.40
EGL (ft) = 1.72

Calculations
Compute by: Known Q
Known Q (cfs) = 57.14
South Outfall

Trapezoidal
Bottom Width (ft) = 10.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 750.00
Slope (%) = 0.50
N-Value = 0.030

Highlighted
Depth (ft) = 1.96
Q (cfs) = 121.92
Area (sqft) = 27.28
Velocity (ft/s) = 4.47
Wetted Perim (ft) = 18.77
Crit Depth, Yc (ft) = 1.50
Top Width (ft) = 17.84
EGL (ft) = 2.27

Calculations
Compute by: Known Q
Known Q (cfs) = 121.92

Elev (ft) | Section | Depth (ft)
---|---|---
750.00 | | 0.00
751.00 | | 1.00
752.00 | | 2.00
753.00 | | 3.00
754.00 | | 4.00

Reach (ft)
West Channel

**Trapezoidal**
- Bottom Width (ft) = 6.00
- Side Slopes (z:1) = 2.00, 2.00
- Total Depth (ft) = 3.00
- Invert Elev (ft) = 750.00
- Slope (%) = 0.50
- N-Value = 0.030

**Calculations**
- Known Q
- Known Q (cfs) = 42.20

**Highlighted**
- Depth (ft) = 1.39
- Q (cfs) = 42.20
- Area (sqft) = 12.20
- Velocity (ft/s) = 3.46
- Wetted Perim (ft) = 12.22
- Crit Depth, Yc (ft) = 1.03
- Top Width (ft) = 11.56
- EGL (ft) = 1.58
Appendix 5
Life and Design Calculations
I. Life and Design Capacity of Facility

The original design capacity for the McAlester Army Ammunition Plant Landfill (Landfill) is approximately 400,325 cubic yards (cy). A summary of the capacity increase associated with this Landfill expansion is listed below:

<table>
<thead>
<tr>
<th>Original Design Capacity</th>
<th>400,325 cy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed Capacity Increase due to Landfill expansion</td>
<td>1,252,326 cy</td>
</tr>
<tr>
<td>New Design Capacity</td>
<td>1,652,651 cy</td>
</tr>
</tbody>
</table>

The existing permitted landfill has a remaining airspace of 25,654 cy (as of December 31, 2018). The proposed vertical expansion of the Landfill will increase the remaining airspace to 1,277,980 cy.

In accordance with Oklahoma Administrative Code (OAC) 252:515-27-8, an economic "life of site" estimate has been developed using the following formula:

\[ L = \frac{[V - (P \times V)] \times D}{W}, \]

where
- \( L \) = Life of the disposal facility in years;
- \( V \) = Total volume of airspace available for waste disposal and daily cover in cubic yards;
- \( P \) = Annual percentage of “\( V \)” that will be consumed by daily cover;
- \( D \) = Anticipated density of waste compacted in-place in pounds per cubic yard; and
- \( W \) = Amount of waste received in the previous year in pounds.

The design life of site calculation was performed utilizing the amount of waste received in the previous year (2018: 2,145.49 tons) and the assumption that \( P = 20\% \) and a conservative \( D = 500 \) pounds per cubic yard (lbs/cy) (OAC 252:515-27-8(a)(2) uses 1000 lbs/cy). Utilizing the above values and equation, the remaining design life of the disposal facility is estimated to be approximately 119 years as of January 1, 2019. The actual life of the facility will vary depending on factors such as actual disposal rates, types of materials disposed, amount of daily and intermediate cover materials used, the settlement and decomposition of in-place wastes, and the in-place density achieved over the operational life of the facility.

II. Soil Borrow Volume

The proposed expansion will require an increase in the amount of soil borrow in order to operate and complete final closure of the Landfill. The amount of soil borrow volume required will include daily cover, intermediate and final cover as well as storm water diversion and earthen channel material requirements. The daily cover volumes can be estimated using the Oklahoma Department of Environmental Quality’s (ODEQ’s) percentage (20% cited above) of total airspace capacity. Therefore the daily cover volume required is:
1,277,980 cy X 0.20 = 255,596 cy

The intermediate and final cover calculated from the design (2.0 feet of clayey on-site material and 1.0 foot of vegetative layer) will require 140,275 cy.

The storm water control will require an additional 38,000 cy of earthen material. Therefore, the total amount of borrow volume required is approximately 433,871 cy.

The final grading for the borrow area proposed as part of the Landfill’s vertical expansion is shown on Figure 5-1. The total volume of available borrow material is 584,387 cy.
Appendix 6
Groundwater Monitoring Program
I. Introduction

A. Purpose and Scope.

The objective of collecting groundwater for analysis is to provide a sample to the laboratory which represents the same geochemical conditions which occur in the aquifer. Because certain parameters are more susceptible to change than others, various techniques are needed depending on what will be tested. The purpose of this monitoring plan is to discuss sample collection techniques for the parameters which will be sampled from the groundwater monitoring wells at the proposed landfill site, McAlester Army Ammunition Plant (MCAAP). Groundwater monitoring well locations are shown in Figure 6-1. The parameters to be tested in the groundwater samples are listed in Table 6-1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Specific Conductivity</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Calcium</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Chloride</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Explosives</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Metals</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Sodium</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Carbonates</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Potassium</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>Sulfate</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>SVOCs</td>
<td>Semi-Annually</td>
</tr>
<tr>
<td>VOCs</td>
<td>Semi-Annually</td>
</tr>
</tbody>
</table>

B. Sampling Strategy.

The best sequence of operations for sampling is as follows:

1. Evacuate slow recharge wells at the outset of the sampling day.
2. Evacuate and sample other wells.
3. Sample slow rechargers, if possible.
4. Return to lab and preserve samples.
5. Prepare samples for shipment.
6. Deliver samples to shipping station.
Do not sample more wells than can be prepared for shipment in one day. Refrigerate samples as soon as sampling is complete or more frequently if sampling is not proceeding expeditiously. Most of the wells will not recharge very quickly.

II. Collection

A. Static Water Levels.

Before any other work is done at the well, the water level shall be taken with an electric probe or other suitable means, and measured from the top of the casing or opening in the well cap. Record the water level to the nearest hundredth of a foot in the logbook (described below) as well as any problems noted with the general condition of the well. Rinse the probe in distilled/deionized water immediately before lowering it into the well and after removing it from the well.

B. Well Evacuation Procedures.

Prior to sample collection, sampling personnel will purge the monitoring wells of stagnant water to ensure that representative water of the groundwater system is collected for analysis. Wells will be purged utilizing submersible electrical pumps or bailers. Purging will generally procedures outlined in the ASTM Standard D 6771-02, “Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Groundwater Quality Investigations.” Tubing or Teflon bailers will be dedicated to a single well and disposed of after the well is purged and sampled.

An adequate purge volume is normally achieved when three to five well volumes of standing water in the well have been removed. However, with low flow purging techniques the parameters typically stabilize before three well volumes, negating the need to purge a full three to five well volumes. Field sampling personnel will monitor pH, specific conductance, dissolved oxygen, temperature, and turbidity of the groundwater removed during purging and recorded these parameters and the volume of water removed. Purging is considered to be complete when the well is pumped dry, or when three consecutive readings for the aforementioned parameters are within the following limits.

- **pH**: (±0.1 unit),
- **Specific Conductance**: (10%),
- **Dissolved Oxygen**: (10% for values greater than 0.5 mg/L, or three consecutive measurements of less than 0.5 mg/L),
- **Temperature**: (stable for three consecutive readings),
- **Turbidity**: (10% for values greater than 5 NTU, or three consecutive measurements of less than 5 NTU)
Measurements will be taken on a frequency that is based on the initial calculated purge volume to ensure a sufficient number of readings to evaluate stability. Groundwater sampling logs will be prepared and submitted along with copies of the sample chains of custody in the semi-annual reports submitted to ODEQ.

C. Well Setups Used at the landfill.

All of the monitoring wells at the landfill are open wells. These wells, which do not contain dedicated equipment, should be evacuated with a Teflon bailer or a peristaltic pump in accordance with ASTM Standard D6771-02. Dedicated disposable equipment will be used for each individual well to minimize cross-contamination.

D. Well Sampling

1. General Procedures.

All monitoring wells should be sampled using a low flow sampling procedure with independent dedicated equipment for individual wells. The pump should be set at the mid-screen point in each well, or at a point representing the middle of the water column if the top of the water is below the screen. The field sampler should fill laboratory provided sample containers in accordance with the method specified sampling procedure. Table 6-2 lists the requirements for all of the parameters at the site.

2. Field Measured Parameters.

Prior to sample collection, pH and Specific Conductance should be determined in the field with pH and conductivity meters. Enough groundwater should be collected and put into a beaker to allow the electrodes to be immersed. Calibrate the meter with two of the buffer solutions, either pH 4.0 and 7.0 or pH 7.0 and 9.0, and then measure and record the pH of the sample to the nearest 0.05 unit. The electrodes should be rinsed with distilled/deionized water between each sample. After the pH measurements, determine the specific conductance in a similar manner, following the directions with the conductivity meter. The approximate temperature must be known, which can be determined from the pH meter. Rinse the probe between samples. Discard this sample when pH and specific conductance measurements are completed.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Container</th>
<th>Refrigeration Required</th>
<th>Preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>NA</td>
<td>NA</td>
<td>Field measurement</td>
</tr>
<tr>
<td>Specific Conductivity</td>
<td>NA</td>
<td>NA</td>
<td>Field measurement</td>
</tr>
<tr>
<td>COD</td>
<td>1-liter glass or plastic</td>
<td>Yes</td>
<td>Sulfuric acid to pH&lt;2</td>
</tr>
<tr>
<td>Metals, Calcium, Sodium, Potassium,</td>
<td>1-liter plastic</td>
<td>Yes</td>
<td>Nitric acid to pH&lt;2</td>
</tr>
<tr>
<td>Chloride, Sulfate, Nitrate</td>
<td>1-liter glass or plastic</td>
<td>Yes</td>
<td>None required</td>
</tr>
</tbody>
</table>
III. Preparation Techniques

A. Sample Preparation.

1. Refrigeration.
Samples must be kept under refrigeration as much as possible. After collection is complete, put the samples into the refrigerator. Remove them to filter and preserve them, and return them to the refrigerator until they are put into the ice chests for shipment. Refrigerate all of the samples if space permits. Otherwise refrigerate only those so indicated in Table 6-1.

2. Chemical Preservatives.
Chemical preservatives such as acids (sulfuric, and nitric) are added in accordance with accepted analytical method requirements to prevent chemical reactions which would change the concentration of the parameter to be tested. In general, the appropriate amount of preservatives are supplied within the containers provided by the receiving analytical laboratory. However, there may be occasions when the laboratory provides the preservative separately for addition to the sample container following sample collection. In such cases, the laboratory will supply the required amount of preservative based upon the anticipated sample volume.

B. Blanks.
Blanks are used to verify that the sample collection and handling processes have not resulted in cross contamination. Blanks are typically provided by the laboratory. If no blanks are provided, the two types of blanks to be prepared are described below.

1. Travel Blanks.
At the onset of the sampling event, a set of containers will be filled with distilled/deionized water and transported within the sampling cooler during field sampling activities. The Travel Blanks will have appropriate labels affixed travel blank labels and will be shipped to the receiving analytical laboratory along with the monitoring well samples. Travel blanks will be analyzed for VOCs.
2. Equipment Blanks.
In the event that non-dedicated and/or non-disposable equipment is used to collect groundwater samples, a set of containers will be filled by running distilled/deionized water drawn sampling equipment used that day after it has been cleaned and rinsed. Use the same preservation procedures as described above. Equipment Blanks will be shipped along with the monitoring well samples to the receiving laboratory and analyzed for the same suite of parameters as the monitoring well samples.

C. Cleaning.
Non-disposable field equipment that is not used to sample for organics may be cleaned with distilled/deionized water and allowed to air dry. Other non-disposable field equipment used in organics sampling must be cleaned with a non-phosphate detergent, such as Liquinox®, rinsed with distilled/deionized water and allowed to air dry.

IV. SHIPMENT

Place all sample containers in resealable plastic bags and stored in coolers on ice. Samples in glass containers should be wrapped in plastic packing material prior to final packaging. Place all samples in doubled resealable plastic bags, inside a doubled plastic trash bag inside a cooler. Ensure that ice and appropriate sample blanks are packed with the field sample shipment in accordance with laboratory specifications. Place the chain of custody document inside a resealable plastic bag, separate from ice. Apply custody seals and secured the cooler with shipping tape. Deliver the ice chests to the shipping station.

V. PAPERWORK

A. Field Logs.
Keep a field log of all operations and record the following: well number, date, water level, well evacuation procedure and rate of recharge, sample method, pH and conductivity readings, any unusual conditions noted (odor or color of water, well damage, etc.), time of collection, time of preservation, time dropped off at shipping station, your names, and any information regarding blanks. The field logs will be included in the semi-annual reports submitted to ODEQ.

B. Chain of Custody Form.
The chain of custody form is required to establish possession of the samples from their collection to their final receipt in the laboratory. The form shall be filled in accordance with laboratory requirements and signed by the field sample collector and the sample preparer. The chain of custody will be enclosed in the sample cooler and samples will remain within sight or secured at all times.
Appendix 7
Landfill Operation Plan
I. Introduction

The McAlester Army Ammunition Plant Landfill (Landfill) is owned by the U.S. Government and is operated by McAlester Army Ammunition Plant (MCAAP) personnel. The Landfill operates under Oklahoma Department of Environmental Quality (ODEQ) Solid Waste Permit Number 3561014. The Landfill only accepts non-hazardous industrial waste from operations at the MCAAP in accordance with the permit.

This document constitutes an operating plan for the Landfill and is intended to provide a reference and directive for operating and maintaining the Landfill facility. The Landfill Operations Plan is to be used in conjunction with the latest version of approved permit design drawings and the July 2019 RCRA-D NHIW Landfill Permit Modification Application. Together, these documents describe the daily operational procedures and protocol to be followed to ensure continued compliance while protecting public health and safety.

The Landfill Operations Plan will need to be updated periodically to reflect current operations. Revisions to this document may require submittal to ODEQ for review and approval.

A. Operating Hours

The normal operating hours for the Landfill are from 0730 to 1500 hours, Monday through Thursday except on holidays. The operating hours may change during times when specific high-priority projects conducted within MCAAP are needed. Asbestos will be disposed of by appointment only.

B. Personnel and Equipment

An equipment operator/attendant will be on duty any time wastes are delivered to the Landfill. Landfill personnel are responsible for compiling and maintaining Landfill records, filing facility reports with ODEQ, interfacing with solid waste collection personnel, and operating and maintaining the Landfill. Working together, the personnel are collectively responsible for operating and maintaining the Landfill and associated Landfill facilities in a manner consistent with this Landfill Operations Plan, the facility permit, and applicable ODEQ rules and regulations. Personnel training regarding Landfill operations, equipment operation/maintenance, and general safety is to be provided to each Landfill employee by MCAAP.

A portable building and sanitary facilities will be provided for employee office, shelter and comfort. Personnel are required to carry mobile phones or other means of communication will be provided for emergency communication. The following equipment or equal will be used for daily operations and site maintenance.

- Crawler/dragger
- Scraper
- D-7 Dozer
Compactor/Dozer

The crawler/dragger, scrapper, and D-7 dozer will be used for daily soil cover excavation and earth movement. The compactor/dozer will be used primarily for the day-to-day operations of spreading, compacting and covering the daily fill. The D-7 dozer will be used as a backup for the compactor/dozer.

C. Public Access Control

Per Oklahoma Administrative Code (OAC) 252:515-19-32, artificial and/or natural barriers shall be used to discourage unauthorized traffic and uncontrolled dumping. Access to the Landfill is controlled by the MCAAP which is a secured military facility. Public Access is to the Landfill is not allowed by the MCAAP.

II. Solid Waste Acceptance

A. Permitted Waste

The Landfill is permitted to handle non-hazardous industrial waste from operations at the MCAAP. These wastes may include:

- Empty cardboard boxes
- Plastic bottles
- Empty crushed cans of paint, paint thinner, etc.
- Metal turnings coated with machine oil
- Inert plastic material
- Small volumes of sandwich wrappings and pop bottles
- Containerized asbestos
- Water treatment plant clarifier sludge/filter backwash
- Sewage sludge

B. Waste Measuring

All waste delivered to the Landfill will be measured using the facility’s scale that is tested and certified annually in accordance with OAC 252:515-19-33(a)(2). If the scale is inoperative, tonnage shall be estimated on a volume basis where 1 cy of waste shall be calculated to weigh 1/3 ton. Fees and monthly reports are to be submitted to the ODEQ and filed in the operating record. An example of the monthly and quarterly reporting forms to be submitted to the ODEQ are included in Attachment 7-1 of this Plan. Monthly reports shall be filed in the operating record and submitted to the ODEQ no later than the 15th of the month following the reporting period.

