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October 20, 2016

Tom Mahler
On-Scene Coordinator
Site Remediation Branch
Superfund Division
U.S. Environmental Protection Agency Region 7
11201 Renner Boulevard
Lenexa, Kansas 66219

Re: Response to October 19, 2016 Comments for EVOH Cover System Work Plan
North Quarry, Bridgeton Landfill, Bridgeton, Missouri Revision 2

Dear Mr. Mahler:

On behalf of our client, Bridgeton Landfill, LLC (hereafter Bridgeton Landfill), Cornerstone Environmental Group, LLC hereby submits a revised version of the EVOH Cover System Work Plan, North Quarry, Bridgeton Landfill (hereafter referred to as EVOH Cover Work Plan) incorporating the requested edits and information based on the comments received in your October 19, 2016 letter to Mr. Paul Rosasco of Engineering Management Support, Inc. This letter briefly states how the comments were addressed.

Comment #1: Refer to the EPA's prior Comment #5, Section 3.3.2 and make the following revisions:
a. The Detail reference does not appear to have been changed to Detail 1, sheet 6;
b. "*Are be*" is to be changed to "*have been*";
c. The work plan should provide details of how the work will be phased, including when the under and above cap features will be designed.

Response #1: *the requested change has been made to Section 3.32 on Page 1 of the revised EVOH Work Plan for comments 1a and 1b. A description of the phasing (from note 4 on Sheet 1 of the engineering plans) has been added as the second paragraph of Section 2 on page 2 to address comment 1c. The undercap and above cap features have been designed and are shown in the engineering plans for Phases 1A and 1B. Section 3.3 included the following statement to address the timing of design for Phases 2 and 3 undercap features. "The undercap features for the Phases 2 and 3 EVOH cover will be designed for those phases prior to construction of those phases based on future site conditions at that time." A similar statement for above cap features for Phase 2 and 3 has been added to Section 3.5 on page 8.*

Comment #2: Page 6, Section 3.4, Comment: Please revise the text to state, *"The final construction submittal and drawings must be stamped by a Missouri Registered Professional Engineer."*

Response #2: *Section 3.4 has been revised to include the requested statement at the end of the second paragraph. The engineering plans in Appendix A have now been sealed by a Missouri Registered Professional Engineer.*

Comment #3: Section 2, middle of page, refers to a 14-sheet drawing set, while reviewers can only can identify 12 plus 1A, for 13 drawings total. Please note this was listed as 11 drawings in the previous submittal. Please clarify correct number of drawings to 13 (or 14 if including the cover page/drawing index with the EVOH designs and cut sheets).

Response #3: *the plan set is a 14-sheet drawing set including the Title Sheet. The Title Sheet has been added to the list of drawings in Section 2.*

Comment #4: Section 3.4, revisions, omitted the reference to the total area of 4.1 acres proposed. Please revise the document to also include the planned area covered by each subsequent phase and a total area covered in acres.

Response #4: *Section 3.4 has been revised to add the current planned area covered by each phase and the total area covered in acres.*

If you have any questions, please feel free to contact us at (630) 633-5857 or Bridgeton Landfill's Division Manager Erin Fanning at (209) 227-9531.

Sincerely,

Cornerstone Environmental Group, LLC

James Walker, P.E.
Senior Client Manager

Adam Larky, P.E.
Region Vice President

Enclosure: EVOH Cover System Work Plan, North Quarry, Bridgeton Landfill, Revised October 2016

cc: Erin Fanning, Bridgeton Landfill
Nick Bauer, Bridgeton Landfill
Paul Rosasco of Engineering Management Support, Inc.
Dan Feezor, Feezor Engineering, Inc.

cornerstone environmental

Building lifetime relationships with our clients and employees.

EVOH Cover System Work Plan

North Quarry
Bridgeton Landfill

Project 160512
June 2016
Revised September 2016
Revised October 2016

Prepared for:
Bridgeton Landfill, LLC
13570 St. Charles Rock Rd.
Bridgeton, Missouri 63044

39395 West 12 Mile Road, Suite 103
Farmington Hills, MI 48331
(630) 633-5520

REPORT CERTIFICATION

EVOH Cover Work Plan

North Quarry
Bridgeton Landfill

The material and data in this report were prepared under the supervision and direction of the undersigned.

Cornerstone Environmental Group, LLC

James Walker, P.E.
Senior Client Manager

Adam Larky, P.E.
Region Vice President

TABLE OF CONTENTS

APPENDIX E STORMWATER MANAGEMENT CALCULATIONS

1 INTRODUCTION AND BACKGROUND

Cornerstone Environmental Group, LLC (Cornerstone) has prepared this Ethylene Vinyl Alcohol (EVOH) Cover System Work Plan for the North Quarry at the Bridgeton Landfill in accordance with Section 35b of the Administrative Settlement Agreement and Order on Consent (AOC) between the U.S. Environmental Protection Agency (U.S.EPA) and Bridgeton Landfill, LLC, dated April 28, 2106.

Section 35b of the AOC requires:

> *Within 60 days of the Effective Date, Respondent shall submit to EPA and MDNR for review and approval a Work Plan for the placement of an EVOH Cover over the North Quarry. The Work Plan shall include the steps and associated timeframes necessary to install the EVOH Cover. Consistent with an EPA approved Work Plan, installation of the EVOH Cover shall proceed to be placed over the North Quarry, starting from the location of the existing EVOH Cover moving north such that the EVOH is continuous up to and covering a line of existing TMPs including TMP-16, 17, 18, 21, 22, 23, 25, 27, 28 and 29. The Work Plan shall also describe measures for operations and maintenance of the EVOH Cover.*

Subsequent to submittal of the EVOH Cover System Work Plan in June of 2016, the U.S. EPA issued review comments received on September 2, 2016. The review comments have been responded to separate from this Work Plan and the changes pertinent to the responses have been incorporated in this revised EVOH Cover System Work Plan. The changes include the addition of EVOH Cap Phases 1B, 2 and 3 which are described in this Work Plan and included in the Engineering Plans.

This Work Plan includes the following:

- Engineering Plans for the North Quarry EVOH Cover Design (Appendix A)
- This narrative describing the design of the EVOH cover and associated components
- Specifications for the EVOH Cover geomembrane (Appendix B)
- Steps and Timeframes for Installation of the EVOH Cover (Appendix C)
- Operations and Maintenance Plan for the EVOH Cover (Section 6)
- Construction Quality Assurance Plan (Appendix D)
- Stormwater Management Calculations (Appendix E)

2 EVOH COVER DESIGN

This 2016 EVOH cover design has many design features similar to the previous 2013 design and has been updated for new phasing, utilities and based on experience managing the existing EVOH cover and associated features. The new North Quarry EVOH Cover is designed to continuously tie-in to the existing EVOH Cover where the proposed EVOH cover abuts the existing EVOH Cover.