III. Landfill Operations

This section outlines the general procedures and guidelines for waste placement and cover material at the Landfill.
A. Landfill Progression

The Landfill will continue with the progression of the trench landfilling until the footprint of the proposed vertical expansion area is complete. The vertical expansion of the Landfill will occur in a sequence of phases as shown in Figure 7-1. Phase I will begin at the northern side of the Landfill, with each subsequent phase expanding to the south. As maximum slopes of four feet horizontal to one foot vertical are achieved, the landfilling will move to the south.

B. Waste Placement

Waste material will be deposited in the area identified as the working face. The working face is a sloped surface upon which the waste is compacted in layers. The slope of the working face will be no more than four feet horizontal to one foot vertical (4:1). The spreading and compaction operations are performed using a waste compactor with a push blade. The compactor generally remains on the slope of the working face and compacts the waste by repeatedly traversing both parallel and perpendicular to the slope. Depending on the nature and type of waste disposed, a dozer may be used to push waste at or near the toe of the working face up the working face slope to the compactor. The height of waste will generally not exceed 10 feet in height and is referred to as a lift.

The width of the working face will be kept as small as practical. The waste will be placed next to the previous day's waste until an established row length is reached. Another row is then started parallel to the previously constructed row. As the row’s form lifts over each area, the top of each Landfill lift should slope in such a manner to allow surface runoff to drain away from the working face. After a number of rows have been constructed (creating a lift), a second lift is constructed over the first lift. Waste placement will alternate between various lifts of waste and will allow Landfill traffic to discharge waste at various levels. This method will allow the earthmoving equipment to stockpile daily cover at the top of the day's waste, if necessary.

C. Asbestos Management

Disposal of asbestos at the Landfill will follow the ODEQ guide on Asbestos Management. Asbestos Containing Material (ACM) is regulated under 40 CFR Part 61, Subpart M and 29 CFR 1826.1101 and requires special handling and disposal practices. Disposition of asbestos will be in accordance with MCAAP’s EM Plan 55. Asbestos will be disposed of in the Landfill "by appointment" only; that is, the date and time for placing asbestos in the Landfill will be arranged with the Landfill operator in advance. The asbestos disposition area is separate from the industrial waste area. Only asbestos certified personnel will be allowed in the asbestos disposition area while an active burial is being conducted. During ACM activities, no other types of waste will be accepted; the Landfill will be closed until the ACM is placed in the disposition area and ready for covering.

1. **Containerization:** ACM wastes resulting from removal/abatement projects shall be double bagged in 6-mil plastic bags and tagged with an appropriate warning label. All large, bulky items when removed, shall be doubled-wrapped in sheets of 6-mil plastic, secured with duct tape, and properly labelled. Glovebags will be used for the removal of piping. All ACM waste is double wrapped while wet and placed in 10-mil dumpster liner
during the removal process. Prior to transport the dumpster liner will be zipped and secured closed and all tie downs will be removed. The truck driver will transport the secured dumpster liner to the landfill. The bag will be checked for damage prior to transport and when it arrives at landfill. Asbestos is transported to the Landfill double wrapped and in a 10-mil dumpster liner with no visible emissions from this process.

2. **Protective Clothing:** During the removal of asbestos from facility structures, workers are required to wear protective clothing and respirators. Personal protective equipment consisting of full-body protective clothing and a high-efficiency particulate absorption filter respirator will be worn to hand-place the ACM in the Landfill.

3. **Placing ACM:** An Asbestos disposition area shall be designated prior to the appointment to dispose of ACM. The asbestos disposition area will generally be located adjacent the working face. The working face will be covered with a minimum 6-inches of soil material and a berm will be constructed of soil material to segregate an area large enough to handle the appointed disposal.

   The dumpster will be opened and the dumpster liner will be released into landfill while the truck moves forward. The shops/contractor will remain present with EM program manager while bag is released from dumpster. If the double wrapped asbestos is deemed necessary to be hand-placed or equipment such as a sky-trak must be utilized to place the double wrapped asbestos in landfill without the dumpster liner, the individuals hand-placing asbestos in the landfill will require the same level of full-body protective clothing and high-efficiency particulate absorption filter respirators. There will be no visible emissions from this process.

4. **Cover:** Sufficient soil cover material will be staged in proximity to the asbestos disposition area prior to the appointment to allow placement of cover as soon as the ACM has been deposited. The dumpster liner will then be covered by landfill operator with 6-inches of soil material under guidance of the EM program manager. There will be no visible emissions from this process.

**D. Daily and Intermediate Cover**

The Landfill is to be developed in phases as presented in Figure 7-1. The Phases will be constructed for the purpose of managing and maintaining the waste disposal operations within the smallest practical area. This will aid in diverting storm water away from the active working face.

In accordance with OAC 252:515-19-51(c)(1), the Landfill will apply 6 inches of daily cover material over solid waste disposed at the facility each working day. Daily cover material shall consist of earthen material that is free of garbage, trash, or other unsuitable materials. By applying 6 inches of earthen cover, disease vectors, water infiltration, and blowing litter associated with the Landfill operations will be controlled.

In accordance with OAC 252:515-19-52, waste disposal areas that are not protected by final cover or managed with runoff control structures must receive intermediate cover consisting of an additional 12 inches of compacted earthen material capable of sustaining vegetation. The earthen material shall be free of garbage, trash, or unsuitable material. Vegetative cover (or ODEQ-
approved alternate material) will be established and maintained at the Landfill for areas that remain inactive for a period of more than 1 year.

**E. Final Cover**
The final cover will be constructed when or as the final elevations of waste placement are achieved. Terraces and storm water management structures will be constructed as the final cover is installed. The final cover will consist of a uniform layer of low shrink-swell clay equivalent to the natural liner material and will be compacted in no more than 8-inch lifts to a depth of 2 feet over the entire surface of the Landfill. A 12-inch layer of soil suitable for topsoil and capable of sustaining plant growth will be placed on the clay cover and vegetated. The final cover vegetation must be effective, long-lasting, and capable of self-regeneration and plant succession. Vegetation shall consist of species that are equal or superior to native vegetation during each season of the year. Permanent or interim vegetation shall be established in areas that have been undisturbed for 90 days or more.

**F. Borrow Source**
The on-site soil borrow area shall be reshaped and revegetated, or otherwise reclaimed, to blend with surrounding terrain within 180 days of the date the area ceased being used in accordance with OAC 252:515-19-55.

**IV. Storm Water Management**
The storm water management plan for the Landfill includes provisions for control of storm water run-on and run-off associated with a 24-hour, 25-year storm event. Storm water runoff within the waste disposal boundary is captured within the Landfill’s storm water system. The storm water system is made up of diversion ditches, down chutes and perimeter storm water channels. As the Landfill is constructed, the perimeter channels will extend around the vertical expansion. During operations, storm water will be diverted to temporary ditches, which will be routed to the perimeter storm water channels. The perimeter storm water channels then route the run-off to the proposed storm water pond. The storm water pond is designed to control the runoff from a 24-hour, 25-year storm event. During storm events less than a 24-hour, 25-year storm, the pond is designed with a skimmer to reduce total suspended solids before releasing them downstream to the existing pond.

Storm water run-off from the Landfill site is managed within the current storm water system described above. Drainage swales and letdown channels will convey storm water run-off from the final cover to perimeter storm water channels and then to the proposed storm water pond. Run-off from the active working face will be contained within the waste disposal area using temporary berms.

During disposal operations, diversion berms and ditches should be utilized as necessary to minimize the amount of storm water that enters any active disposal areas. Additionally, non-active areas should be covered with daily and intermediate cover to reduce the infiltration of water.
V. Leachate Management

Storm water that interfaces with waste in the working face of the Landfill will be contained by temporary run-off ditches. The leachate will be allowed to be evaporated or absorbed by the underlying waste/earthen daily cover material. If the leachate does not evaporate or becomes an issue to contain, the Landfill will haul the leachate offsite for disposal.

VI. Landfill Maintenance and Safety

A. Fire Safety

Fire extinguishers are provided for fire protection purposes on all equipment. MCAAP maintains an emergency response plan for the entire installation including the Landfill. The facility emergency response plan will be regularly updated to consider current Landfill operations. All employees will be familiar with emergency response and evacuation procedures.

B. Vectors

In general, vectors will not find suitable harborage in the Landfill due to the compaction and covering of the waste. However, if a vector problem should arise, an assessment of the operating conditions will be made and necessary corrective actions will be taken. If the vector problem persists after initial corrective action, a professional exterminator will be hired to mitigate the problem.

C. Litter Control

Blowing litter will be controlled in accordance with OAC 252:515-19-35. The Landfill will conduct unloading of waste in such a manner as to reduce the blowing of waste from outside the working face. The working face will be covered at the end of each day and as necessary during the operational day to help minimize the scattering of waste. In addition, mobile litter fencing will be placed downwind of the active area during windy weather periods.

D. Dust Control

Dust resulting from vehicular traffic, construction activity, and Landfill operations will be kept to a minimum within the property through the utilization of a water truck, road base material, and/or vegetation establishment. If necessary, a water truck is utilized throughout the day to apply water to various haul roads throughout the site. During the life of the Landfill, water will be applied to the access roads to control dust on as-needed basis.

VII. Environmental Monitoring

A. Surface Water Monitoring

Surface water will be monitored in accordance with the MCAAP’s current Oklahoma Pollutant Discharge Elimination System (OPDES) permit.

Numerous storm water drainage control structures will be constructed at the Landfill. These structures include perimeter channels, letdown channels, and terraces. Routine maintenance must
be conducted on these structures to ensure proper operation. These drainage structures will be inspected in accordance with the facility's Storm Water Pollution Prevention Plan (SWPPP). If erosion damage has occurred to a drainage structure, it will be repaired as soon as possible. Temporary surface run-on and run-off control will be implemented as operationally necessary to reduce the amount of run-on and run-off coming into contact with the active refuse face of the Landfill or to reduce erosion from disturbed areas of the site.

B. Groundwater Monitoring

Groundwater will be monitored in accordance with the approved Groundwater Monitoring Plan for the Landfill, which is maintained in the facility's operating record.

VIII. Recordkeeping

In accordance with OAC 252:515-19-40, the operating record of the facility will be maintained on-site, for the Landfill the operating record must be maintained within the MCAAP. The operating record will include all records concerning the planning, construction, operation, closing, and post-closure monitoring of the facility until the post-closure monitoring period is terminated.

The location demonstration reports include all permits required by local, state and federal agencies concerning all operation at the site. The daily operational record will record operational information including the amount of waste received, any unusual circumstances that may take place during operations, and any other pertinent information regarding the general work carried out at the facility. The monitoring and test results will be maintained in the operating record and submitted to the ODEQ. A copy of all groundwater and storm water records will be kept on-site for review by any local, state, or federal agency. The ODEQ Guidance on Recordkeeping and Reporting is included in Attachment 7-2.
Attachment 7-1
<table>
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<tr>
<th>Date</th>
<th>Generator Name</th>
<th>Waste Name</th>
<th>App #</th>
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DEQ Form #520-821R
Revised July 1998
QUARTERLY RETURN FOR SOLID WASTE LANDFILLS

Due no later than 30 days after the end of each calendar quarter

<table>
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<tr>
<th>Permit Number</th>
<th>Quarter</th>
<th>Year</th>
<th>DEQ Invoice Number</th>
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**For Office Use Only**

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1. Number of operating days this quarter (see instructions)
   ___________ days

2. Total weight, in tons, of waste received during this quarter
   ___________ tons
   a. Weight received, in tons, which was productively reused or recovered and sold (see instructions)
      ___________ tons
   b. Weight received, in tons, from a DEQ approved emergency or special event (see instructions)
      ___________ tons
   c. Weight received, in tons, from large industrial waste generators under the large industrial waste generator exemption (see instructions)
      ___________ tons

3. Weight subject to state disposal fees (line 2 minus sum of lines 2a, 2b, and 2c)
   ___________ tons

4. Total volume, in cubic yards, of waste received during this quarter
   ___________ yd³
   a. Weight received, in cubic yards, which was productively reused or recovered and sold (see instructions)
      ___________ yd³
   b. Weight received, in cubic yards, from a DEQ approved emergency or special event (see instructions)
      ___________ yd³
   c. Weight received, in cubic yards, from large industrial waste generators under the large industrial waste generator exemption (see instructions)
      ___________ yd³

5. Volume subject to state disposal fee (line 4 minus sum of lines 4a, 4b, and 4c)
   ___________ yd³

6. Volume weight subject to state disposal fee (multiply line 5 by 0.33)
   ___________ tons

7. Determine volume weight from total volume (multiply line 4 by 0.33)
   ___________ tons

8. Total weight received (add line 2 and line 7)
   ___________ tons

9. Average weight received per operating day (divide line 8 by line 1)
   ___________ tons/day

10. Weight received subject to state disposal fee (add line 3 and line 6)
    ___________ tons

11. Enter state disposal fee (If line 10a < $40,000, line 10 x $1.50, otherwise, line 10 x $1.25)
    ___________ tons

12. Enter capital investment waiver (see instructions)
    ___________ tons

13. Determine total capital investment waiver to date (see instructions)
    ___________ tons

14. Enter handling waiver (see instructions)
    ___________ tons

15. Enter total allowable waivers (add line 12 and line 14)
    ___________ tons

16. Penalties (see instructions)
    ___________ tons

17. **TOTAL STATE DISPOSAL FEE DUE** (line 11 plus line 16 minus line 15)
    ___________ tons

**Typed/Printed Name of Authorized Agent:** __________________________

**Date:** __________________________

**Signature of Authorized agent:** __________________________

**Phone No.:** __________________________

**Remit original report with payment to:**
Oklahoma Department of Environmental Quality
Administrative Service - Accounts Receivable
P.O. Box 2036
Oklahoma City, OK 73101-2036

**Remit copy of report to:**
Oklahoma Department of Environmental Quality
Land Protection Division
P.O. Box 1677
Oklahoma City, OK 73101-1677

**Electronic submissions should be submitted to:**
solidwastereports@deq.ok.gov bernice.green@deq.ok.gov

DEQ Form #515-030  Jan-18
GENERAL INSTRUCTIONS

All solid waste landfills, except generator owned and operated non-hazardous industrial waste monofills, are required by 27A O.S. §2-10-802 to collect fees on solid waste received at the landfill.

This return should be completed and returned to the Financial and Human Resources Division of the Department of Environmental Quality no later than 30 days after the end of each calendar quarter. Calendar quarters are: 1st quarter--January 1 through March 31, 2nd quarter--April 1 through June 30, 3rd quarter--July 1 through September 30, 4th quarter--October 1 through December 31.

If the return and fees cannot be submitted within 30 days of the end of the quarter, an extension for up to 30 days may be granted by the Department. A request for an extension must be submitted no later than the due date of the return and must include a detailed description of why the extension is needed. The Department will notify you if the extension is granted or not. Please note that extensions cannot be granted which will result in a due date of more than 60 days after the end of the quarter.

SPECIFIC LINE INSTRUCTIONS

Line 1: Enter the number of days during the quarter the landfill was open to receive waste.

Line 2a & 4a: The activities must be included in, and conducted in accordance with, the landfill’s permit. Records pertaining to this fee exemption must be included with the quarterly return. Exemption documentation is to include: 1) waste types and 2) weight/volume recycled and method of recycling for each waste type. If this information is not included, the claim may be disallowed.

Line 2b & 4b: A copy of the DEQ’s written approval waiving the fee must be included with the quarterly return. If a copy is not included, the claim may be disallowed.

Line 2c & 4c: Enter the amount of waste received from large industrial waste generators which was accompanied by a large industrial waste generator fee exemption certificate issued by the DEQ.

Line 10a: If utilizing the capital investment waiver, enter line 13 from previous quarter, otherwise enter $40,000.00.

Line 12: If not utilizing the capital investment waiver, enter $0.00, otherwise see below.
If line 13 of last quarter’s return is $40,000, enter $0.00, otherwise:
If line 9 is less than 100 tons/day, multiply line 8 by $0.50.
If line 9 is equal to or more than 100 tons/day, multiply line 8 by $0.25.