The proposed EVOH cover is designed with four phases as shown on the engineering plans. The Phase 1A boundary is based on the AOC issued by U.S EPA dated April 28, 2016. The Phase 1B EVOH cover boundary is based on the ridgeline of the North Quarry and captures the area on the south side of the ridgeline and outside of the area that could be affected by a potential thermal isolation barrier. The Phase 2 EVOH cover boundary coincides with the solid waste boundary. The Phase 3 EVOH cover boundary is similar to the proposed EVOH cover boundary delineated in the North Quarry EVOH geomembrane Cover and Cap Integrity System Plans dated October 2013.

This plan presents the systems that will be installed including the following:

- Management of existing gas well and leachate forcemain piping
- Subgrade fill and preparation for the EVOH cover
- Undercap gas and liquids collection
- EVOH Geomembrane Cover
- Enhanced stormwater management system
- Light-duty access roads

Each of these engineered components is discussed in subsequent sections of this plan along with installation considerations, construction quality control, and operations and maintenance considerations.

Engineering Plans for the North Quarry EVOH Cover consist of a fourteen sheet plan set included in Appendix A. The plan set includes the following:

- Title Sheet with list of drawings
- Sheet 1 shows the North Quarry existing site conditions
- Sheet 1A shows the EVOH proposed cap phase limits
- Sheet 2 shows the North Quarry existing site conditions in the proposed EVOH Cover area

- Sheet 3 shows the proposed EVOH cover subgrade grading plan
- Sheet 4 shows the proposed EVOH cover undercap features
- Sheet 5 shows the proposed EVOH cap limits, edge detail references, access roads and stormwater management features
- Sheets 6 – 12 show details of the proposed EVOH cover system

3 EVOH COVER SYSTEM COMPONENTS

3.1 Coordination of Existing Gas Collection and Leachate Management Components

In preparation for the EVOH cover installation, the existing gas and leachate collection components will need to be modified, capped and replaced and or managed to allow for regrading of the ground surface and installation of the EVOH cover. Existing utilities are shown in Sheet 2 of the engineering plans.

The existing utilities to be modified include:

- raising of gas wells
- gas collection header piping

The existing utilities to be capped and replaced include:

- gas lateral piping below ground
- leachate forcemain piping below ground
- air supply piping below ground
- electric power

The existing utilities to be managed include:

- above ground GCCS piping
- air supply piping above ground

3.2 Subgrade Fill and Preparation

The subgrade for the EVOH cover will be regraded where necessary to achieve a 7% minimum slope and 25% maximum slope as shown in Sheet 3. In addition, existing stormwater benches will be regraded to promote sheet flow down to the perimeter channels. All grass cover will be stripped in preparation for the EVOH cover. The grass cover (mixed with vegetative soil) will be mixed in with other borrow soil to fill areas where existing grades will be raised to increase the slope. The east perimeter anchor trench and stormwater channel will be excavated in preparation for the EVOH liner. Additional anchor trenches will be constructed on the north and south sides of the proposed EVOH

cover while the west side of the new EVOH cover will be welded to the existing EVOH cover.

3.3 Undercap Collection System

The intent of the undercap collection system below the EVOH cover is to provide a means of collecting and conveying gas or liquid that may develop beneath the EVOH cover to a dedicated sumps where they can be safely removed and managed. The relatively low-permeability of this cap component, compared to the accompanying soils, provides a barrier to liquid and gas movement and collection and removal mechanisms below the EVOH cover have been designed based on previous experience to insure its integrity.

The existing landfill gas (LFG) management components (as shown on Sheets 1 and 2 of the engineering drawings), including extraction wells, and extraction piping will be incorporated into the EVOH cover system. Those components that are currently installed below grade will be maintained in this relative position, with existing access points penetrating the new EVOH cover and secured to the FML via pipe boot seals. Additional or supplemental LFG management components will be installed above the EVOH cover and connected to the existing infrastructure by means of welded, flanged or flexible connectors as appropriate for each connection point. . Air, forcemain and gas lateral piping will be installed above the EVOH where practical to minimize protrusions through the cap. The undercap features for the Phases 2 and 3 EVOH cover will be designed for those phases prior to construction of those phases based on future site conditions at that time.

A discussion of the major undercap system components is included the following subsections:

- 3.3.1 Undercap strip drains and access risers
- 3.3.2 Perimeter collection trench and collection sumps

3.3.1 Undercap Collectors & Access Risers

Gas and liquids that may collect below the EVOH cover will be intercepted and controlled by several components of the undercap collection system. Within the quarry area, the undercap collection system is comprised of strip drains, access risers, edge drains, and perimeter collection sumps. At the toe of the EVOH cover, a perimeter strip drain will be constructed which will drain to one of two collection sumps.

The undercap collectors within the quarry area include 12-inch wide cross slope and 12-inch wide downslope strip drains (refer to Sheet 4 for the proposed strip drain locations and the corresponding details on Sheets 7 and 8 of the engineering drawings). Strip drains will be installed on the soil surface below the EVOH cover, at cross slope locations to serve as interceptors for liquids or gas moving along the EVOH cover / underlying soil interface.

Liquids/gas collected by the cross slope strip drains will be directed to the downslope strip drains (See details on Sheet 8) to the perimeter collection trench. The downslope strip drains will have a 4" diameter HDPE stubbed riser pipe initially capped as a potential access point (riser locations a minimum of every 500 feet) for gas extraction if necessary.

Liquids that are directed to the existing perimeter collection trench will be removed by a series of existing collection sumps installed along the perimeter collection trench. These sumps have been installed within the trench and will allow for removal of collected liquids utilizing a pneumatic pumping system or vac truck. The perimeter collection trench will also serve to intercept any liquids/gases collected near the perimeter of the area. Liquids will be discharged to a proposed forcemain, which will convey these liquids to the leachate management system for treatment and disposal.

Collected gas will be directed to the existing GCCS for treatment and disposal via the landfill's flaring system. Lateral piping will be constructed above the EVOH cover to provide vacuum, to the extraction points and convey gas to the existing GCCS.

3.3.2 Existing Perimeter Collection Trench, and Collection Sumps

The existing perimeter trench is constructed with a 6-inch diameter perforated SDR 17 HDPE pipe which will be connected to each collection sump (refer to Detail 1 on Sheet 6 of the engineering plans). Clean-outs are provided between sumps to flush the piping each way ("Y" connection). Perimeter collection sumps have been installed to a depth of 20 feet below existing grade. The existing perimeter trench will be modified as shown in Detail 2, Sheet 8 so that when the existing ground is raised to provide a 7% minimum slope, gravel will be added above the existing trench so that it extends to the ground surface to intercept liquids collecting under the cap or be drained from the downslope strip drain collectors.

3.4 EVOH Cover

The EVOH cover will consist of a green 60 mil Ethylene Vinyl Alcohol (EVOH) textured geomembrane underlain by a minimum 6 ounce per square yard (oz/sy) geotextile. EVOH geomembrane is manufactured as a "sandwich", the outside layers are composed of HDPE with an inner layer of semi-crystalline thermoplastic resin - EVOH manufacturer's information describing the EVOH geomembrane is included in Appendix B. The EVOH geomembrane proposed for the North Quarry is the same material as the EVOH geomembrane installed for the South Quarry. The current planned area for each phase is:

Phase 1A	4.1 acres
Phase 1B	4.0 acres
Phase 2	4.7 acres
Phase 3	5.0 acres
Total	17.8 acres

The Phase 2 and 3 areas are subject to change due to future agreements or orders with regulatory agencies.

The proposed EVOH cover will be installed over the North Quarry Unit as shown in Sheets 3 - 5. The new EVOH cover will be continuously seamed and continuously tied into the existing EVOH cover where the new EVOH cover abuts the existing EVOH cover.

The geotextile underlying the EVOH cover will be installed on a prepared subgrade as described on Sheet 4. Cap integrity components discussed in this narrative will be constructed below and above the EVOH cover to help preserve long term operation of the cover.

The EVOH cover will be installed with panels orientated up and down slopes. Locations and details of liner edge termination are provided on Sheet 7 of the engineering plans.

The EVOH cover will be installed by an experienced contractor and crews in accordance with the project specifications and QA/QC Plan included in Appendix E. The installation of the EVOH cover will be monitored in accordance with the QA/QC Plan by an experienced third-party engineering firm. A final certification report will be prepared under the direction of a certified engineer and will be submitted to the U.S. EPA and the Missouri Department of Natural Resources (MDNR) as this action is occurring under the authority of the ASAOC. A registered Professional Engineer will certify the installation of the EVOH cover and ensure this work plan is performed in accordance with the approved work plan and construction quality assurance plan.

Additional pertinent EVOH cover information will be presented in the following subsections including:

- 3.4.1 Tie-in with existing South Quarry EVOH or HDPE cap
- 3.4.2 Anchorage, ballast and light duty roads
- 3.4.3 Pipe boots and above cap piping

Each will be discussed subsequently.

The final construction submittal and drawings must be stamped by a Missouri Registered Professional Engineer.

3.4.1 Tie-in with Existing EVOH Cap

The EVOH cover is manufactured as a "sandwich", the outside layers being composed of HDPE; therefore, the proposed EVOH cover can be welded to the existing EVOH cover with traditional welding equipment. The EVOH cover measures are being performed until conditions at the landfill stabilize, which will eventually make it possible to install a

permanent Subtitle D cap at Bridgeton Landfill. The EVOH cover will be operated and maintained in accordance with the OM&M Plan described in Section 6.

3.4.2 Anchorage, Ballast & Light Duty Roads

The perimeter edge of the new EVOH cover will either be welded to the existing EVOH cap or anchored at the perimeter as shown on Sheet 7 of the engineering plans. Access roads will be constructed above the EVOH cover at locations shown on Sheet 5 to provide ballast for the cover and designed for everyday use of light weight equipment. The roads are designed with a cushion geocomposite layer below and above the EVOH cover and will be 24-inch thick per Detail 1 on Sheet 8 and will be constructed with a lower aggregate base layer comprised of 2 to 4 inch sized crushed limestone capped-off with a 2 to 3 inch thickness of Missouri Department of Transportation (MDOT) Type V Dense Graded Aggregate. Calculations were performed to ensure that the proposed light-duty access roads and header piping above the EVOH cover would provide adequate ballast weight against wind uplift. The results of the calculations showed that the proposed design would prevent uplift from a 75 mph wind.

3.4.3 Pipe Boots and Above Cap Piping

Pipe penetrations of the EVOH cover will be sealed utilizing welded pipe boots. These boots, comprised of EVOH will be welded to the EVOH cover and the riser pipe penetrating the membrane. These boot seals can be inspected during periodic monitoring of the cap for vapor emissions. Upon observation that settlement may or is effecting the boot seal of pipes penetrating the EVOH cover, the boot seal will be repaired or replaced to provide an effective boot seal.

3.5 Above Cap Piping

Above cap piping and utility lines will be connected to gas wells, extraction sumps, and leachate collection sump LCS-5A. Where necessary to assure the integrity of the EVOH cover and piping, the piping will be secured by means of pipe stands where required to maintain slope and allow for movement due to temperature effects. The above cap GCCS piping will be connected to the existing GCCS piping by means of standard fusion joints, flanges or flexible connectors as warranted by the conditions of individual extraction points. The above cap features for Phases 1A and 1B are shown in the engineering plans. The above cap features for the Phases 2 and 3 will be designed for those phases prior to construction of those phases based on future site conditions at that time.

3.6 Collection Sumps and Liquids Force Main

Liquids draining to the collection sumps and pumped from wells will be pumped through a double-walled forcemain to the leachate lift stations and on to the onsite pretreatment plant

for processing where it is direct-discharged to a municipal wastewater treatment plant. Detail 1 on Sheet 9 shows the details of the connection of the collection sump to the forcemain and airline. The forcemain will be constructed above the EVOH cover to provide access for maintenance and other possible tie-ins if additional pumping units are necessary in the future. The forcemain will have cleanout risers spaced at approximately 500 feet per Detail 4, Sheet 9. The location of the forcemain will be field fit for access to the collection sumps and gas wells requiring liquids extraction.

Additionally, each sump will be fabricated with a 2-inch diameter suction line and a tank fitting. This will allow the sump to be evacuated manually during emergency situations or in the event that the pump malfunctions.

3.7 Stormwater Management System

The stormwater management system design has been previously designed and described in detail in the Stormwater Management System Design Report, dated July 2013. The report describes the techniques that the North Quarry will employ to manage the increased runoff from the EVOH cap. The stormwater management system has been designed for a 24-hour / 25-year storm event in accordance with the Missouri Rules of Natural Resources, Division 80 Solid Waste Management Chapter 3 Sanitary Landfill Section 10 CSR 80-3.010(8)(F) Water Quality. The stormwater management features for this North Quarry EVOH cover was revised slightly so that the east channel is designed to flow to the north instead of to the south and a culvert C-11 was added. The stormwater management features include:

- Regrading of the existing benches to promote sheet flow to perimeter channels
- Proposed perimeter channels to collect and convey stormwater to downstream culverts
- Downstream culverts to convey the storwater flow to one of two existing detention basin located at the east and south sides of the North Quarry

Stormwater calculations for the proposed EVOH cover included in this Work Plan are provided in Appendix E. The stormwater calculations have been amended to include cap Phases 1A and 1B assuming all future contributing EVOH cap areas to Phase 1B channels and culverts are incorporated.