NOTE: Records documenting the capital investment and the use of the funds must be included with the quarterly return.

Line 13: If not utilizing the capital investment waiver, enter $0.00, otherwise see below.
If line 13 of last quarter’s return is less than $40,000, add line 13 of last quarter’s return and line 12 of this quarter’s return. If line 13 of last quarter’s return is $40,000, enter $40,000.00.

Line 14: If not utilizing the capital investment waiver, enter $0.00, otherwise see below.
If line 13 of last quarter’s return is less than $40,000.00, enter $0.00.
If line 13 of last quarter’s return is $40,000 AND this return is filed on time, multiply line 11 by 0.10. Otherwise, enter $0.00.

PENALTIES

There is a 5% penalty for returns postmarked more than 30 days after the due date (or filed after the extension date). Your penalty is determined by multiplying line 11 of the return by 0.05 and including this figure on line 16.

There is a 15% penalty per month for returns postmarked more than 60 days after the due date of the return. Your penalty is determined by multiplying line 11 of the return by 0.15, then by the number of months which have elapsed after the due date (or the extension date if applicable) and including this figure on line 16.

If you have any questions, please contact Amber Edwards, Land Protection Division Solid Waste Unit (405) 702-5133.
DEQ Guidance on Recordkeeping and Reporting


NOTE: The guidance text herein has been modified to remove portions that are not applicable to MCAAP and to incorporate practices conducted by the facility that meet and/or exceed the regulatory requirements.

Purpose. To provide guidance on the records to be maintained in the facility operating record and submitted to the DEQ.

Technical Discussion. All solid waste disposal facilities are required to maintain an operating record containing all records concerning the planning, construction, operation, closing and, if applicable, post-closure monitoring of the facility. Preferably, the operating record should be maintained at the disposal facility; however, an off-site location near the facility which is under the direct control of the owner/operator and accessible during DEQ inspections can be used. For the purposes of this rule, facility records maintained by consultants cannot be considered part of the operating record.

Various Subchapters of OAC 252:515 identify records that must be maintained and/or submitted to the DEQ. This guidance will identify those records so that owner/operators can ensure all required records are being maintained and submitted in a timely manner.

Subchapters 3 through 31 - Permit Applications and Related Documents

- All applications for new and modified permits must be submitted to the DEQ and maintained in the operating record. The permit application includes all text related to the application as well as all maps, drawings, construction plans, QA/QC reports, legal access documents, public notices, etc. required by other Subchapters.
- All correspondence to/from the DEQ related to the permit application must be maintained in the operating record.
- A copy of the approved permit and all associated modifications must be maintained in the operating record.

Subchapter 9 - Groundwater Monitoring and Corrective Action

- Within 60 days of groundwater sampling, a copy of groundwater monitoring results and associated statistical analysis (or cumulative analysis data for C/D landfills) must be placed in the operating record and submitted to the DEQ.
- Within 14 days of determining there is a statistically significant increase (SSI) in one or more monitoring constituents, the DEQ must be notified of the SSI in writing and a copy of the notice placed in the operating record.

1 This includes all correspondence to/from the DEQ.
• Within 90 days of determining there is a statistically significant increase, either an assessment monitoring program, or a demonstration that the increase was not caused by the facility, must be submitted to the DEQ and placed in the operating record.

• Within 14 days of receiving the results from an assessment monitoring event, the DEQ must be notified of the constituents that were detected.

• Prior to a public meeting to discuss an assessment of corrective measures, the DEQ must be provided with:
   an affidavit (with a copy of the published notice) showing that public notice of the meeting was published in a local newspaper;
   copies of certified mail receipts showing that the entities identified in OAC 252:515-9-113(b) were notified of the public meeting; and
   property and mineral ownership maps covering the area within a 2 mile radius of the facility.

• Within 60 days of the public meeting to discuss an assessment of corrective measures, a proposed remedy must be submitted to DEQ for approval and a copy placed in the operating record.

• When the remedy is complete, a certification signed by the owner/operator and a qualified groundwater scientist must be submitted to the DEQ for approval and the approved certification placed in the operating record.

Subchapter 13 - Leachate Collection and Management

• Documentation must be submitted to the DEQ and maintained in the operating record showing any underground storage tanks used to store leachate meet the requirements of the Oklahoma Corporation Commission at OAC 165:25, Subchapter 1, Part 8.

• Plans for leachate recirculation and/or irrigation must be submitted to the DEQ and maintained in the operating record, as well as all correspondence to/from DEQ related to those plans.

• Any testing results required by leachate recirculation/irrigation plans must be submitted to DEQ and maintained in the operating record.

• If leachate is discharged to a POTW, a copy of a letter from the POTW stating it will accept the leachate must be placed in the operating record and submitted to the DEQ.

• The results of any testing required by the POTW must be maintained in the operating record.

• If leachate is discharged under an OPDES permit, a copy of the permit must be maintained in the operating record.

• Any testing required by the OPDES permit must be submitted to DEQ and maintained in the operating record.

NOTE: Quarterly leachate reports are no longer required to be maintained or submitted.

Subchapter 17 - Stormwater Management

• A copy of the Stormwater Pollution Prevention Plan and OPDES Sector L permit must be maintained in the operating record.

• A copy of the OPDES stormwater permit for construction sites must be maintained in the operating record for any on- or off-site soil borrow areas of greater than one acre in size.

• OPDES Sector L visual monitoring and Numeric Effluent Limitation Monitoring results must be maintained in the operating record.
• The Annual Comprehensive Site Compliance Evaluation Report must be submitted to the DEQ’s WQD no later than March 1st for the previous calendar year.
• All NELM monitoring results must be submitted to the DEQ no later than January 15th of each year for the previous year’s reporting period (January 1 thru December 31).

Subchapter 19 - Operational Requirements

• Monthly waste receipt reports must be submitted to the DEQ and a copy placed in the operating record no later than the 15th of the month following the reporting month.2
• To avoid penalties, quarterly returns and fees for landfills must be submitted to the DEQ within 30 days of the end of the quarter.3 A copy of the quarterly return must be maintained in the operating record.
• Copies of approved out-of-state waste disposal plans must be on file with the DEQ and maintained in the operating record, as well as all correspondence to/from DEQ related to the development of the approved plan.
• The DEQ must be notified at least 5 working days in advance of any proposed changes to an approved out-of-state waste disposal plan.
• Copies of initial design capacity reports required by the New Source Performance Standards (NSPS), as well as required updates to the design capacity, must be submitted to the DEQ and placed in the operating record.
• Copies of all test results required by NSPS must be submitted to DEQ and maintained in the operating record.
• Landfills accepting asbestos must maintain the records identified in the Management of Friable Asbestos guidance document.

Subchapter 25 - Closure and Post-Closure Care

• Copies of closure and post-closure plans, all amendments, maps, drawings, construction plans, QA/QC reports, legal access documents, etc. required by the plans must be submitted to the DEQ and maintained in the operating record. All correspondence to/from the DEQ related to the permit application must also be maintained in the operating record.
• Documentation of all activities performed for closure must be submitted to the DEQ with the final closure report and placed in the operating record.
• A copy of the land records notice as recorded must be submitted to the DEQ at the conclusion of closure activities.
• All correspondence to/from the DEQ related to closure and/or post-closure activities must be maintained in the operating record.
• No later than April 1st of each year, a post-closure maintenance and monitoring report must be submitted to the DEQ, and a copy placed in the operating record.
• At the conclusion of post-closure, a Certification of Post-closure Performance must be submitted to the DEQ.

2 Monthly reports are not required to be submitted to the DEQ for large NHIW generator landfills, generator owned and operated NHIW monofills, transfer stations, and processing facilities (including incinerators and regulated medical waste facilities). However, records identifying the amount of waste received must be maintained in the operating record and made available to DEQ upon request.
3 Returns and fees submitted later than this are subject to penalties and are not eligible for the handling waiver.
Appendix 8
Storm Water Run-On/Run-Off Plan
I. Introduction

The McAlester Army Ammunitions Plant Landfill (Landfill) is owned by the U.S. Government and is operated by McAlester Army Ammunitions Plant (MCAAP) personnel. The Landfill operates under Oklahoma Department of Environmental Quality (ODEQ) Solid Waste Permit Number 3561014. The Landfill only accepts non-hazardous industrial waste from operations at the MCAAP in accordance with the permit.

Wastes disposed at the Landfill include:

- Empty cardboard boxes
- Plastic bottles
- Empty crushed cans of paint, paint thinner, etc.
- Metal turnings coated with machine oil
- Inert plastic material
- Small volumes of sandwich wrappings and pop bottles
- Containerized asbestos
- Water treatment plant clarifier sludge/filter backwash
- Sewage sludge

In accordance with Oklahoma Administrative Code (OAC) 252:515-17-2, all active landfill disposal facilities in the State of Oklahoma shall be designed, constructed, and maintained with:

1. a run-on control system to prevent flow onto active portions of the facility during the peak discharge from a 24-hr, 25-year storm; and
2. a run-off control system with sufficient capacity to collect and control all contaminated storm water resulting from a 24-hour, 25-year storm.

This Run-On and Run-Off Control Plan has been prepared to satisfy the requirements of this statute.

II. Run-On Controls

OAC 252:515-17-2(1) requires existing non-hazardous industrial waste (NHIW) disposal facilities to design, construct, operate and maintain a run-on control system to prevent the flow onto the active portion of the Landfill during the peak discharge from a 24-hour, 25-year storm event. In order to verify that the Landfill complies with the run-on control system requirements, drainage calculations were performed assuming a 25-year, 24-hour storm precipitation of 7.5 inches, based on the current National U.S. Geological Survey (USGS) Rainfall Summary. Drainage calculations are provided in Appendix 4 of the RCRA-D Landfill Permit.

To prevent run-on flow from a 24-hour, 25-year storm event from entering the active portion of the landfill during operations, run-on water will be directed around the perimeter of the Landfill. The perimeter storm water infrastructure is designed to be constructed at higher elevations than the surrounding terrain. The perimeter ditch and storm water pond are also bordered by berms that
would prevent run-on from a 24-hour, 25-year storm event.

III. Run-Off Controls

OAC 252:517-13-2(2) requires existing NHIW landfill facilities to design, construct, operate and maintain a run-off control system from the active portion of the Landfill to collect and control at least the water volume resulting from a 24-hour, 25-year storm. Run-off from the capped portions of the Landfill is designed to run along diversion ditches, down chutes, and perimeter storm channels, and subsequently into a surface impoundment designed to control runoff from a 24-hour, 25-year storm event. As the Landfill is constructed, the perimeter storm water channels will be extended around the vertical expansion.

Storm water run-off from the active working face will be contained within the waste disposal area using temporary berms. Diversion berms and ditches will be utilized to minimize the amount of storm water that enters active disposal areas. The berms and ditches will be moved as the working face changes, keeping any storm water that contacts waste within the open face of the landfill. Non-active areas will be covered with daily intermediate cover to reduce infiltration of storm water.

Storm water that comes into contact with waste will be considered leachate and will be contained within the waste disposal area using temporary berms. The leachate will be allowed to evaporate or infiltrate the active portion of the Landfill. Should the leachate fail to evaporate or becomes an issue to contain, it will be transported offsite for disposal.

IV. Plan Amendments

In accordance with OAC 252:515-25-2(c)(2), MCAAP will amend this written Run-On and Run-Off Control Plan at any time provided the revised plan is placed in the facility’s operating record. MCAAP is required to amend this written Run-On and Run-Off Control Plan whenever there is a permit modification that would substantially affect the closure or post-closure requirements or duties.

V. Record Keeping Requirements

In accordance with OAC 252:515-19-40(a), MCAAP must maintain this Run-On and Run-Off Control Plan in the facility operating record. Unless specified otherwise, each file must be retained until the post-closure monitoring period is terminated. The landfill closure plan is provided in Appendix 9.
Appendix 9
Landfill Closure Plan
LANDFILL CLOSURE PLAN
MCALESTER ARMY AMMUNITION PLANT

I. Introduction

The McAlester Army Ammunition Plant Landfill (Landfill) is owned by the U.S. Government and is operated by McAlester Army Ammunitions Plant (MCAAP) personnel. The Landfill operates under Oklahoma Department of Environmental Quality (ODEQ) Solid Waste Permit Number 3561014 and is a Non-Hazardous Industrial Waste (NHIW) facility. The Landfill only accepts non-hazardous industrial waste from operations at the MCAAP in accordance with the permit.

Oklahoma Administrative Code (OAC) 252:515-25-31 requires that the Landfill be closed in accordance with an approved plan and in a manner that minimizes the need for further maintenance and controls and minimizes post-closure escape of waste and waste constituents to the environment.

Closure requirements specific to the Landfill are presented in Section II of this plan. More specifically, Section II addresses the design of the final cover system, grading plans for waste disposal areas, soil budget, phased closure plans, contingencies for unexpected closure, ancillary facilities, monitoring systems, and certification and notification requirements pertaining to closure. Section III presents a general closure schedule associated with the planned sequential closure of Landfill and associated closure activity timelines. Section IV addresses the estimated cost for closure.

II. Closure Requirements

The MCAAP Landfill permit area will consist of approximately 49.279 acres. Once waste disposal operations cease at the Landfill or as areas reach final design grades, closure procedures will be initiated as outlined herein. The following subsections discuss the general landfill design, and the activities and considerations required for proper closure of the facility.

A. General Landfill Design

The Landfill is permitted to handle industrial waste from operations at the MCAAP. These wastes may include:

- Empty cardboard boxes
- Plastic bottles
- Empty crushed cans of paint, paint thinner, etc.
- Metal turnings coated with machine oil
- Inert plastic material
- Small volumes of sandwich wrappings and pop bottles
- Containerized asbestos
- Water treatment plant clarifier sludge/filter backwash
- Sewage sludge

A more detailed list is provided in Appendix 13.

The Landfill will continue with the progression of the trench landfilling until the footprint of the proposed vertical expansion area is complete. The vertical expansion of the Landfill will occur in a sequence of six phases as presented in Figure 9-1. Phase I will begin at the northern side of the landfill, with each subsequent phase expanding to the south. As maximum slopes of four feet horizontal to one foot vertical are achieved, the landfilling will progress to the south.

The entire permitted waste disposal area will be 49.279 acres, which represents the largest area of the disposal facility requiring final cover during the active phase. It is anticipated that the final cover will be installed in phases throughout the life of the facility. Based on the 2019 Permit Modification Application, the total design capacity of the landfill is 1,652,651 cubic yards (cy), which represents the maximum inventory of waste anticipated to ever be on-site during the active life of the facility.

**B. Final Cover System Description**

The final cover will be constructed when or as the final elevations of waste placement are achieved. Terraces and storm water management structures will be constructed as the final cover is installed. The final cover will consist of a uniform layer of low shrink-swell clay equivalent to the natural liner material and will be compacted in no more than 8-inch lifts to a depth of 2 feet over the entire surface of the Landfill. A 12-inch layer of soil suitable for topsoil and capable of sustaining plant growth will be placed on the clay cover and vegetated. The final cover vegetation must be effective, long-lasting, and capable of self-regeneration and plant succession. Vegetation shall consist of species that are equal or superior to native vegetation during each season of the year. Permanent or interim vegetation shall be established in areas that have been undisturbed for 90 days or more.

Should the Landfill close unexpectedly (prior to attaining final design contours), the final cover will be applied to areas that have received waste after the area has been shaped and graded as necessary. MCAAP will submit a permit modification application to ODEQ representing re-designed final contours and permanent storm water structures prior to a premature closure of the Landfill.

During the installation of the final cover system, the construction methods and material consistency will be monitored, tested, and documented in accordance with current and applicable regulatory requirements.

The final cover system for the Landfill will include a compacted earthen barrier layer overlain by an erosion layer. Prior to installation of the compacted barrier layer, the subgrade will be prepared by removing any established vegetative cover, then reworking any daily or intermediate cover layers to provide a smooth, stable, uniformly graded subgrade surface for the construction of the final cover system.
The barrier layer will be at least 30 inches in thickness with a hydraulic conductivity no greater than $1.0 \times 10^{-5}$ centimeters per second (cm/sec) and will be constructed in accordance with the following minimum standards:

- The material shall be substantially free of organics, frozen material, foreign objects, or other deleterious materials;
- Earthen material selected for the construction of the barrier layer shall be demonstrated that it will satisfy the hydraulic conductivity requirement;
- The largest particle size allowed shall be less than 2 inches in diameter;
- Earthen material shall be compacted in lifts that do not exceed 8 inches in a loose condition and/or 6 inches in a compacted condition; and
- Lifts shall be moisture conditioned and compacted to the extent possible to achieve a minimum in place density of 95% of the soil maximum dry density based on as standard proctor analysis.