4 STEPS AND TIMEFRAMES NECESSARY FOR THE EVOH COVER INSTALLATION

Steps and timeframes necessary for Phases 1A, 1B, 2 and 3 of the EVOH cover installation are shown in the figures in Appendix C. The EVOH cover installation is dependent on approval of this Work Plan by the U. S. EPA and weather conditions. Once the revised document is approved, the U.S. EPA and the MDNR will receive from the Bridgeton Landfill, a revised schedule that assigns these construction activities to specific start and completion dates. The EVOH cover construction activities will be discussed and submitted with the routine field reports and schedule updates provided within the monthly ASAOC status reports. If it is determined that there is not sufficient time to complete Phase IA in 2016, Phases IA and IB will be completed simultaneously in 2017 when weather conditions permit.

5 CONSTRUCTION QUALITY ASSURANCE

The EVOH cover will be constructed in accordance with the following existing plans which are on file and have been approved by the appropriate regulatory authority responsible for their approval(s):

1. Temporary Cap and Cap Integrity System Construction Quality Assurance Plan Bridgeton Landfill (CQA Plan)

2. Health and Safety Plan

3. Odor Management Plan

4. Bird Hazard Monitoring Mitigation Plan

The CQA Plan addresses the measures to confirm industry accepted practices for the installation of the geosynthetic products and earthworks related to the installation of the EVOH geomembrane cover and associated components. Upon completion of the EVOH Cover, a certification report will be prepared under the supervision of a registered Professional Engineer and submitted to the U. S. EPA and MDNR.

6 OPERATIONS AND MAINTENANCE PLAN

The EVOH cover will be operated and maintained in accordance with the Operations, Maintenance and Monitoring Plan (OM&M Plan) prepared by Civil & Environmental Consultants, Inc., dated March 2016, (or subsequent update) once approval is granted by the appropriate regulatory authority responsible for approval. The OM&M Plan addresses the measures and guidelines for maintaining the integrity and operations of the EVOH Cover and its underlying integrity system.

APPENDIX A

ENGINEERING PLANS FOR THE NORTH QUARRY EVOH COVER DESIGN

ENGINEERING PLANS FOR THE

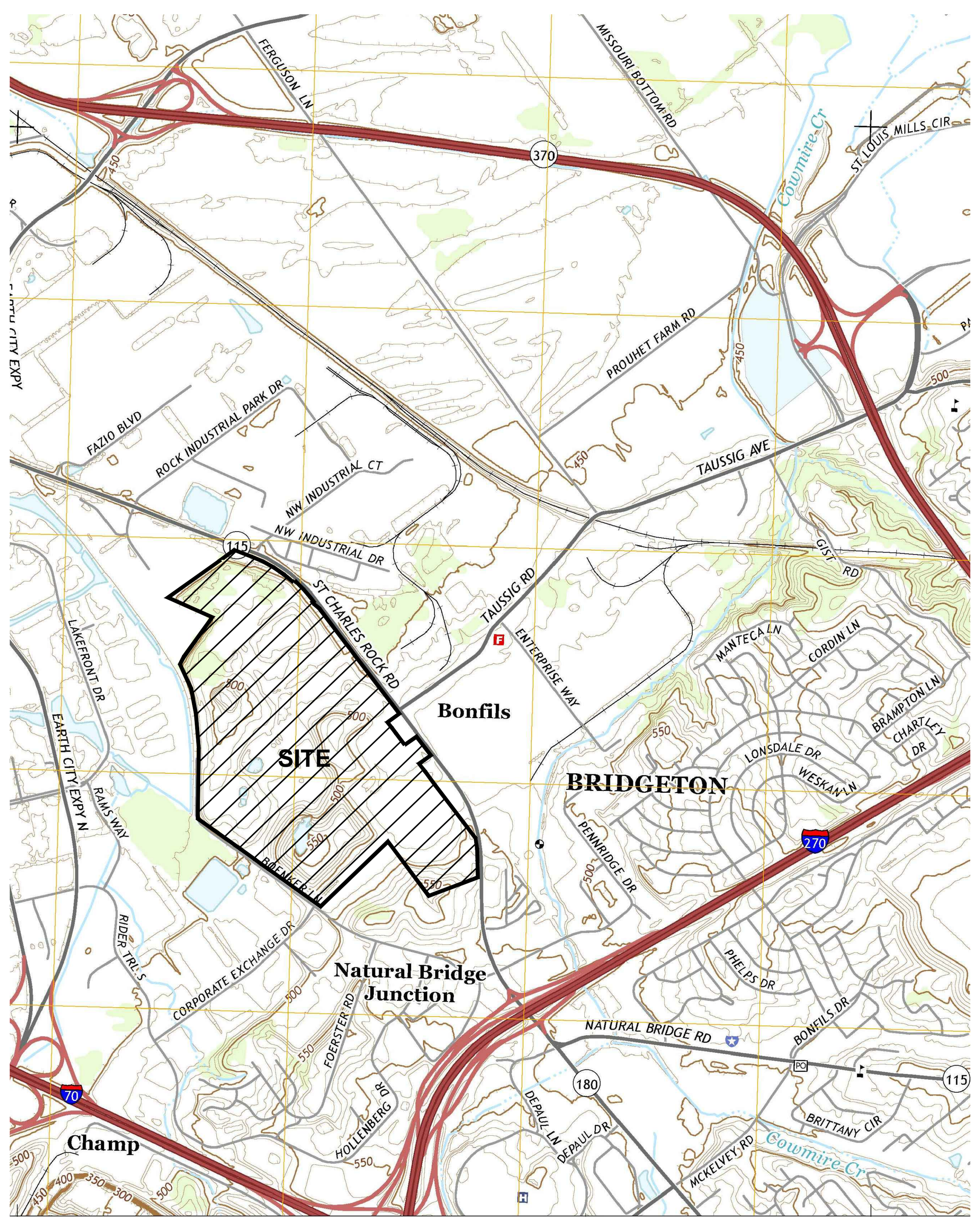
EVOH COVER DESIGN

AT BRIDGETON LANDFILL

BRIDGETON, MISSOURI

JUNE 2016

REVISED SEPTEMBER 2016 △1



LOCATION MAP

SOURCE: SAINT CHARLES, MO. 7.5 MIN. U.S.G.S. QUADRANGLE MAPS – 2015

PREPARED FOR:

BRIDGETON LANDFILL, LLC

PREPARED BY:

cornerstone environmental

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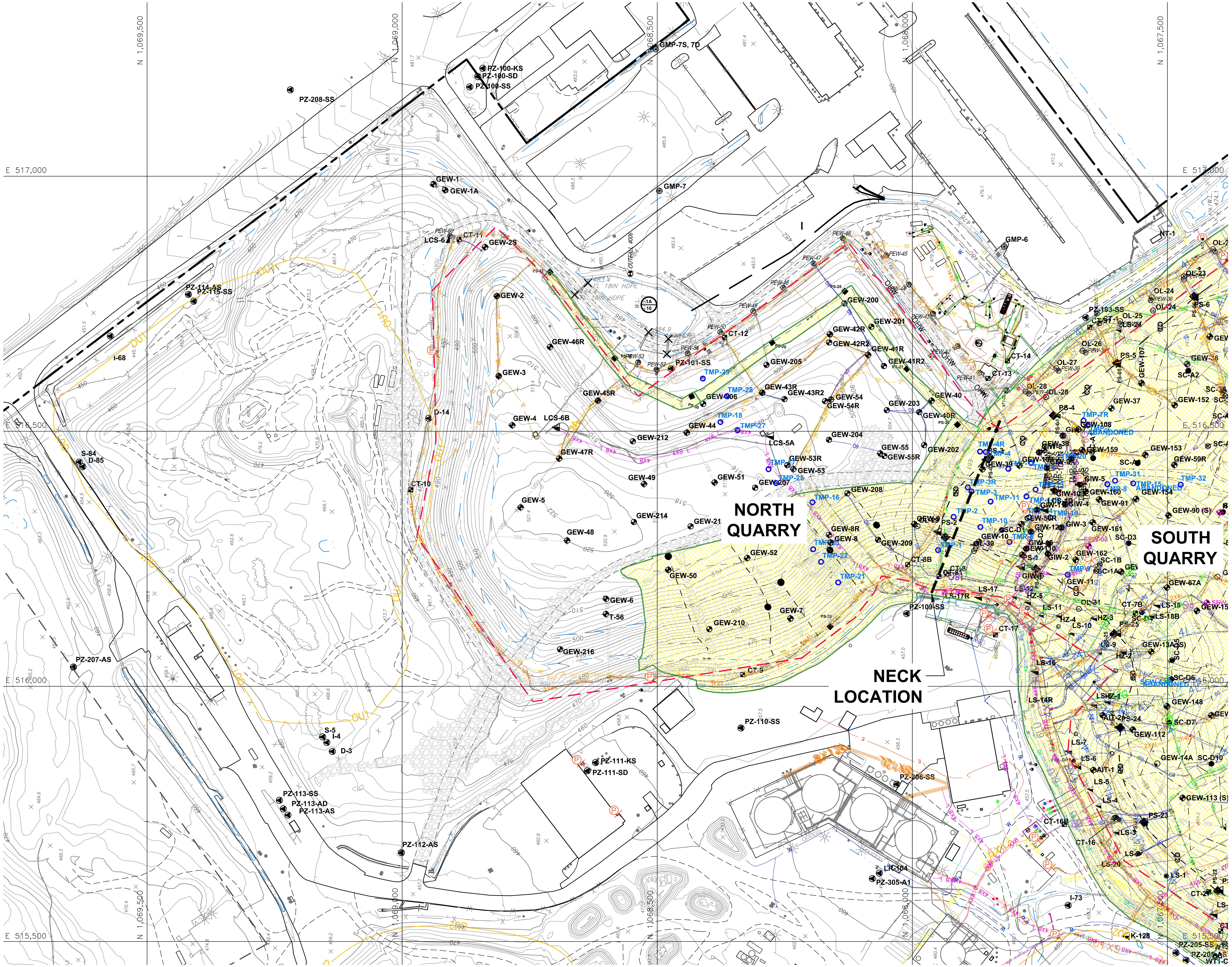
STATE OF MISSOURI
ADAM STEVEN LASKY
NUMBER E-28655
REGISTERED PROFESSIONAL ENGINEER

9/30/16

INDEX OF DRAWINGS

		TITLE SHEET
	1	EXISTING NORTH QUARRY PLAN
△1	1A	PROPOSED CAP PHASING PLAN
	2	EXISTING CONDITIONS - PROPOSED EVOH COVER AREA
	3	EVOH COVER SUBGRADE GRADING PLAN
	4	EVOH COVER UNDERCAP PLAN
	5	EVOH COVER PLAN
	6	DETAILS
△1	7	DETAILS
	8	DETAILS
	9	DETAILS
	10	DETAILS
	11	DETAILS
△1	12	DETAILS

CEG PROJECT # 160512



N

0 100 200
SCALE IN FEET

LEGEND

Symbol	Description
	EXISTING PROPERTY BOUNDARY
	SOLID WASTE BOUNDARY
480	EXISTING 10' CONTOUR
	EXISTING 2' CONTOUR
GMP-4	GAS MONITORING PROBE
PZ-204-AS	PIEZOMETER MONITORING WELL
GEW-38	GAS EXTRACTION WELL
ITS1	INTERCEPTOR TRENCH SUMP
SEW-63	SURFACE EXTRACTION WELL
PEW-20	PERIMETER GAS EXTRACTION WELL
	LFG ISOLATION VALVE
	LEACHATE ISOLATION VALVE
	FLOW METER
	GRIT CHAMBER
	LIFT STATION
CT-1	CONDENSATE SUMP
CT/HC-1	CONDENSATE TRAP/HEADER CONNECTION SUMP
LS-1 LS-6	LEACHATE COLLECTION SUMP
HZ-1	HORIZONTAL COLLECTION SUMP
PS-15	PERIMETER SUMP
LCS-2D	LEACHATE COLLECTION SUMP
SC-B1	SURFACE COLLECTOR
TMP-9	TEMPERATURE MONITORING PROBE
GC-3	SUBSURFACE RCP WELLS
ET-2	TRENCH SUMP
IT-7	INTERCEPTION TRENCH RISER
PL-7	PERIMETER LEACHATE SUMP
	WELL HEAD RISER
WB-1	WELL BORE BOOT
TS-1	TRENCH SUMP
OL-12	OVER LINER TIE IN POINT
GIW-1	GAS INTERCEPTOR WELL
GIW-4	GAS INTERCEPTOR WELL/HEAT EXTRACTION POINT
CO	CLEAN OUT
GEW-38(S)	GAS EXTRACTION WELL WITH 4" STINGER
P	POWER PANEL
TMP-25	EXISTING TEMPERATURE MONITORING PROBE (1)
L	LEACHATE COLLECTION PIPING
L	DUAL CONTAINED LCS FORCEMAIN (SIZE VARIES)
L	DUAL CONTAINED PERIMETER FORCEMAIN (SIZE VARIES)
L	LEACHATE COLLECTION PIPING (SIZE VARIES)
	TOE DRAIN
4PU	4" PERFORATED TRENCH DRAIN
	BUBBLE SUCKER
2A	AIR LINE
2AU	AIR LINE (PRESSURIZED BELOW GROUND)
6GU	BURIED LFG COLLECTION PIPING (SIZE VARIES)
2G	2" ABOVE GROUND LFG COLLECTION LATERAL PIPING
4G	4" ABOVE GROUND LFG COLLECTION LATERAL PIPING
6G	6" ABOVE GROUND LFG COLLECTION LATERAL PIPING
8G	8" ABOVE GROUND LFG COLLECTION LATERAL PIPING
	10" ABOVE GROUND LFG COLLECTION LATERAL PIPING
	10" STEEL GROUND LFG COLLECTION PIPING
	12" ABOVE GROUND LFG COLLECTION LATERAL PIPING
18G	18" ABOVE GROUND LFG COLLECTION HEADER PIPING
	24" ABOVE GROUND LFG COLLECTION LATERAL PIPING
	2" PRESSURIZED AIR / 2" FORCEMAIN IN COMMON TRENCH
UE	ABOVEGROUND ELECTRIC LINE
E	UNDERGROUND ELECTRIC LINE
W	WATERMAIN
NGAS	NATURAL GAS LINE
FO	FIBER OPTIC LINE
X	FENCE LINE
4G	INTERCEPTOR TRENCH
	HEAT EXTRACTION EFFLUENT PIPING
	HEAT EXTRACTION INFLUENT PIPING
	EXISTING EVOH GEOMEMBRANE
	BUILDING
	HAUL ROAD