The erosion layer shall be a minimum of six inches in thickness and shall be placed as soon as possible after the barrier layer is completed. Material to be used for the erosion layer will be of sufficient quality to support vegetative growth. Soil enhancers (e.g., lime, fertilizer, etc.) are to be applied as needed and if required. The exterior side-slopes of the completed Landfill will not exceed 4:1 and the top of the landfill will be graded to a minimum slope of 4% to facilitate positive drainage.

C. Final Grading Plan

The final grading plan associated with the Landfill is presented on Sheet C-4 of the Permit Drawings. Generally, the final cover system will be graded to drain at a minimum slope of 4% and a maximum slope of 25%. The top of the 4:1 slopes will be constructed to an elevation that generally does not exceed 835 feet above mean sea level (msl). The maximum height of the Landfill grading plan will generally not exceed 838 feet above msl.

The design of the final cover system includes provisions for storm water diversion swales and storm water down chutes. The diversion swales, down chutes, and perimeter storm water channels will assist in managing and controlling storm water run-off associated with the final cover system while minimizing the potential for erosion. The diversion swale will generally be at least 18 inches in height. The down chutes will consist of a 6-foot wide trapezoidal channel that is at least 18 inches deep. The down chutes will be lined with a geotextile filter fabric/rip-rap, concrete revetment, or equivalent high-velocity channel lining material. The final grading plan for the Landfill includes provisions for perimeter drainage and access as shown on the Permit Drawings. The perimeter storm water channel will consist of a trapezoidal channel at least 3 feet deep and 6 feet wide on the south and west sides if the Landfill and 8 feet wide on the north and east sides of the Landfill. The perimeter storm water channel will be lined with a geotextile filter fabric/rip-rap, concrete revetment, or equivalent high velocity channel lining material.
The existing storm water and process water impoundment east of the landfill and the proposed relocated impoundment adjacent to eastern boundary of the landfill will manage storm water runoff from the landfill area. All discharges storm water from the landfill will be via an Oklahoma Pollutant Discharge Elimination System (OPDES) permitted outfall located on the east side of the landfill site.

D. Soil Budget

An adequate quantity of soil material suitable for use as a compacted barrier layer is available within the permit area. It is estimated that the final cover system will require roughly 140,275 cy of material for the construction of the barrier layer (24-inch thickness) and erosion layer (12-inch thickness). The storm water control will require an additional 38,000 cy of earthen material; therefore, the total amount of borrow volume required is approximately 433,871 cy. The total volume of available borrow material has been calculated to be 584,387 cy.

E. Anticipated Phased Closure

The development plan for the Landfill consists of six phases as shown on the Permit Drawings included in the August 2019 Permit Modification Application and previously discussed in this Closure Plan. It is anticipated that as phases are developed and achieve final elevations, phased closure will similarly be implemented.

Once the outer slopes of Phase 1 and 2 have reached final grades, it is anticipated that final cover will be constructed over those areas either in phases or at one time. In a similar manner, Phases 3, 4, 5, and 6 will be ready to receive final cover upon the outer slope of each phase attaining final grade. Engineering plans for any proposed partial or phased closure project will be submitted to ODEQ for approval prior to implementation.

F. Unexpected Closure

In the event that the landfill must close prior to reaching the landfill final grades, the following procedures and standards shall apply.

- Engineering plans will be developed to address site closure at the time of unexpected closure.
- Areas that have received waste shall be shaped and graded to a minimum slope of 4% and a maximum slope of 4:1.
- Final cover shall be applied to all areas that have received waste to a minimum thickness of 36 inches including a 24-inch barrier layer and 12-inch erosion layer (capable of sustaining vegetative growth).
- Final cover drainage diversion swales should be installed for every 25 feet of vertical landfill height on 4:1 side slopes. The drainage diversion swales should divert storm water run-off to the down chutes described in previous sections.
- All areas disturbed by landfill activity including exempt fill areas shall be graded, shaped, and seeded.
• Erosion control mechanisms such as hay bales, silt fences, rip-rap, erosion control matting, and channel lining shall be installed as needed and required to minimize erosion while stabilizing surface soils.

Notification, certification, and reporting requirements per Section F shall apply to the unexpected closure scenario.

G. Ancillary Facilities and Monitoring Systems

1. Surface Water Monitoring
Surface water will be monitored in accordance with the MCAAP’s current OPDES permit.

Numerous storm water drainage control structures will be constructed at the landfill. These structures include perimeter channels, down chutes, and drainage diversion swales. Routine maintenance must be conducted on these structures to ensure proper operation. These drainage structures will be inspected in accordance with the facility's Storm Water Pollution Prevention Plan (SWPPP). If erosion damage has occurred to a drainage structure, it will be repaired as soon as possible. Temporary surface run-on and run-off control will be implemented as operationally necessary to reduce the amount of run-on and run-off coming into contact with the active refuse face of the landfill or to reduce erosion from disturbed areas of the site.

2. Groundwater Monitoring
Groundwater will be monitored in accordance with the approved Groundwater Monitoring Plan for the Landfill, which is maintained in the facility's operating record.

H. Notification and Certification Requirements
MCAAP will notify ODEQ in writing prior to beginning any closure activities at the site. For any partial or phased closure project, construction will be performed and monitored in accordance with current and applicable regulatory requirements and a certification document will be prepared and sealed by a professional engineer (PE) registered in the State of Oklahoma for submittal to ODEQ providing the following items at minimum:

• Certification by the PE stating that the area was closed in accordance to the approved Closure Plan, the permit, and applicable regulations;
• As-built drawings prepared by a professional land surveyor (PLS) documenting the thicknesses of the barrier and erosion layers and providing as-built grades; and
• Related drawings, plans, or specifications, and narrative describing how closure was performed.

Although final cover placement, QC, and certification may occur in phases, final closure of the site will not occur until the entire landfill has been filled to the design contours or if waste disposal operations cease at the site (whichever comes first). In accordance with OAC 252:515-25-33, final closure shall begin within 90 days after the last receipt of waste or at the time ODEQ approves amendments to the Closure Plan, whichever is later.
Upon completion of the final closure for the entire site, a Certification of Final Closure shall be prepared and sealed by a PE registered in the State of Oklahoma for submittal to ODEQ providing the following items at minimum:

- Signature of the owner/operator;
- Certification by the PE stating that the area was closed according to the approved closure plan, the permit, and applicable regulations;
- Related drawings, plans, or specifications, and narrative describing how closure was performed and completed;
- As-built drawings prepared by a PLS documenting the thicknesses of the barrier and erosion layers and providing final as-built grades; and
- A summary of the post-closure monitoring activities required and, if necessary, an updated post-closure plan shall be submitted.

Once the closure has been accepted by ODEQ, a notice shall be recorded with the facility property deed in Pittsburg County giving notice to any potential purchaser or lessee that the site was used for the disposal of solid waste and has been closed. The notice shall specify the type, location, and quantity of waste disposed. A copy of the notice is to be sent to ODEQ and maintained in the facility permanent operating record. The notice must also state that the site will be monitored for a specified period, that a survey plat has been filed with ODEQ, and shall contain a prominent note stating that the land has been used for solid waste disposal and that future uses may be restricted.

Final closure of the site must be approved by ODEQ in writing. After final closure certification has been approved by ODEQ the post-closure care period will commence.

III. Closure Schedule

As designed, the Landfill should provide useful waste disposal capacity for MCAAP for several years. Additional airspace capacity provided by the August 2019 Permit Modification Application is expected to provide the Landfill with space needed to operate through the year 2138 (119 years as of January 1, 2019). The actual life of the facility will vary depending on factors such as actual disposal rates, types of materials disposed, amount of daily and intermediate cover materials used, the settlement and decomposition of in-place wastes, and the in-place density achieved over the operational life of the facility. It is anticipated that final cover will be applied in phases as areas reach the final design contours and are not at risk of disturbance from landfill activities.

ODEQ shall be notified in writing prior to the beginning of final closure of a facility or closure of a disposal cell. Closure activities shall begin no later than 90 days after the final receipt of wastes at the facility or final receipt of wastes into a disposal cell as applicable.

Closure activities will generally consist of the construction of the final cover system including construction of required storm water controls and reclamation of soil borrow areas. Closure activities shall be completed according to this Closure Plan within 180 days after closure activities are initiated.
Appendix 10
Historical Landfill Plates
Appendix 11
Historical Geologic Logs
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<th>ELEVATION</th>
<th>DEPTH</th>
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Bottom of Hole @ 41.0'}
### Drilling Log

**HOLE NO. 90**

**PROJECT**
- LANDFILL SITING (SECTION 30)

**LOCATION**
- 33.369570, 260485.40

**DRILLING AGENCY**
- TULSA DISTRICT

**HOLE NO.**
- 90

**DATE HOLE STARTED**
- 03/18/87

**DATE HOLE COMPLETED**
- 03/19/87

**ELEVATION TOP OF HOLE**
- 769.8

**TOTAL DEPTH OF HOLE**
- 40.5

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<td>792.6</td>
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**SIGNATURE OF INSPECTOR**
- FLAMING

**REMARKS**
- HOLE DRY AT 37.1 AT TIME OF DRILLING.
- SAMPLE DEPTH
  - J-1 0.0 - 1.5
  - J-2 1.5 - 4.5
  - J-3 4.5 - 7.5
  - J-4 7.5 - 11.0
  - J-5 11.0 - 14.5
  - J-6 14.5 - 17.5
  - J-7 17.5 - 21.0
  - J-8 21.0 - 24.5
  - J-9 24.5 - 28.0
  - J-10 28.0 - 31.0
  - J-11 31.0 - 34.0
  - J-12 34.0 - 38.0
  - J-13 38.0 - 40.5
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<td>2.5 - 15.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>735.7</td>
<td></td>
<td></td>
<td>SHALE (SH) (15.5 - 29.8)</td>
<td>J-2</td>
<td>MOVED OVER HOLE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td></td>
<td>SHALE, DARK GRAY, DRY, FIRM W/ORANGE</td>
<td>6&quot; AUGER 0.0-40.0'</td>
<td>W.L. 20.0' AT 1035 HOUR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>IRON CONCRETIONS DOWN TO 24.5'</td>
<td>39.0'</td>
<td></td>
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<tr>
<td>211.8</td>
<td>25</td>
<td></td>
<td>SANDSTONE (SS) (28.8 - 40.0)</td>
<td>J-6</td>
<td>HIT H2O AT 30.0'</td>
<td></td>
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<tr>
<td></td>
<td>21.5</td>
<td></td>
<td>SANDSTONE, 28.8-30.0</td>
<td>39.0'</td>
<td>OPEN TO 39.0'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td></td>
<td>SOURCE H2O</td>
<td>30.0'</td>
<td>W.L. 20.0' AT 1035 HR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td></td>
<td>OF ORANGE</td>
<td>30.0'</td>
<td>SET PIEZO,</td>
<td></td>
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<tr>
<td></td>
<td>21.5</td>
<td></td>
<td>W/WHITE</td>
<td>30.0'</td>
<td>BACK FILLED W/SAND</td>
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</tr>
<tr>
<td></td>
<td>21.5</td>
<td></td>
<td>TO 12.0'</td>
<td>30.0'</td>
<td>TO 12.0'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td></td>
<td></td>
<td>30.0'</td>
<td>1/2 BUCKET OF PELLETS</td>
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<td></td>
<td>21.5</td>
<td></td>
<td></td>
<td>30.0'</td>
<td>TO 10.5'</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21.5</td>
<td></td>
<td></td>
<td>30.0'</td>
<td>4.39' STICKUP</td>
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ENG FORM 1838  PREVIOUS EDITIONS ARE OBSOLETE.

TRANSTUDIO
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<th>ELEVATION (ft)</th>
<th>DEPTH (ft)</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>% CORE RECOVERY</th>
<th>REMARKS</th>
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<tr>
<td>10.3</td>
<td>0.0 - 7.0</td>
<td>CLAY (CL)</td>
<td>MOVED OVER HOLE 6&quot; AUGER 0.0-41.5&quot;</td>
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<td>CLAY (CL), ORANGE-BROWN, MOIST 0.0-1.5</td>
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<td>CLAY (CL-CH) MOIST, GREEN TAN 1.5-7.0</td>
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<td>Silt Gravel</td>
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<td>J-4</td>
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<td>TOP OF ROCK</td>
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<td>J-5</td>
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<td>21.3</td>
<td>7.0 - 30.0</td>
<td>SHALE (SH)</td>
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<td>J-6</td>
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<td>SHALE TAN GREEN, DRY WEATHERED 7.0-30.0</td>
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<td>FIRMER BELOW 14.0'</td>
<td></td>
<td>J-8</td>
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<td></td>
<td>12.0</td>
<td>SHALE (SH)</td>
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<tr>
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<td>18.0</td>
<td>MOD. FIRM</td>
<td></td>
<td>J-10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24.0</td>
<td></td>
<td></td>
<td>J-11</td>
<td></td>
</tr>
<tr>
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<td>36.0</td>
<td></td>
<td></td>
<td>J-12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.5</td>
<td></td>
<td></td>
<td>J-13</td>
<td></td>
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</table>

**REMARKS:** (Drilling fluid, water, lens depth of weathering, etc., if applicable)

**BOTTOM OF HOLE AT 41.5**
<table>
<thead>
<tr>
<th>Elevation (ft)</th>
<th>Depth (ft)</th>
<th>Legend</th>
<th>Classification of Materials</th>
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<tr>
<td>73.34</td>
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<td>CLAY (CL-ML) BROWN MOIST – WET</td>
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<td>0.0 – 1.5</td>
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<td></td>
<td>CLAY (CL-CH) BROWN MOIST</td>
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<td></td>
<td></td>
<td></td>
<td>1.5 – 7.5</td>
</tr>
<tr>
<td>73.58</td>
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<td>TOP OF ROCK</td>
</tr>
<tr>
<td>0</td>
<td></td>
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<td>SHALE (SH) (7.5 – 41.0)</td>
</tr>
<tr>
<td></td>
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<td>SHALE TAN GREEN, MOD. FIRM.</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>WEATHERED DRY. 7.5 – 21.0'</td>
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<td></td>
<td>SHALE, DARK GRAY, VERY FIRM</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>21.0 – 41.0</td>
</tr>
</tbody>
</table>

**Remarks:**
- J-1: MOVED OVER HOLE 6" AUGER 0.0 – 41.0'
- J-2: HOLE OPEN TO 38.2' DRY
- J-3: CLEANED OUT HOLE
- J-4: SAMPLE DEPTH
- J-5: WL 3-16-87, 0800, 38.2 DRY