STATE OF MISSOURI
ADAM STEVEN LARKY
NUMBER E-23655
REGISTERED PROFESSIONAL ENGINEER

9/30/16

NOTES:

1. THE 2016 TOPOGRAPHIC MAP WAS PROVIDED BY COOPER AERIAL SURVEY CO., PHOENIX, AZ. DATE OF PHOTO: 02/27/2016.
2. UTILITIES SHOWN TAKEN FROM FEEZOR ENGINEERING, INC., DRAWING TITLED "BRIDGETON LANDFILL 2016 Q1 SITE INFRASTRUCTURE", PROJECT BT-092, DATED APRIL 2016.
3. THE PROPERTY BOUNDARY, SOLID WASTE PERMIT BOUNDARIES AND QUARRY BOUNDARY WERE OBTAINED FROM A DWG FILE TITLED "BRIDGETON AND WESTLAKE LANDFILL PARCEL REFERENCE MAP" PREPARED BY SHERBUT-CARSON-CLAYTON LLC, DATED JUNE 2011.

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
1	09/30/16	RESPONSE TO 09/02/16 USEPA COMMENTS	DAT	JGW	ASL	ASL

DATE OF ISSUE 06/27/16
DRAWN BY DAT
DESIGNED BY JGW
CHECKED BY ASL
APPROVED BY ASL

cornerstone environmental

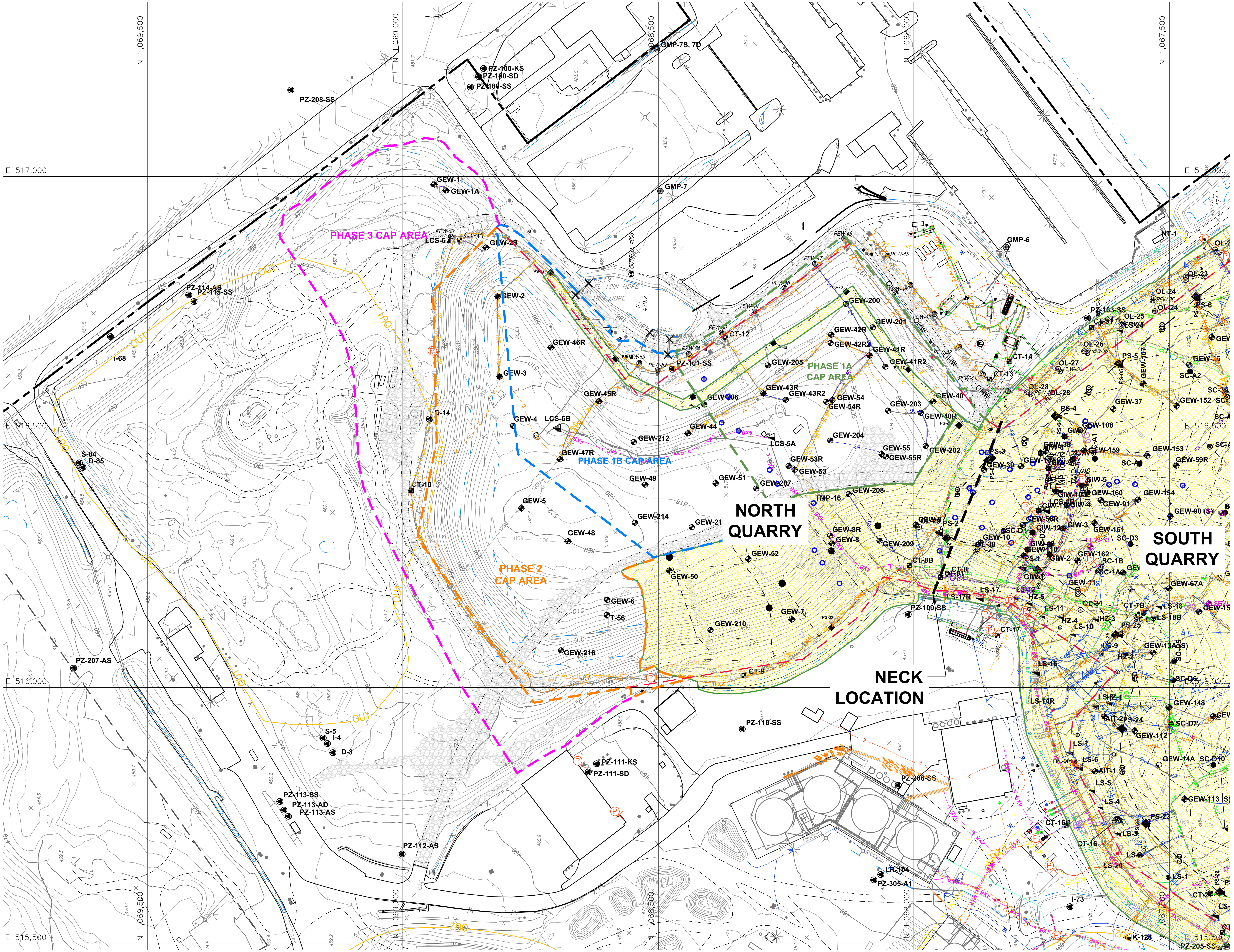
PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

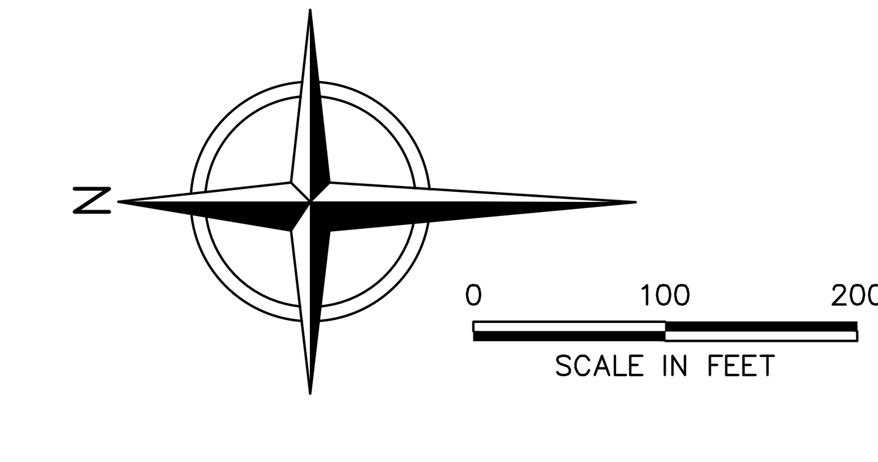
BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
EXISTING NORTH QUARRY PLAN