**Additional Details:**
- **Hole No:** 98
- **Depth Drilled Into Rock:** 33.5
- **Total Depth of Hole:** 41.0
- **Date Hole Started:** 03/12/87
- **Date Hole Completed:** 03/12/87
- **Elevation Top of Hole:** 770.9
- **Total Core Recovery for Boring:** 0.0
- **Total Number Core Boxes:** 0
- **Driller:** Wyatt
- **Drilling Agency:** Tulsa District
- **Drill Type:** Failing 1500
- **Type of Hole:** Core
- **Size and Type of Bit:** 5.5" Auger
<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Classification of Materials (Description)</th>
<th>Box or Sample No.</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>4.0</td>
<td>CLAY (CL) (0.0 - 7.5)</td>
<td>J-1</td>
<td>AUGERED 0.0-41.0, DRY</td>
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<td>CLAY, MODERATELY SOFT, MOIST, MINOR</td>
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<td>SAND, LOW PLASTICITY, AT 2.4'</td>
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<tr>
<td></td>
<td>CLAY IS STIFF, TAN-GREEN.</td>
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<tr>
<td>4.5</td>
<td>SAMPLE DEPTH</td>
<td>J-2</td>
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<tr>
<td></td>
<td>J-1 2.4-2.5</td>
<td></td>
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<tr>
<td></td>
<td>J-2 2.4-2.5</td>
<td></td>
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<tr>
<td></td>
<td>J-3 2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J-4 2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J-5 2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>SHALE (SH) (7.5 - 41.0)</td>
<td>J-3</td>
<td></td>
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<tr>
<td></td>
<td>MODERATELY SOFT, WEATHERED, BLOKGY, TAN-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GREEN, GREEN-GRAY AT 14.0'</td>
<td></td>
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<tr>
<td></td>
<td>GRAY BELOW 20.0'</td>
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<tr>
<td></td>
<td>VERY SILTY AT 34.0'</td>
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<td>5.5</td>
<td>SAMPLE DEPTH</td>
<td>J-4</td>
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<tr>
<td></td>
<td>J-6 2.4-2.5</td>
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<td></td>
<td>J-7 2.4-2.5</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>J-8 2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J-9 2.4-2.5</td>
<td></td>
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</tr>
<tr>
<td>6.0</td>
<td>SAMPLE DEPTH</td>
<td>J-5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>J-10 2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5</td>
<td>SAMPLE DEPTH</td>
<td>J-6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>J-11 2.4-2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>J-12 2.4-2.5</td>
<td></td>
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<tr>
<td>7.0</td>
<td>SAMPLE DEPTH</td>
<td>J-7</td>
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</tr>
<tr>
<td>7.5</td>
<td>SAMPLE DEPTH</td>
<td>J-8</td>
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<td>8.0</td>
<td>SAMPLE DEPTH</td>
<td>J-9</td>
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<tr>
<td>8.5</td>
<td>SAMPLE DEPTH</td>
<td>J-10</td>
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<tr>
<td>9.0</td>
<td>SAMPLE DEPTH</td>
<td>J-11</td>
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<tr>
<td>9.5</td>
<td>SAMPLE DEPTH</td>
<td>J-12</td>
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<tr>
<td>10.0</td>
<td>SAMPLE DEPTH</td>
<td>J-13</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The legend for the SHALE (SH) indicates that it is a moderately soft shale, weathered, blocky, tan-green, green-gray at 14.0', gray below 20.0 feet, and very silty at 34.0 feet. The samples are taken at various depths, with specific depths and characteristics noted in the table. The remarks section indicates that the augered depth ranges from 0.0 to 41.0 feet, and the area is measured with a water level meter on 9/18/87. The project for this hole is LANDFILL SITING (SECTION 30).
1. PROJECT  
LANDFILL SITING (SECTION 30)

2. LOCATION (Coordinates or Station)  
553354.80  
2804418.90

3. DRILLING AGENCY  
TULSA DISTRICT

4. HOLE NO.  
104A

5. NAME OF DRILLER  
WYATT

6. DIRECTION OF HOLE  
VERTICAL

7. THICKNESS OF OVERBURDEN  
7.5

8. DEPTH DRILLED INTO ROCK  
13.7

9. TOTAL DEPTH OF HOLE  
21.2

10. SIZE AND TYPE OF BIT  
5.5" AUGER

11. DATUM FOR ELEVATION SHOWN  
MSL

12. MANUFACTURER'S DESIGNATION OF DRILL  
FAILING 1500

13. TOTAL NO OF OVER-  
DISTURBED 0  
UNDISTURBED 0

14. TOTAL NUMBER CORE BOXES  
0

15. ELEVATION GROUND WATER  
DRY (9 MAR 87)

16. DATE HOLE STARTED  
03/03/87

17. ELEVATION TOP OF HOLE  
778.1

18. TOTAL CORE RECOVERY FOR BORING  
0.0

19. SIGNATURE OF INSPECTOR  

REMARKS  
DID NOT COLLECT SAMPLES FOR HOLE, SEE LOG TO HOLE 104 FOR DESCRIPTION OF MATERIAL.

AUGERED 0.0-21.2', SET PIEZOMETER IN DRY HOLE, HOLE DRY ON 9 MARCH 1987.

ELEVATION  

DEPTH  

LEGEND  

CLASSIFICATION OF MATERIALS (Description)  

% CORE RECOVERY  

BOX OF SAMPLE NO.  

REMARKS  
Drilling time, water level, depth of weathering, etc., if relevant.

275.9  

24  
20  
16  
12  
8  
4  
0  
-4  
-8  
-12  
-16  
-20  
-24  
-28  
-32  
-38  
-40

BOTTOM OF HOLE

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MAR 71  

PROJECT  
LANDFILL SITING (SECTION 30)

HOLE NO.  
104A
<table>
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<th>ELEVATION</th>
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<th>CLASSIFICATION OF MATERIALS</th>
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<td>763.5</td>
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<td>CLAY (CL) (0.0 - 5.5) SHORT, LOW PLASTICITY, MOIST, BROWN</td>
<td>J-1</td>
<td>AUGERED 0.0-49.0' HIT WATER AT 32.0', SET PIEZOMETER, MEASURED WATER IN PIEZOMETER AT 26.4' ON 16 MARCH 1987.</td>
</tr>
<tr>
<td></td>
<td>12.0</td>
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<td>SOFT, DAMP, MODERATE TO HIGH PLASTICITY, TAN-GREEN BELOW 2.5'</td>
<td>J-2</td>
<td>SAMPLE DEPTH</td>
</tr>
<tr>
<td></td>
<td>24.0</td>
<td></td>
<td>SHALE (SH) (5.5 - 49.0) SOFT, WEATHERED, BLOCKY, SILTY</td>
<td>J-3</td>
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<td>36.0</td>
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<td>TAN-GREEN, GRAY-BELOW 12.0'</td>
<td>J-4</td>
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<td></td>
<td>48.0</td>
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<td>MODERATE SOFT, GRAY TO DARK</td>
<td>J-5</td>
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<td>GRAY BELOW 18.5', VERY SILTY, WET 32.0-32.4'</td>
<td>J-6</td>
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</table>

**HOLE NO. 105**

**PROJECT** LANDFILL SITING (SECTION 30)

**DIVISION** SOUTH-WEST

**INSTALLATION** MCALESTER

**HEIGHT** 1 of 2 SHEETS

**1. PROJECT** LANDFILL SITING (SECTION 30)

**2. LOCATION** (Coordinate or Section) 53335.970

**3. DRILLING AGENCY** TULSA DISTRICT

**4. HOLE NO.** (As shown on drawing title and line number) 105

**5. NAME OF DRIller** WYATT

**6. DIRECTION OF HOLE** VERTICAL

**7. THICKNESS OF OVERBURDEN** 5.5

**8. DEPTH DRILLED INTO ROCK** 43.5

**9. TOTAL DEPTH OF HOLE** 49.0

**10. SIZE AND TYPE OF BIT** 5.5' AUGER

**11. DATUM FOR ELEVATION BROWN** (Tie in MSL)

**12. MANUFACTURER'S DESIGNATION OF DRILL** FAILING 1500

**13. TOTAL NO OF OVER-** DISTURBED 15 UNDISTURBED 0

**14. TOTAL NUMBER CORE BORES** 0

**15. ELEVATION GROUND WATER** 26.4' (18 MAR 87)

**16. DATE HOLE STARTED** 03/04/87

**17. ELEVATION TOP OF HOLE** 769.0

**18. TOTAL CORE RECOVERY FOR BORING** 0.0

**19. SIGNATURE OF INSPECTOR** FLAMING
**DRILLING LOG**

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
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<tbody>
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<td>720.0</td>
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<td>BOTTOM OF HOLE</td>
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**CLASSIFICATION OF MATERIALS**

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<td>56.0</td>
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<td>MODERATE SOFT, GRAY TO DARK</td>
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<td>62.0</td>
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<td>GRAY BELOW 18.5', VERY SILTY, WET 32.0 - 32.4'</td>
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**REMARKS**

- J-13
- J-14
- J-15

**PROJECT**

- LANDFILL SITING (SECTION 30)

**HOLE NO.**

- 105

**LOCATION**

- 2605354.70

**DRILLING AGENCY**

- TULSA DISTRICT

**DATE HOLE STARTED**

- 03/04/87

**DATE HOLE COMPLETED**

- 05/05/87

**DATE OF ELEVATION GROUND WATER**

- 28.4' (16 MAR 87)

**DATE WATER SAMPLE TAKEN**

- 03/05/87
<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>% CORE RECOVERY</th>
<th>BOX OR SAMPLE NO.</th>
<th>REMARKS</th>
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<td>DID NOT SAMPLE HOLE. SEE LOG OF HOLE 105 FOR DESCRIPTION OF SOIL AND ROCK MATERIAL.</td>
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<td>AUGERED 0.0-25.0', HOLE DRY. SET PIEZOMETER.</td>
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</table>
DRILLING LOG | DIVISION | SOUTHWEST | INSTALLATION | McALESTER | SHEET 1 OF 1 SHEETS
---|---|---|---|---|---
1. PROJECT | LANDFILL SITING (SECTION 30) | | | | 
2. LOCATION | 833346.00 | 2605861.00 | | | 
3. DRILLING AGENCY | TULSA DISTRICT | | | | 
4. HOLE NO. | 1058 | | | | 
5. NAME OF DRILLER | WYATT | | | | 
6. DIRECTION OF HOLE | | | | | 
7. THICKNESS OF OVERBURDEN | 0.0 | | | | 
8. DEPTH DRILLED INTO ROCK | 0.0 | | | | 
9. TOTAL DEPTH OF HOLE | 25.4 | | | | 
10. SIZE AND TYPE OF BIT | 8" AUGER | | | | 
11. DATUM FOR ELEVATION SHOWN | MSL | | | | 
12. MANUFACTURER'S DESIGNATION OF DRILL | FAILING 1500 | | | | 
13. TOTAL NO. OF CORE BOXES | 0 | 0 | | | 
14. ELEVATION GROUND WATER | DRY (14MAR88) | | | | 
15. DATE HOLE STARTED | 03/14/88 | | | | 
16. DATE HOLE COMPLETED | 03/14/88 | | | | 
17. ELEVATION TOP OF HOLE | 768.8 | | | | 
18. TOTAL DRY RECOVERY FOR BORING | 0.0 | | | | 
19. SIGNATURE OF INSPECTOR | BOWEN | | | | 

**LEGEND**
- **a**: Elevation
- **b**: Depth
- **c**: Classification of Materials
- **d**: % Core Recovery
- **e**: Box or Sample No.
- **f**: Remarks

**CLASSIFICATION OF MATERIALS**
- **Description**: AUGERED TO 25.4', NO SAMPLES TAKEN OR DESCRIPTION OF SOIL OR ROCK MATERIAL AVAILABLE.

**REMARKS**
- **Drilling Time, Water Loss, Depth of weathering, etc. - If significant**

**BOTTOM OF HOLE**
- **No water encountered in hole; set 2" piezometer**
<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>% CORE RECOVERY</th>
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<td>6&quot; AUGER 29.4-42.1</td>
<td>WEL 37.4 AT 1300 HR</td>
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**Drilling Log Details**

1. **Project**: Landfill Siting (Section 30)
2. **Log No.**: 33384410
3. **Location**: Tulsa District
4. **Hole No.**: 108
5. **Name of Driller**: Wyatt
6. **Date Started**: 03/05/87
7. **Elevation Top of Hole**: 787.9
8. **Core Recovery**: 0.0
9. **Total Depth of Hole**: 42.1
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<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
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<td>HOLE TAPED AT 49.92'</td>
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<td>CLAY(CL-CH) MOIST, TAN GREEN</td>
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<td>48.0-52.0</td>
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</table>

**Remarks:**
- Drilling time, water usage, depth of sampling, etc. if important.
- Module 5-10-87 49.92 CAVINGS.
### HOLE NO. 107

**Drilling Log**

1. **Project:** LANDFILL SITING (SECTION 30)
2. **Location:** 2606210.40
3. **Drilling Agency:** TULSA DISTRICT
4. **Hole No.:** 107
5. **Name of Driller:** WYATT
6. **Direction of Hole:** 7. **Thickness of Overburden:** 7.0
7. **Depth Drilled into Rock:** 48.0
8. **Total Depth of Hole:** 52.0

<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Legend</th>
<th>Classification of Materials (Consistency)</th>
<th>% Core Recovery</th>
<th>Box or Sample No.</th>
<th>Remarks</th>
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<td>44.0</td>
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<td>DRY 30.5 - 52.0</td>
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<td>BOTTOM OF HOLE AT 52.0'</td>
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</table>

**Additional Information**

- **Elevation for Elevation Shown:** MSL
- **Total Number Core Cored:** 0
- **Elevation Ground Water:** 3/09/87
- **Date Hole Started:** 03/09/87
- **Date Hole Completed:** 03/09/87
- **Elevation Top of Hole:** 779.9
- **Total Core Recovery for Boring:** 0.0

**Signature of Inspector:** FLAMING

**Project:** LANDFILL SITING (SECTION 30)
# Drilling Log

**HOLE NO. 108**

<table>
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<th>Field</th>
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<td><strong>2. LOCATION</strong></td>
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<td><strong>3. DRILLING AGENCY</strong></td>
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<td><strong>4. HOLE NO.</strong></td>
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<td><strong>5. NAME OF DRILLER</strong></td>
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<tr>
<td><strong>6. DIRECTION OF HOLE</strong></td>
<td>DEEP FROM HORIZ.</td>
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<tr>
<td><strong>7. THICKNESS OF OVERBURDEN</strong></td>
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<tr>
<td><strong>8. DEPTH DRILLED INTO ROCK</strong></td>
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<td><strong>9. TOTAL DEPTH OF HOLE</strong></td>
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<tr>
<td><strong>10. SIZE AND TYPE OF BIT</strong></td>
<td>5.5&quot; ALUM.</td>
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<tr>
<td><strong>11. DATUM FOR ELEVATION SHOWN</strong></td>
<td>MSL</td>
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<td><strong>12. MANUFACTURER'S DESIGNATION OF DRILL</strong></td>
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<td><strong>13. TOTAL NO. OF OVER-</strong></td>
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<td><strong>14. TOTAL NUMBER CORE BOXES</strong></td>
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<td><strong>15. ELEVATION GROUND WATER</strong></td>
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<td><strong>16. DATE HOLE STARTED</strong></td>
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<td><strong>17. ELEVATION TOP OF HOLE</strong></td>
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<td><strong>18. TOTAL CORE RECOVERY FOR CORES</strong></td>
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**ENG FORM 1036 PREVIOUS EDITIONS ARE OBSOLETE.**

**PROJECT**

LANDFILL SITING (SECTION 30)

**HOLE NO.**

108
### Drilling Log Details

- **Hole No.**: 109
- **Drilling Agency**: Tulsa District
- **Location**: Landfill Site (Section 30)
- **Drill Type**: 5.5" Auger
- **Elevation**: 784.5
- **Depth Drilled**: 32.0
- **Date Started**: 03/11/87
- **Date Completed**: 03/11/87

### Log Data

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### Notes
- **Remarks**: 8" auger 0.0-52.0'
- **Water**: Dry, 3/18/87 51.12 Deep - Dry

---

*Project*: Landfill Site (Section 30)
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**Bottom of Hole 52.0’**
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ENG FORM 1836  
PREVIOUS EDITIONS ARE OBSOLETE  
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LELANDFILL SITING (SECTION 30)  
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**HOLE NO. 114**

**LOCATION**
- 34°47'12" N
- 8°05'34.70" E

**Drilling Agency**
- TULSA DISTRICT

**Driller**
- WYATT

**Date of Elevation**
- 03/23/87

**Elevation of Hole**
- 758.3' on 03/23/87

**Total Length of Hole**
- 41.5'
## DRILLING LOG

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</tr>
<tr>
<td>753.0</td>
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<td>SHALE (SH) (19.0 – 25.5)</td>
<td>J-7</td>
<td></td>
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</tr>
<tr>
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<td></td>
<td>SHALE, GREEN TAN, FIRM DRY</td>
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<tr>
<td>748.5</td>
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<td>SHALE (SH) (25.5 – 41.5)</td>
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<td>SHALE, DARK GRAY, VERY FIRM, DRY</td>
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</tr>
<tr>
<td></td>
<td>28</td>
<td></td>
<td>S.S. 37.6'</td>
<td>J-10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>38</td>
<td></td>
<td></td>
<td>J-12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.5</td>
<td></td>
<td>BOTTOM OF HOLE AT 41.5'</td>
<td>J-13</td>
<td></td>
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</tbody>
</table>