SHEET NO. 1

PROJECT NO. 160512





LEGEND

EXISTING PROPERTY BOUNDARY
SOLID WASTE BOUNDARY
PHASE 1A CAP BOUNDARY
PHASE 1BA CAP BOUNDARY
PHASE 2 CAP BOUNDARY
PHASE 3 CAP BOUNDARY
480 EXISTING 10' CONTOUR
EXISTING 2' CONTOUR
GMP-4 GAS MONITORING PROBE
PZ-204-AS PIEZOMETER MONITORING WELL
GEW-38 GAS EXTRACTION WELL
ITS1 INTERCEPTOR TRENCH SUMP
SEW-63 SURFACE EXTRACTION WELL
PEW-20 PERIMETER GAS EXTRACTION WELL
LFG ISOLATION VALVE
LEACHATE ISOLATION VALVE
FLOW METER
GRIT CHAMBER
LIFT STATION
CT-1 CONDENSATE SUMP
CT/HC-1 CONDENSATE TRAP/HEADER CONNECTION SUMP
LS-1 LS-6 LEACHATE COLLECTION SUMP
HZ-1 HORIZONTAL COLLECTION SUMP
PS-15 PERIMETER SUMP
LCS-2D LEACHATE COLLECTION SUMP
SC-B1 SURFACE COLLECTOR
TMP-9 TEMPERATURE MONITORING PROBE
GC-3 SUBSURFACE RCP WELLS
ET-2 TRENCH SUMP
IT-7 INTERCEPTION TRENCH RISER
PL-7 PERIMETER LEACHATE SUMP
WELL HEAD RISER
WB-1 WELL BORE BOOT
TS-1 TRENCH SUMP
OL-12 OVER LINER TIE IN POINT
GIW-1 GAS INTERCEPTOR WELL
GIW-4 GAS INTERCEPTOR WELL/HEAT EXTRACTION POINT
CO CLEAN OUT
GEW-38(S) GAS EXTRACTION WELL WITH 4" STINGER
POWER PANEL
TMP-25 EXISTING TEMPERATURE MONITORING PROBE
LEACHATE COLLECTION PIPING
DUAL CONTAINED LCS FORCEMAIN (SIZE VARIES)
DUAL CONTAINED PERIMETER FORCEMAIN (SIZE VARIES)
LEACHATE COLLECTION PIPING (SIZE VARIES)
TOE DRAIN
4PU 4" PERFORATED TRENCH DRAIN
BUBBLE SUCKER
2A AIR LINE
2AU AIR LINE (PRESSURIZED BELOW GROUND)
6GU BURIED LFG COLLECTION PIPING (SIZE VARIES)
2G 2" ABOVE GROUND LFG COLLECTION LATERAL PIPING
4G 4" ABOVE GROUND LFG COLLECTION LATERAL PIPING
6G 6" ABOVE GROUND LFG COLLECTION LATERAL PIPING
8G 8" ABOVE GROUND LFG COLLECTION LATERAL PIPING
10" ABOVE GROUND LFG COLLECTION LATERAL PIPING
10" STEEL GROUND LFG COLLECTION PIPING
12" ABOVE GROUND LFG COLLECTION LATERAL PIPING
18G 18" ABOVE GROUND LFG COLLECTION HEADER PIPING
24" ABOVE GROUND LFG COLLECTION LATERAL PIPING
2" PRESSURIZED AIR / 2" FORCEMAIN IN COMMON TRENCH
E ABOVEGROUND ELECTRIC LINE
UE UNDERGROUND ELECTRIC LINE
W WATERMAIN
NGAS NATURAL GAS LINE
FO FIBER OPTIC LINE
X FENCE LINE
4G INTERCEPTOR TRENCH
HEAT EXTRACTION EFFLUENT PIPING
HEAT EXTRACTION INFLUENT PIPING
EXISTING EVOH GEOMEMBRANE
BUILDING
HAUL ROAD

STATE OF MISSOURI — ADAM STEVEN LESKY — NUMBER E-22655 — PROFESSIONAL ENGINEER
9/30/16

NOTES:

1. THE 2016 TOPOGRAPHIC MAP WAS PROVIDED BY COOPER AERIAL SURVEY CO., PHOENIX, AZ. DATE OF PHOTO: 02/27/2016.
2. UTILITIES SHOWN TAKEN FROM FEEZOR ENGINEERING, INC., DRAWING TITLED "BRIDGETON LANDFILL 2016 Q1 SITE INFRASTRUCTURE", PROJECT BT-092, DATED APRIL 2016.
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REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
1	09/30/16	RESPONSE TO 09/02/16 USEPA COMMENTS NEW PLAN SHEET	DAT	JGW	ASL	ASL

DATE OF ISSUE 09/30/16 — DRAWN BY MJB — DESIGNED BY JGW — CHECKED BY ASL — APPROVED BY ASL

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PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