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**HOLE NO. 115**

**DRILLER:** WYATT

**LOCATION:** TULSA DISTRICT

**DATE:** 03/24/87

**COMPLETED ON:** 03/24/87

**ELEVATION TOP OF HOLE:** 772.0'
**DRILLING LOG**

**DIVISION**

**SOUTHWEST**

**INSTALLATION**

**McALESTER**

**HOLE NO. 116**

---

1. **PROJECT:** LANDFILL SITING (SECTION 30)
2. **LOCATION:** 533976.50
3. **DRILLING AGENCY:** CORPS OF ENGR.
4. **HOLE NO. (As shown on drawing title and the number):** 116
5. **NAME OF DRILLER:** WYATT
6. **DIRECTION OF HOLE:** VERTICAL
7. **THICKNESS OF OVERBURDEN:** 7.5
8. **DEPTH DRILLED INTO ROCK:** 43.5
9. **TOTAL DEPTH OF HOLE:** 51.0
10. **SIZE AND TYPE OF BIT:** 5.5" AUGER
11. **DATE FOR ELEVATION SHOWN:** MSL
12. **MANUFACTURER'S DESIGNATION OF DRILL:** FAILING 1500
13. **TOTAL NO OF OVERTURNOVER:** 18
14. **TOTAL NUMBER CORE BOXES:** 0
15. **ELEVATION GROUND WATER:** 04/01/87
16. **DATE HOLE STARTED:** 04/01/87
17. **ELEVATION TOP OF HOLE:** 773.4
18. **TOTAL CORE RECOVERY FOR HOLE:** 0.0

---

**ELEVATION**

**DEPTH**

**LEGEND**

**CLASSIFICATION OF MATERIALS**

<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS</th>
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<td>CLAY (CL) (0.0 – 7.5)</td>
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<td>CLAY (CL-ML) BROWN, MOIST</td>
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<td>CLAY (CL-H) TAN, MOIST</td>
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<td>1.0–4.0</td>
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<td></td>
<td>CLAY (CL-H) TAN, DRY</td>
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<td>4.0–7.5</td>
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<td>TOP OF ROCK</td>
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<td>SHALE, TAN, GREEN, DRY, MOD.</td>
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<td>FIRM, 7.5–14.0</td>
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<td>SHALE, GREEN TAN, DRY, MOD.</td>
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<td>FIRM 14.0–20.5</td>
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<td>SHALE (SH) (20.5 – 51.0)</td>
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<td>SHALE, DARK GRAY, FIRM</td>
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<td>20.5–51.0</td>
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<tr>
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<td></td>
<td>SANDSTONE STRATA 22.0, 25.5,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AND 31.0, AND 35.8</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SANDSTONE AT 45.0, 48.0, 50.0</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>AND 50.0</td>
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**CORE RECOVERY**

<table>
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<tr>
<th>BOX OF SAMPLE NO.</th>
<th>REMARK (Drilling time, water loss, depth of overburden, etc., if significant)</th>
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<tbody>
<tr>
<td>J-1</td>
<td>DOWN 30 MIN. PACKING, HYDRACYLINDER</td>
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<tr>
<td>J-2</td>
<td>MOVED ON HOLE 6&quot; AUGER 0.0–51.0</td>
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<tr>
<td>J-3</td>
<td>HOLE OPEN 47.4&quot;, NO H2O ENCOUNTERED</td>
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<tr>
<td>J-4</td>
<td>SAMPLE DEPTH</td>
</tr>
<tr>
<td>J-5</td>
<td>J-1 0.0–1.0</td>
</tr>
<tr>
<td>J-6</td>
<td>J-2 1.0–4.0</td>
</tr>
<tr>
<td>J-7</td>
<td>J-3 4.0–7.5</td>
</tr>
<tr>
<td>J-8</td>
<td>J-4 7.5–10.5</td>
</tr>
<tr>
<td>J-9</td>
<td>J-5 10.5–14.0</td>
</tr>
<tr>
<td>J-10</td>
<td>J-6 14.0–17.0</td>
</tr>
<tr>
<td>J-11</td>
<td>J-7 17.0–20.5</td>
</tr>
<tr>
<td>J-12</td>
<td>J-8 20.5–23.5</td>
</tr>
<tr>
<td>J-13</td>
<td>J-9 23.5–26.5</td>
</tr>
<tr>
<td>J-14</td>
<td>J-10 26.5–29.5</td>
</tr>
<tr>
<td>J-15</td>
<td>J-11 28.5–30.0</td>
</tr>
<tr>
<td>J-16</td>
<td>J-12 30.0–36.0</td>
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<tr>
<td>J-17</td>
<td>J-13 36.0–40.0</td>
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<tr>
<td>J-18</td>
<td>J-14 40.0–43.0</td>
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<td>J-15 43.0–46.5</td>
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<tr>
<td></td>
<td>J-16 46.5–51.0</td>
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</table>

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**ENG FORM**

**PREVIOUS EDITIONS ARE OBSOLETE.**

**MAR 71**

**TRANSPARENT**

**PROJECT**

**LANDFILL SITING (SECTION 30)**

**HOLE NO.**

116
<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>CLASSIFICATION OF MATERIALS</th>
<th>% CORE RECOVERY</th>
<th>OBSERVATIONS</th>
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<tbody>
<tr>
<td>51.0</td>
<td>SHALE (SH) (20.5 - 51.0)</td>
<td>J-14</td>
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<tr>
<td>49.5</td>
<td>SHALE, DARK GRAY, FIRM</td>
<td>J-15</td>
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<tr>
<td>48.0</td>
<td>SANDSTONE STREAK 22.0', 25.5', AND 31.0', AND 35.0'</td>
<td>J-16</td>
<td></td>
</tr>
<tr>
<td>52.0</td>
<td>SANDSTONE AT 45.0', 48.0', 50.0'</td>
<td>J-17</td>
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</tr>
<tr>
<td>Bottom of Hole 51.0'</td>
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</table>

HOLE NO. 116

PROJECT LANDFILL SITING (SECTION 30)

LOCATION 533976.30 2804399.40

DRILLING AGENCY CORPS OF ENGR

HOLE NO. 118

DATE HOLE STARTED 04/01/87 COMPLETED 04/01/87

ELEVATION TO TOP OF HOLE 773.4

TOTAL NUMBER OF BOXES 0

TOTAL CORE RECOVERY FOR BORING 0.0

SIGNATURE OF INSPECTOR

LEGEND

- SHALE (SH)
- SHALE, DARK GRAY, FIRM
- SANDSTONE STREAK 22.0', 25.5', AND 31.0', AND 35.0'
- SANDSTONE AT 45.0', 48.0', 50.0'

PROJECT LANDFILL SITING (SECTION 30) 116
<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>% CORE RECOVERY</th>
<th>REMARKS (Drilling Test, water level, depth of overburden, etc.)</th>
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</thead>
<tbody>
<tr>
<td>772.0</td>
<td></td>
<td></td>
<td>Silt (ML) (0.0 - 1.5)</td>
<td>J-1</td>
<td>AUGERED 0.0-10.0 SET Casing and Cored with 4&quot; Carbonyl Bit, Encountered Water at 80.8' Water Level at 88.0' on 30MAR87, Drilled Using Air.</td>
</tr>
<tr>
<td></td>
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<td>Clay (CL) (1.5 - 7.5)</td>
<td>J-2</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Moderate Soft, Moist, Light Brown, High Plasticity, At 3.5 Becomes Tan-Green.</td>
<td>J-3</td>
<td>REAMED OUT HOLE WITH A 7 7/8&quot;BIT TO 100 AND SET MONITORING WELL ON SAUGER7</td>
</tr>
<tr>
<td>766.0</td>
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<td>Shale (SH) (7.5 – 27.4)</td>
<td>J-4</td>
<td>CARTON SAMPLES</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>2. 26.2-26.9'</td>
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<td>3. 26.8-27.3'</td>
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<td>4. 36.1-37.3'</td>
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<td>5. 51.2-52.4'</td>
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<td>6. 82.5-93.8'</td>
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<td>30.0</td>
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<td>Shale (SH) (27.4 - 56.5)</td>
<td>BOX 1</td>
<td>SAMPLE DEPTH</td>
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<tr>
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<td>Moderately Soft, Slightly Silty, Calcereous, Zone of Large Cemented Silstone Nodules 39.7-39.7' And 43.4 To 56.9', Minor Fractures At 41.3 To 43.9.</td>
<td>BOX 2</td>
<td>J-1 0.0-1.5</td>
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<td>J-3 1.5-3.5</td>
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<td>J-4 3.5-6.0</td>
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<td>J-5 6.0-7.5</td>
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<td>BOX 1 10.0-17.0</td>
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<td>BOX 2 17.0-23.7</td>
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<td>BOX 3 23.7-32.7</td>
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<td>BOX 4 32.7-40.9</td>
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<td>BOX 5 40.9-48.7</td>
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<td>BOX 6 48.9-56.4</td>
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<td>BOX 7 56.4-64.5</td>
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<td>BOX 8 64.5-72.2</td>
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<td>BOX 11 94.8-100.9</td>
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<td>BOX 12 94.8-100.9</td>
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</table>

**Remarks:**
- Box 1
- Box 2
- Box 3
- Box 4
- Box 5
- Box 6
- Box 7
- Box 8
- Box 9
- Box 10
- Box 11
- Box 12

**Legend:**
- Silt (ML)
- Clay (CL)
- Shale (SH)

**Classification of Materials (Description):**
- Soft, Moist to Wet, Brown, V. Clayey
- Moderate Soft, Moist, Light Brown, High Plasticity, At 3.5 Becomes Tan-Green
- Moderately Soft, Slightly Silty, Calcereous, Zone of Large Cemented Silstone Nodules 39.7-39.7' And 43.4 To 56.9', Minor Fractures At 41.3 To 43.9.
<table>
<thead>
<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>% CORE RECOVERY</th>
<th>BOX OR SAMPLE NO.</th>
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<tr>
<td>672.6</td>
<td></td>
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<td>SHALE (SH) (86.3 - 100.9) MODERATELY SOFT, MINOR SILT, CALCAREOUS, FRACATURES AT 93.9' AND 98.3'.</td>
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<td>SHALE (SH) (56.5 - 88.3) MODERATELY SOFT, CALCAREOUS, SILTY, VERY FOSSILIFEROUS TO 86.3' BRACHIOPODA AND PYRITIZED PLANT STEMS. ZONE OF FRACATURES WITH SLICINESS 70.2 - 77.7.</td>
<td>89.0</td>
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<td>Elevation</td>
<td>Depth</td>
<td>Legend</td>
<td>Classification of Materials</td>
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<td>76.4</td>
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<td>SHALE (SH) 7.0 – 28.4</td>
<td>SOFT TO MODERATELY SOFT, GRAY–BROWN, WEATHERED WITH IRON OXIDE STAIN, SILTY, FRACTURES WITH SQUIRREL SIZE, CALCAREOUS, BLOCKY.</td>
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<td>J–4</td>
<td>7.0–10.0</td>
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**Remarks:**
- AUGERED 0.0–10.0 FEET WITH AIR 10.0–100.0 FEET, USED 4'' CARBRETED BIT. MEASURED WATER LEVEL AT 56.92' ON APR 15, 1987.
- ENCOUNTERED WATER AT 46.6'.
<table>
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<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>DESCRIPTION</th>
<th>% CORE RECOVERY</th>
<th>BOX NO.</th>
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<td>95.0</td>
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<td>(84.7 - 90.0)</td>
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**Notes:**
- Data and legend entry for drilling log details.
- Classification of materials present at each depth.
- Percentage of core recovery indicated.
- Boxes for sample collection marked.
### Drilling Log

#### Details
- **Project:** Landfill Siting (Section 30)
- **Location:** 534007.20
- **Date:** 2806290.10

#### Drilling Details
- **Type:** Landfill Siting
- **Driller:** Wyatt
- **Drilling Agent:** Corps of Eng.
- **Depth Drilled Into Rock:** 40.2

#### Classification of Materials

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<tr>
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<th>Depth</th>
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<td>751.7</td>
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<td>Clay (Cl) (0.0 - 10.0)</td>
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<td>Moved on Hole</td>
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<tr>
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<td></td>
<td>Clay (Cl-CH) Brown, Moist 0.0-1.0</td>
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<td>J-2</td>
<td>Hit Water about 35.0'</td>
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<td>Clay (Cl-CH) Tan Green, Moist 1.0-4.5</td>
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<td>W/L @ 28.7 at 1:00 hrs</td>
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<td>Clay (Cl-CH) Tan Green Dry 4.5-10.0</td>
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<td>Shale (Sh) (10.0 - 22.5)</td>
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<td>Sample Depth</td>
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<td>Shale, Tan Green, Dry, Mod.</td>
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<td>Shale, Green Tan, Mod. Firm -</td>
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<td>FIRM 10.0'15.5'</td>
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<td>S.S. STREAK 23.5', 30.0, 35.0'</td>
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</table>

#### Additional Details
- **Total Core Recovery for Boring:** 0.0
- **Signature of Inspector:** 
- **Elevation Top of Hole:** 761.7
- **Elevation Ground Water:** 
- **Total Number Core Boxes:** 0
- **Date Bore Started:** 04/02/87
- **Date Bore Completed:** 04/02/87

---

**Note:** The diagram and legend are not fully transcribed due to the complexity and nature of the document.
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<tr>
<th>ELEVATION</th>
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<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
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<td>724.5</td>
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BOTTOM OF HOLE 50.2'

HOLE NO. 119

PROJECT LANDFILL SITING (SECTION 30)

INSTALLATION McALESTER

DIVISION SOUTHWEST

10. SIZE AND TYPE OF BIT 5.5" AUGER
11. DATUM FOR ELEVATION SHOWN MSL
12. MANUFACTURER'S DESIGNATION OF DRILL FALING 1500
13. TOTAL NO OF OVER- DISTURBED 16 UNDISTURBED 0
14. TOTAL NUMBER CORE BOXES 0
15. ELEVATION GROUND WATER
16. DATE HOLE STARTED 04/02/87 COMPLETED 04/02/87
17. ELEVATION TOP OF HOLE 781.7
18. TOTAL CORE RECOVERY FOR BORING 0.0 %

LEGEND:
- SHALE (SH) (22.5 - 50.2)
- S.S STREAK 23.5', 30.0, 35.0'

SIGNATURE OF INSPECTOR

ENG FORM 1835 PREVIOUS EDITIONS ARE OBSOLETE.

MAR 71

PROJECT LANDFILL SITING (SECTION 30) 119
<table>
<thead>
<tr>
<th>Elevation</th>
<th>Depth</th>
<th>Legend</th>
<th>Classification of Materials (Description)</th>
<th>% Core Recovery</th>
<th>Box or Sample No.</th>
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<td>MOVED ON HOLE</td>
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<td>CLAY (CL) (0.0 - 6.0)</td>
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<td>6&quot; AUGER 0.0 - 37.7&quot;</td>
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<td>LT BROWN GREEN, MOIST</td>
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<td>CHANGED AUGER TEETH AT 37.5&quot;</td>
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<td>32 22 34 88.2 CH</td>
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BOTTOM OF HOLE 37.7'
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<td>48.1</td>
<td>52.7</td>
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**Drilling Log**

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<tr>
<th>Hole No.</th>
<th>MW123</th>
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</table>

**Project**

LANDFILL SITING (SECTION 30)

**Location**

523597.00

2605109.00

**Drilling Agency**

TULSA DISTRICT

**Hole No.**

As shown on drawing title and the number

**Total No. of Over-**

- Disturbed: 0
- Undisturbed: 0

**Name of Driller**

WYATT

**Direction of Hole**

CDI VERTICAL CDI HORIZONTAL DEEP FROM VERT.

**Thickness of Overburden**

5.0

**Depth Drilled into Rock**

75.0

**Total Depth of Hole**

80.0

**Remarks**

ROCKBIT HOLE WITH AIR ENCLOSED WATER AT 68.0'.

HOLE WAS NOT LOGGED.

OVERBURDEN IS APPROXIMATELY 5.0'. SET 4" PVC MONITORING WELL SEE SCHEMATIC FOR DETAILS.
1. PROJECT
LANDFILL SITING (SECTION 30)

2. LOCATION (Coordinates or Section)
533818.00, 2804390.00

3. DRILLING AGENCY
TULSA DISTRICT

4. HOLE NO. (As shown on drawing title and the number)
MW124

5. NAME OF DRILLER
WYATT

6. DIRECTION OF HOLE
VERTICAL [ ] INCLINED [ ]

7. THICKNESS OF OVERBURDEN
5.0

8. DEPTH DRILLED INTO ROCK
75.0

9. TOTAL DEPTH OF HOLE
80.0

10. SIZE AND TYPE OF BIT
7 7/8 RB

11. DATUM FOR ELEVATION SHOWN
MSL

12. MANUFACTURER'S DESIGNATION OF DRILL
FAILING 1500

13. TOTAL NO OF OVER-
DISTURBED 0
UNDISTURBED 0

14. TOTAL NUMBER CORE BOXES
0

15. ELEVATION GROUND WATER
DRY 24 AUG 87

16. DATE HOE STARTED
06/05/87
COMPLETED
08/06/87

17. ELEVATION TOP OF HOLE
775.0

18. TOTAL CORE RECOVERY FOR BORING
0.0 %

19. SIGNATURE OF INSPECTOR
BOWEN

LEGEND

CLASSIFICATION OF MATERIALS (Description)

% CORE RECOVERY

SIX OF SAMPLE NO.

REMARKS (Drilling time, water loss, depth of monitoring, etc., if significant)

ROCKBIT HOLE WITH AIR, NO SAMPLES TAKEN. SOME WATER IN HOLE WHEN DRILLED. AFTER WELL INSTALLED, HOLE DIDN'T MAKE WATER.

ROCKBIT HOLE WITH AIR, DID NOT LOG HOLE. OVERBURDEN IS APPROXIMATELY 5.0', INSTALLED 4" PVC WELL IN HOLE. SEE SCHEMATIC FOR DETAILS.
<table>
<thead>
<tr>
<th>DRILLING LOG</th>
<th>DIVISION</th>
<th>SOUTHWEST</th>
<th>INSTALLATION</th>
<th>SHEET</th>
<th>1</th>
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<tbody>
<tr>
<td>1. PROJECT</td>
<td>LANDFILL SITING (SECTION 30)</td>
<td></td>
<td></td>
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<tr>
<td>2. LOCATION</td>
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<td></td>
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<tr>
<td>3. DRILLING AGENCY</td>
<td>TULSA DISTRICT</td>
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<td>4. HOLE NO.</td>
<td>(as shown on drilling site and the number)</td>
<td>MW125</td>
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<td>5. NAME OF DRILLER</td>
<td>WYATT</td>
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<td>6. DIRECTION OF HOLE</td>
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<tr>
<td>7. THICKNESS OF OVERBURDEN</td>
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<td>8. DEPTH DRILLED INTO ROCK</td>
<td>35.0</td>
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<td>9. TOTAL DEPTH OF HOLE</td>
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</table>

<table>
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<tr>
<th>ELEVATION</th>
<th>DEPTH</th>
<th>LEGEND</th>
<th>CLASSIFICATION OF MATERIALS (Description)</th>
<th>% CORE RECOVERY</th>
<th>REMARKS</th>
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</thead>
<tbody>
<tr>
<td>0-10</td>
<td></td>
<td></td>
<td>ROCKET HOLE WITH AIR. ENCLOSED WATER AT 29.0'.</td>
<td></td>
<td>ROCKBIT HOLE WITH AIR. DID NOT LOG HOLE. SET 4&quot; PVC WELL IN HOLE. OVERBURDEN IS APPROXIMATELY 5.0' DEEP.</td>
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<td>10-20</td>
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<td>90-100</td>
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</tbody>
</table>

ENG FORM 1896 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)
HOLE NO. MM128

1. PROJECT: LANDFILL SITING (SECTION 30)
2. LOCATION: (Coordinate or Station) 3337352.00 2804988.00
3. DRILLING AGENCY: US GEOL. SURVEY
4. HOLE NO.: (As shown on drawing title and the number) MM128
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: VERTICAL
7. THICKNESS OF OVERBURDEN: 0.0
8. DEPTH DRILLED INTO ROCK: 0.0
9. TOTAL DEPTH OF HOLE: 120.0
10. SIZE AND TYPE OF BIT: 5 5/8 RB
11. DATUM FOR ELEVATION SHOWN: (BM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL: FAILING 1500
13. TOTAL NO. OF OVER- DISTURBED: 0 UNDISTURBED: 0
14. TOTAL NUMBER CORE BOXES: 0
15. ELEVATION GROUND WATER: 48.0 (3/14/88)
16. DATE HOLE STARTED: 01/04/88 COMPLETED: 03/14/88
17. ELEVATION TOP OF HOLE: 774.9
18. TOTAL CORE RECOVERY FOR BORING: 0.0 x
19. SIGNATURE OF INSPECTOR:

ELEVATION

DEPT.

LEGEND

CLASSIFICATION OF MATERIALS
(DESCRIPTION)

% CORE RECOVERY

BOREHOLE

REMARKS

ROCKBIT HOLE TO 120.0'. NO SAMPLES TAKEN. NO DESCRIPTION OF SOIL OR ROCK MATERIAL AVAILABLE.

ROCKBIT HOLE TO 120.0'. HIT WATER AT 105.0'.
Appendix 12
Historical Monitoring Well Schematics
3 PROTECTIVE POSTS

6 in x 5.0 ft PROTECTIVE PIPE WITH LOCKABLE CAP

4. STICKUP

4 x 4 x 0.5 ft CONCRETE PAD

CEMENT GROUT

WELL SCREENS 63. - 73.

PUC CASING 4 in THREADJOINT

BENTONITE SEAL 24. TO 30.

WL = 41. 8-24-87

SAND FILTER 30. TO 80.

WELL SCREEN 0.010 in SLOTS

MCALESTER LANDFILL
MONITORING WELL MW123
FIGURE 2
May 19, 2005

Darrell Elliott, Director  
Environmental Management Office  
U. S. Army Ammunition Plant  
1 C Tree Road  
McAlester, OK 74501-9002

Re:  Groundwater – Replacement Well and Plugging Records  
McAlester Army Ammunition Plant – New Landfill  
Pittsburg Co., Permit No. 3561014

Dear Mr. Elliott:

The Land Protection Division of the Department of Environmental Quality (Department) is in receipt of McAlester Army Ammunition Plant Groundwater letter dated April 26, 2005 and received April 28, 2005.

You have supplied the Department with well drilling logs and a completion report for the new well MW-123A. The well was drilled in accordance with Oklahoma Water Resources Board (OWRB) regulations. The new replacement well will require two years quarterly background testing in accordance with OAC 252:515-9-2-31. Also supplied was the plugging record for MW-123.

If you have any questions or other comments, please contact Jim Cammack of my office at 405-702-5195.

Sincerely,

[Signature]

Saba Tahmassebi, Ph.D., P.E.  
Chief Engineer  
Land Protection Division

ST/jwe  
File: Groundwater - Permit No. 3561014
Environmental Management Office

Mr. Saba Tahmassebi, Ph.D., PE
Chief Engineer, Land Protection Division
Oklahoma Department of Environmental Quality
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

Dear Mr. Tahmassebi:

This letter is in response to the Oklahoma Department of Environmental Quality (ODEQ) October 1, 2004 letter to the McAlester Army Ammunition Plant (MCAAP), containing the subject "Groundwater-Replacement Well", for the New Landfill at MCAAP; Permit No. 3561014. This letter requested that drilling logs and completion reports be submitted to ODEQ for the new well (MW-123A) at the New Landfill.

MW-123 at the New Landfill was removed and MW-123A was successfully installed in the approved location according to Oklahoma Water Resources Board (OWRB) regulations (785:35-7-2). Quarterly monitoring will be conducted at MW-123A according to OAC 252:515-9-2-31 and the results will be submitted accordingly. Also mentioned in your letter, the legal description of the New Landfill permitted boundary needs to be corrected and this will be looked at closer and submitted to ODEQ at a later date.

Enclosed in this letter are the drilling logs and completion reports for the installation of the replacement well (MW-123A) at the New Landfill as requested.

If you have any questions or other comments, please contact Mr. Ryan Williams at 918-420-6551.

Sincerely,

Darrell L. Elliott
Director, Environmental Management Office

Enclosures

Cf (w/enclosures): Mr. Jim Cammack, Solid Waste Permitting Unit, Land Protection Division, Oklahoma Department of Environmental Quality, P.O. Box 1677, Oklahoma City, Oklahoma 73101-1677

Mailed 4/27/05
PLUGGING REPORT FOR
Groundwater and Monitoring Wells

Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
Telephone (405) 530-8990

Legal Location of Water Well or Boring

North

Section 29

Township 4

Range 13

Deer Do Not Write In This Space

Well Record ID Number

*After August 1, 2003 a measured latitude and longitude may be substituted for the Legal Description

Latitude ____________________

Longitude ____________________

Data collected (latitude and longitude), if different from date the well was drilled:
   Method latitude and longitude was collected: □ GPS-uncorrected data,
   □ GPS-corrected data (WASS), □ GPS-corrected data (DGPS), □ GPS-corrected to base station

County Pittsburgh

WELL OWNER - NAME AND ADDRESS

Well Owner: McAlester Army Ammunition Plant

Address/City/State: McAAP/ McAlester/ OK

Phone 918 420 6591 Zip 74501

TYPE OF WELL OR BORING BEING PLUGGED

□ Groundwater Test Hole □ Groundwater well □ Geothermal/Heat Pump □ Geotechnical Boring □ Monitoring well

USE OF WELL BEFORE PLUGGING

*Indicate the use of the well being plugged, to the best of your knowledge.

Use of well: Groundwater Monitoring

PLUGGING INFORMATION

Date Well or Boring Was Plugged: Nov 17 2004

Total depth of well being plugged (feet): 85'

Was the well contaminated or was it plugged as though it was contaminated? □ Yes □ No

If the well or boring was plugged as if it was contaminated, was the casing removed or perforated? □ Yes □ No

Backfilled with:

□ Native Materials, □ Clean Washed Sand, □ Other Describe: _________________.

Backfilled from ______ feet to ______ feet

Grouted with:

□ Cement Grout, □ Cement Grout/Bentonite, □ H.S. Bentonite Grout, □ Bentonite Pellets, □ Bentonite Granules/Chips

Grouted From ______ feet to ______ feet

Was Grout Treated? □ Yes □ No

Grouted with:

□ Cement Grout, □ Cement Grout/Bentonite, □ H.S. Bentonite Grout, □ Bentonite Pellets, □ Bentonite Granules/Chips

Grouted From ______ feet to ______ feet

CERTIFICATION

The work described above was done under my supervision. This report is correct to the best of my knowledge.

Firm Name ____________________________ D/PC No. ____________________________

Operator Name ____________________________ OP No. ____________________________

Signature ____________________________ Date April 2003

Plugging Report for Groundwater & Monitoring Wells www.owrb.state.ok.us
MONITORING WELL COMPLETION REPORT

Oklahoma Water Resources Board
3880 North Classen Boulevard
Oklahoma City, OK 73118
Telephone (405) 524-8800

Legal Location of Monitoring Well

North

Section 29
Township 4 N
Range 13 E

* After August 1, 2003 a measured latitude and longitude may be substituted for the Legal Description

Latitude
Longitude

Date collected (latitude and longitude), if different from date the well was drilled:

Method latitude and longitude was collected: [ ] GPS-uncorrected data,
[ ] GPS-corrected data (WASS), [ ] GPS-corrected data (DGPS), [ ] GPS-corrected to base station

County Pittsburg
WELL OWNER – NAME AND ADDRESS

Well Owner: McAlester Army Ammunition Plant Phone (918) 420-6591
Address/City/State McAAP/ McAlester OK Zip 74501-9000

Finding Location

TYPE OF WORK
[ ] Monitoring Well

USE OF WELL
[ ] Air Sparging
[ ] Pump & Treat
[ ] Site Assessment
[ ] Unstained Zone
[ ] Vapor Extraction
[ ] Water Quality

NEW WELL CONSTRUCTION DATA

An application for a variance must be requested and obtained before any changes are made to the minimum construction standards for any well.

Date Well Was Completed 12-27-05

Hole Diameter 4.5 inches From 0 feet to 91 feet

Hole Diameter ______ inches From ______ feet to ______ feet

CASING INFORMATION: *Note: If surface casing is used please indicate that on the appropriate well casing information line.

1) Well Casing Material (check one): [ ] H.C. Steel [ ] P.V.C. [ ] Other
   Well Casing Diameter (inches): 4 inches Well Casing From 3 feet to 80 feet

2) Well Casing Material (check one): [ ] H.C. Steel [ ] P.V.C. [ ] Other
   Well Casing Diameter (inches): ______ inches Well Casing From ______ feet to ______ feet

SCREEN OR PERFORATION INFORMATION:

Type of Screen: [ ] BVC [ ] H.C. Steel [ ] Stainless Steel [ ] Other

Type of Slots or Openings: [ ] Perforations [ ] Factory Slotted [ ] Hand Slotted or Perforated [ ] Other Describe:

Screened Interval: From 80 feet to 90 feet

From ______ feet to ______ feet

From ______ feet to ______ feet

FILTER PACK INFORMATION:

Filter Pack Material: [ ] Course Gravel [ ] Fine Gravel [ ] Coarse Sand [ ] Medium Sand [ ] Fine Sand [ ] Native Material

Filter Pack Interval: From 78 feet to 91 feet

Monitoring Well Record www.owrb.ok.gov Revised: April 2003
WELL SEAL INFORMATION:
Type of Surface Seal: _Cement Grout_ □ _Cement Grout with Bentonite_ □ _Other_ Describe: **Concrete**
Surface Seal Interval: From ___0___ feet to ___1___ feet

Annular Seal Material: □ _Cement Grout_ □ _Cement Grout/Bentonite_ □ _H.S. Bentonite Grout_ □ _Bentonite Pellets_ □ _Bentonite Granules/Chips_ □ _Other_
Annular Seal Interval: From ___1___ feet to ___75.5___ feet

Filter Pack Seal Material: □ _Cement Grout_ □ _Cement Grout/Bentonite_ □ _H.S. Bentonite Grout_ □ _Bentonite Pellets_ □ _Bentonite Granules/Chips_ □ _Other_
Filter Pack Seal Interval: From ___75.5___ feet to ___78___ feet

TYPE OF COMPLETION: □ _Above Ground with Casing Protection_ □ _Flush Mounted_ □ _Below Ground (connections between wells)_

Was There a Cement Pad Installed Around the Well? □ _Yes_ □ _No_
Size of Cement Pad if Installed: ___4___ feet by ___4___ feet

HYDROLOGIC DATA
Depth to water at time of drilling ________________ Estimated yield of well ________________ gpm First water zone ________________ feet
Drawdown Pumping Test: Depth to water before start of test was ________________ feet; Well was pumped/bailed at ________________ gpm for ________________ hours, which resulted in a drawdown depth to water of ________________ feet.

LITHOLOGY DESCRIPTION
Note: If no lithology descriptions were made then, in the "Material" data field please indicate "no lithologic description obtained".

<table>
<thead>
<tr>
<th>MATERIAL (Indicate with a check mark a zone that is saturated)</th>
<th>ENCLOSED</th>
<th>TO</th>
<th>ENCLOSED</th>
<th>TO</th>
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</thead>
<tbody>
<tr>
<td>Foot clay, yellow Brn</td>
<td>0</td>
<td>1.5</td>
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<tr>
<td>Clayey shale, light ol. Grn</td>
<td>1.5</td>
<td>35</td>
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<td>Silt &amp; shale, med.</td>
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<td>75</td>
<td></td>
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<td>75</td>
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<tr>
<td>Silt &amp; dark brown shal.</td>
<td>75</td>
<td>91</td>
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CERTIFICATION

The work described above was done under my supervision. This report is correct to the best of my knowledge.

Firm Name: **Cherokee America Drilling**
Operator Name: **Tim Fite**

Signature

Date: 2-2-05

Monitoring Well Record  www.owdb.state.ok.us  Revised: April 2003
3 PROTECTIVE POSTS
6inx5.0ft PROTECTIVE PIPE WITH LOCKABLE CAP
4.1 STICKUP
4x4x0.5 ft CONCRETE PAD
CEMENT GROUT
WELL SCREENS 65. - 75.
BENTONITE SEAL 24. TO 30.
SAND FILTER 30. TO 80.
WELL SCREEN 0.010in SLOTS
WL = DRY 8-24-87
MCALESTER LANDFILL
MONITORING WELL MW124
FIGURE 3
October 9, 2005

Darrell Elliott, Director
Environmental Management Office
U. S. Army Ammunition Plant
1 C Tree Road
McAlester, OK 74501-9002

Re: Groundwater – Replacement Well – 124
McAlester Army Ammunition Plant – New Landfill
Pittsburg Co., Permit No. 3561014

Dear Mr. Elliott:

The Land Protection Division of the Department of Environmental Quality (Department) is in receipt of McAlester Army Ammunition Plant groundwater well replacement letter dated May 26, 2005 and received August 16, 2005.

This letter confirms our conversation on May 24, 2005 regarding MW-124. MW-124 has been determined to have a hole in the screen or pipe separation and must be replaced. The new well needs a new number, MW-124A. The new well is to be offset approximately 10 feet from the old MW-124.

The Department approves the new location. You will need to submit the actual well location, well drilling logs, and completion reports for the new well. The well is to be drilled in accordance with Oklahoma Water Resources Board (OWRB) regulations under the heading of OWRB 785:35-7-2 (Minimum Standards For Completing Monitoring Wells). The new replacement well will require two years quarterly background testing in accordance with OAC 252:515-9-31.

If you have any questions or other comments, please contact Jim Cammack of my office at 405-702-5195.

Sincerely,

Saba Tahmassebi, Ph.D., P.E.
Chief Engineer
Land Protection Division

ST/jwe
File: Groundwater - Permit No. 3561014
October 25, 2005

Environmental Management Office

Mr. Saba Tahmassebi, Ph.D., PE
Chief Engineer, Land Protection Division
Oklahoma Department of Environmental Quality
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

Dear Mr. Tahmassebi:

This letter is in response to the Oklahoma Department of Environmental Quality (ODEQ) October 09, 2005 letter to the McAlester Army Ammunition Plant (MCAAP), containing the subject “Groundwater-Replacement Well-124”, for the New Landfill at MCAAP; Permit No. 3561014. This letter requested that drilling logs and completion reports be submitted to ODEQ for the new well (MW-124A) at the New Landfill.

MW-124 at the New Landfill was removed and MW-124A was successfully installed in the approved location according to Oklahoma Water Resources Board (OWRB) regulations (785:35-7-2). Quarterly monitoring will be conducted at MW-124A according to OAC 252:515-9-2-31 and the results will be submitted accordingly.

Enclosed in this letter are the well drilling logs and completion reports for the installation of the replacement well (MW-124A) as requested. In addition, the survey information of MW-124A is also enclosed.

If you have any questions or other comments, please contact Mr. Ryan Williams at 918-420-6551.

Sincerely,

Darrell L. Elliott
Director, Environmental Management Office

Enclosures

Cf (w/enclosures): Mr. Jim Cammack, Solid Waste Permitting Unit, Land Protection Division, Oklahoma Department of Environmental Quality, P.O. Box 1677, Oklahoma City, Oklahoma 73101-1677

Dsg/SJMMC-EM RW
Williams

M:\Common Files\200-1a2 WATER\GW\Cover Letter to ODEQ-New Landfill Drilling Logs and Completion Report MW-124A (24 Oct 2005).doc

Printed On Recycled Paper
November 29, 2005

Darrell Elliott, Director
Environmental Management Office
U. S. Army Ammunition Plant
1 C Tree Road
McAlester, OK 74501-9002

Re: Groundwater - Replacement Well – 124A
McAlester Army Ammunition Plant – New Landfill
Pittsburg Co., Permit No. 3561014

Dear Mr. Elliott:

The Land Protection Division of the Department of Environmental Quality (Department) is in receipt of McAlester Army Ammunition Plant groundwater well drilling logs for replacement well and completion reports for MW-124A. Your letter is dated October 25, 2005 and was received October 31, 2005.

Old well MW-124 was properly plugged and abandoned on July 21, 2005 at a total depth of 80 feet. The new MW-124A is complete, with the monitoring well completion report, and drilling logs of this well.

If you have any questions or other comments, please contact Jim Cammack of my office at 405-702-5195.

Sincerely,

Saba Tahmassebi, Ph.D., P.E.
Chief Engineer
Land Protection Division

ST/jwc
File: Groundwater - Permit No. 3561014
LEMKE LAND SURVEYING, Inc.
3625 W. Main, Suite 109 - Norman, OK 73072
Ph (405) 366-8541  FAX (405) 366-8540  E-mail robbij@lemke-ls.com
C.A. No. 2054 (expires 6/30/06)

MONITORING WELL 124-A
McAlester Army Ammunition Plant, Oklahoma
for CRC & ASSOCIATES, INC.

<table>
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<th>EASTING</th>
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<td>MW-124-A TOP NOTCH/6in PVC</td>
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<tr>
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<td>2,572,805.50</td>
<td>777.30</td>
<td>MW-124-A CORP BRASS CAP</td>
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<td>777.10</td>
<td>MW-124-A GROUND</td>
</tr>
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<td>533,272.49</td>
<td>2,572,775.94</td>
<td>783.06</td>
<td>B ASHLAND</td>
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<tr>
<td>533,375.99</td>
<td>2,576,520.90</td>
<td>770.98</td>
<td>B8CY58</td>
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</tbody>
</table>

HORIZONTAL DATUM: NAD83, OKLAHOMA STATE PLANE SOUTH ZONE
VERTICAL DATUM: NGVD29
McAAP CONTROL MONUMENTS: 'B8CY58' & 'B ASHLAND'

Date of Survey: 8 August 2005
Crew: Courange / Scott

Robby L. Johnson
Oklahoma Registered Land Surveyor # 1539
CONSTRUCTION AND PLUGGING REPORT FOR
Groundwater Test Holes or Geotechnical Borings

Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
Telephone (405) 530-8800

Legal Location
North
Section 29

Township 4 North South
Range 13 WIM EIM ECM

Do Not Write In This Space
Well Record ID Number

* After August 1, 2003 a measured latitude and longitude may be substituted for the Legal Description

Latitude
Longitude

Date collected (latitude and longitude), if different from date the well was drilled: ______________________

Method latitude and longitude was collected: ☐ GPS-uncorrected data,
☐ GPS-corrected data (WASS), ☐ GPS-corrected data (DGPS), ☐ GPS-corrected to base station

County Pittsboro

Variance Request No. (if applicable)

* Number of borings represented on this log which are within the same 10 acre-tract and with the same general depths and lithologies?

WELL OWNER – NAME AND ADDRESS

Well Owner McAlester Army Ammunition Plant
Address/City/State Phone (918) 420-6591 ZIP

Finding Location

TYPE OF WORK
☐ Geotechnical Boring ☐ Groundwater Test Hole ☒ monitoring well

NEW BORING OR WELL CONSTRUCTION DATA
An application for a variance must be requested and obtained before any changes are made to the minimum construction standards for any well.

Date Well or Boring was Completed

Hole Diameter ______ inches Boring Drilled From ______ feet to ______ feet

HYDROLOGIC DATA
Depth to water at time of drilling ______ Estimated yield of well ______ gpm. First water zone ______ feet

PLUGGING INFORMATION
Date Well or Boring Was Plugged: 7-21-05 Total depth well was plugged (feet): 20

Was the well contaminated or was it plugged as though it was contaminated? ☒ Yes ☐ No

If the well or boring was plugged as if it was contaminated, was the casing removed or perforated? ☒ Yes ☐ No

Backfilled with: ☐ Native materials, ☐ Clean washed sand, ☐ Other Describe: ________________

Backfilled from ______ feet to ______ feet

Grouted with: ☐ Cement grout, ☒ Cement grout/bentonite, ☐ H.S. bentonite grout, ☐ Bentonite pellets, ☐ Bentonite granules/chips

Grouted From ______ feet to ______ feet Was Grout Tremied? ☒ Yes ☐ No

Grouted with: ☐ Cement grout, ☐ Cement grout/bentonite, ☐ H.S. bentonite grout, ☐ Bentonite pellets, ☐ Bentonite granules/chips

Grouted From ______ feet to ______ feet

Groundwater & Geotechnical Boring Record www.owrb.state.ok.us

Revised: April 2003
MONITORING WELL COMPLETION REPORT

Oklahoma Water Resources Board
3800 North Classen Boulevard
Oklahoma City, OK 73118
Telephone (405) 530-8800

Legal Location of Monitoring Well

Section 29
 Township 4 ❑ North ❑ South
 Range 13 ❑ WIM ❑ EIM ❑ ECM

* After August 1, 2003 a measured latitude and longitude may be substituted for the Legal Description

Latitude
Longitude

Date collected (latitude and longitude), if different from date the well was drilled:

Method latitude and longitude was collected: ❑ GPS-uncorrected data,
❑ GPS-corrected data (WASS), ❑ GPS-corrected data (DGPS), ❑ GPS-corrected to base station

County Pittsburg

WELL OWNER - NAME AND ADDRESS
Well Owner McAlester Army Ammunition Plant Phone (918) 220-6591
Address/City/State McAlester, McAlester, OK Zip 73501
Finding Location New Sand Fill - MW-124-A

TYPE OF WORK
❑ Monitoring Well
❑ Air Sparging
❑ Pump & Treat
❑ Site Assessment
❑ Unsaturated Zone
❑ Vapor Extraction
❑ Water Quality

NEW WELL CONSTRUCTION DATA
An application for a variance must be requested and obtained before any changes are made to the minimum construction standards for any well.
Date Well Was Completed 7-26-05
Hole Diameter 10 inches From 0 feet to 80 feet
Hole Diameter inches From feet to feet

CASING INFORMATION: *Note: If surface casing is used please indicate that on the appropriate well casing information line.
1) Well Casing Material (check one): ❑ H.C. Steel ❑ P.V.C. ❑ Other
   Well Casing Diameter (inches): 4 inches Well Casing From 70 feet to 80 feet
2) Well Casing Material (check one): ❑ H.C. Steel ❑ P.V.C. ❑ Other
   Well Casing Diameter (inches): inches Well Casing From feet to feet

SCREEN OR PERFORATION INFORMATION:
Type of Screen: ❑ PVC ❑ H.C. Steel ❑ Stainless Steel ❑ Other
Type of Slots or Openings: ❑ Perforations ❑ Factory Slotted ❑ Hand Slotted or Perforated ❑ Other Description
Screened Interval: From 80 feet to 70 feet
From feet to feet
From feet to feet

FILTER PACK INFORMATION:
Filter Pack Interval: From 80 feet to 68 feet

Monitoring Well Record www.owrb.state.ok.us Revised: April 2003
WELL SEAL INFORMATION:

Type of Surface Seal: [ ] Cement Grout [ ] Cement Grout with Bentonite [ ] Other Describe: 

Surface Seal Interval: From ___ feet to ___ feet

Annular Seal Material: [ ] Cement Grout [ ] Cement Grout/Bentonite [ ] H.S. Bentonite Grout [ ] Bentonite Pellets [ ] Bentonite Granules/Chips [ ] Other

Annular Seal Interval: From ___ feet to ___ feet

Filter Pack Seal Material: [ ] Cement Grout [ ] Cement Grout/Bentonite [ ] H.S. Bentonite Grout [ ] Bentonite Pellets [ ] Bentonite Granules/Chips [ ] Other

Filter Pack Seal Interval: From ___ feet to ___ feet

TYPE OF COMPLETION: [x] Above Ground with Casing Protection [ ] Flush Mounted [ ] Below Ground (connections between wells)

Was There a Cement Pad Installed Around the Well? [x] Yes [ ] No

Size of Cement Pad if Installed: ___ feet by ___ feet

HYDROLOGIC DATA

Depth to water at time of drilling: ___-9-1

Estimated yield of well: ___ gpm

First water zone: ___ feet

Drawdown Pumping Test: Depth to water before start of test was ___ feet; Well was pumped/bailed at ___ gpm for ___ hours, which resulted in a drawdown depth to water of ___ feet.

LITHOLOGY DESCRIPTION

Note: If no lithology descriptions were made then, in the “Material” data field please indicate “no lithologic description obtained”

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>ENCRONTED</th>
<th>ENCRONTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>(indicate with a check mark a zone that is saturated)</td>
<td>FROM (Feet)</td>
<td>TO (Feet)</td>
</tr>
<tr>
<td>Grass</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Gravel</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Top Soil</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Shale Sand</td>
<td>48</td>
<td>80</td>
</tr>
<tr>
<td>Gray Shale</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CERTIFICATION

The work described above was done under my supervision. This report is correct to the best of my knowledge.

Firm Name: Cherokee America Drilling

D/PC No. 0060

Operator Name: Steven Wadrow

OP No. 1198

Date: 7-26-05

Signature

Monitoring Well Record www.perb.state.ok.us

Revised: April 2003
3 PROTECTIVE POSTS

6in x 5.0ft PROTECTIVE PIPE WITH LOCKABLE CAP

2.6 STICKUP

4x4x0.5 ft CONCRETE PAD

CEMENT GROUT

WELL SCREENS 27.5 - 37.5

PVC CASING 4.0 in THREADJOINT

BENTONITE SEAL 16.0 TO 22.5 WL= 22.8 8-24-87

WELL SCREEN 0.010 in SLOTS

SAND FILTER 22.5 TO 40.0

MCALESTER LANDFILL
MONITORING WELL MW125
FIGURE 4
WELL SCREENS
109. - 119.

- CEMENT GROUT
- W.L = 49.3-1-88
- BENTONITE SEAL
  89. TO 102.
- SAND FILTER
  102. TO 120.

MCALESTER LANDFILL
MONITORING WELL MJ126
FIGURE 5
<table>
<thead>
<tr>
<th>Depth (Ft.)</th>
<th>Sample No.</th>
<th>REC %</th>
<th>Lithologic Description / USCS Classification</th>
<th>Well Diagram / Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2'</td>
<td></td>
<td></td>
<td>Sand very fine and Silt; little clay; yellow-brown 10 YR 5/4</td>
<td></td>
</tr>
<tr>
<td>2-6'</td>
<td></td>
<td></td>
<td>Sand very fine to fine; little silt; trace clay; yellow-brown 10YR 5/6 and light brown-gray 10 YR 6/6</td>
<td></td>
</tr>
<tr>
<td>6-9'</td>
<td></td>
<td></td>
<td>Silt; trace sand very fine; trace sand very fine; gray-brown 10YR 5/2</td>
<td></td>
</tr>
<tr>
<td>9-13'</td>
<td></td>
<td></td>
<td>Shale; dark gray-brown 10YR 4/2; soft</td>
<td></td>
</tr>
<tr>
<td>13-19'</td>
<td></td>
<td></td>
<td>Shale; dark gray 10YR 4/1 and gray-brown 10YR 5/2; very soft</td>
<td></td>
</tr>
<tr>
<td>19-95'</td>
<td></td>
<td></td>
<td>Shale; dark gray-brown 10YR 4/2; soft; moist 78-95'</td>
<td></td>
</tr>
</tbody>
</table>
Date: 5 February 2015
Drill Rig: B-80
Drill Method: Air Rotary
Drill Crew: Hoover, Maners, Farro
Geologist: J. Maio

Depth in Feet

MW-LF-2

Clay; trace silt  Dark brown 10YR 3/3
Silt and clay  Light olive- brown 2.5YR 5/4
Silt and clay; trace very fine sand
Light olive- brown 2.5YR 5/4
Shale
Dark grqy- brown 10YR 4/2
Siltstone  Dark gray- brown 10YR 4/2
Shale
Gray- brown 10YR 5/2
Shale
Dark gray- brown 2.5YR 4/2
Very wet

B-2
Appendix 13
Common MCAAP NHIW Waste Stream
The following is a list of common items that are deposited in the MCAAP NHIW Landfill.

- Empty Cans, Pails, Brushes, Cups (Previously containing Paint, Thinner, Mil-C-450, Oil, Grease, Coolant, Hydraulic Fluid, Empty Epoxy Polyamide with lids off)
- Empty 55 gallon drums (previously containing Oil, Grease, Coolant, Hydraulic Fluid)
- Empty Cardboard boxes and liners previously Containing explosive
- Empty cardboard tubes and end caps from Renovation processes
- Grit Dust
- Empty Aluminum powder bags
- Non-reactive activated carbon from waste water treatment processes
- Cutting sand from Machine Shop
- Water Plant lagoon sludge
- Ash from Fire training due to burning of untreated wood
- Digester Sludge
- Car wash sludge
- Cement Dust/Residue Drums Waste from Baghouse or Cement mix waste
- Desiccant, Labels, tags, markers, paper, tapes, earplugs, wipes, items contaminated with K-70 grease, molykote, waste asphalt and items contaminated with only asphalt, unserviceable plug caps, sandpaper, Empty 5 minute epoxy containers, Used (dry) Roofing Felt, gloves contaminated with only dirt, empty containers of Loctite, dryersheets touch up pens, damaged fiber tubes, tissue, rags/bear tex pads, crocus cloth, dirt/rust (dry), empty silicone tubes; Items contaminated with Compound, Molykote 55, Cutting Oil and Locktite. Items contaminated with Cement, Filters from Parts, Vermiculite, and items contaminated with cement and sealing compound, and unserviceable plug, inert plastic items including plastic banding, electrical tape, flashbulbs, fiberglass insert of yaw screen
- Items that contain asbestos
- Asbestos