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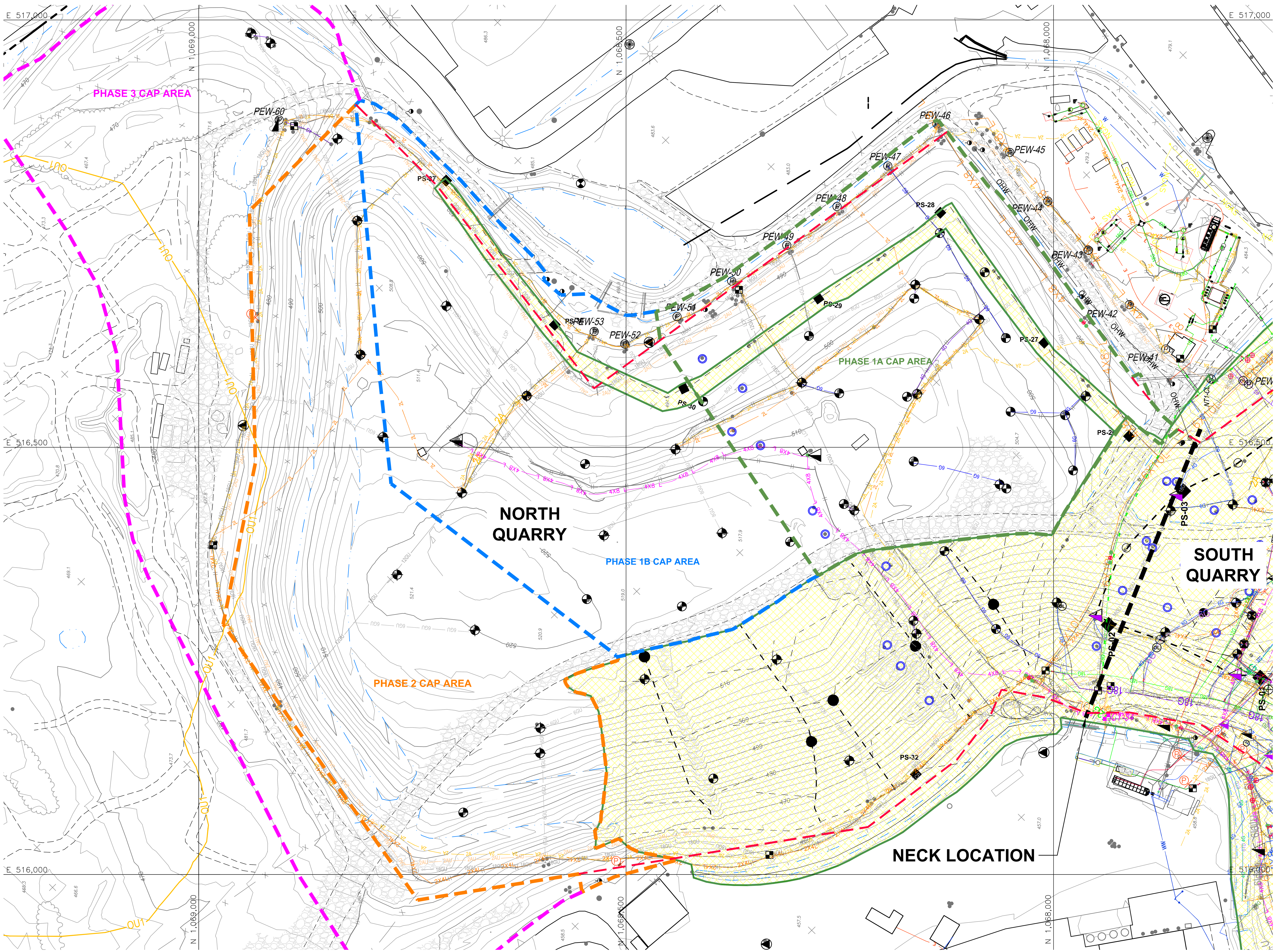
BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

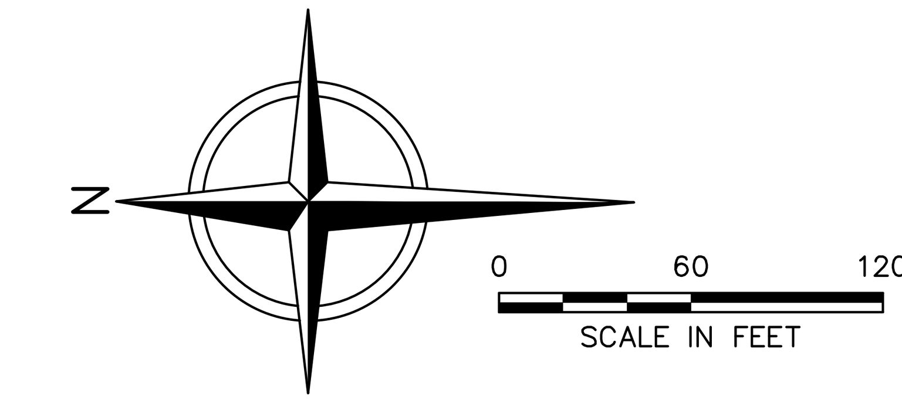
NORTH QUARRY - EVOH COVER DESIGN
PROPOSED CAP PHASING PLAN

SHEET NO. 1A
PROJECT NO. 160512

File: W:\PROJECTS\BRIDGETON (MO)\160512 - NORTH QUARRY EVOH COVER DESIGN_Plan Set_RESPONSE TO COMMENTS SEPT 2016\FNBL 2016 NQ 01 EC.dwg Layout: 01A CAP PHASING 100 sc User: thierry.dechope Sep 30, 2016 - 11:14am

1" 1/2" 0"





LEGEND

- SOLID WASTE BOUNDARY
- PHASE 1A CAP BOUNDARY
- PHASE 1BA CAP BOUNDARY
- PHASE 2 CAP BOUNDARY
- PHASE 3 CAP BOUNDARY
- 480 — EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- GMP-4 — GAS MONITORING PROBE
- PZ-204-AS — PIEZOMETER MONITORING WELL
- GEW-38 — GAS EXTRACTION WELL
- ITS1 — INTERCEPTOR TRENCH SUMP
- SEW-63 — SURFACE EXTRACTION WELL
- PEW-20 — PERIMETER GAS EXTRACTION WELL
- LFG ISOLATION VALVE
- LEACHATE ISOLATION VALVE
- FLOW METER
- GRIT CHAMBER
- LIFT STATION
- CT-1 — CONDENSATE SUMP
- CT/HC-1 — CONDENSATE TRAP/HEADER CONNECTION SUMP
- LS-1 LS-6 — LEACHATE COLLECTION SUMP
- HZ-1 — HORIZONTAL COLLECTION SUMP
- PS-15 — PERIMETER SUMP
- LCS-2D — LEACHATE COLLECTION SUMP
- SC-B1 — SURFACE COLLECTOR
- TMP-9 — TEMPERATURE MONITORING PROBE
- GC-3 — SUBSURFACE RCP WELLS
- ET-2 — TRENCH SUMP
- IT-7 — INTERCEPTION TRENCH RISER
- PL-7 — PERIMETER LEACHATE SUMP
- WELL HEAD RISER
- WB-1 — WELL BORE BOOT
- TS-1 — TRENCH SUMP
- OL-12 — OVER LINER TIE IN POINT
- GIW-1 — GAS INTERCEPTOR WELL
- GIW-4 — GAS INTERCEPTOR WELL/HEAT EXTRACTION POINT
- CLEAN OUT
- GEW-38(S) — GAS EXTRACTION WELL WITH 4" STINGER
- POWER PANEL
- TMP-25 — EXISTING TEMPERATURE MONITORING PROBE
- L — LEACHATE COLLECTION PIPING
- L — DUAL CONTAINED LCS FORCEMAIN (SIZE VARIES)
- L — DUAL CONTAINED PERIMETER FORCEMAIN (SIZE VARIES)
- L — LEACHATE COLLECTION PIPING (SIZE VARIES)
- TOE DRAIN
- 4PU — 4" PERFORATED TRENCH DRAIN
- BUBBLE SUCKER
- 2A — AIR LINE
- 2AU — AIR LINE (PRESSURIZED BELOW GROUND)
- 6GU — BURIED LFG COLLECTION PIPING (SIZE VARIES)
- 2G — 2" ABOVE GROUND LFG COLLECTION LATERAL PIPING
- 4G — 4" ABOVE GROUND LFG COLLECTION LATERAL PIPING
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- 18G — 18" ABOVE GROUND LFG COLLECTION HEADER PIPING
- 24" ABOVE GROUND LFG COLLECTION LATERAL PIPING
- 2" PRESSURIZED AIR / 2" FORCEMAIN IN COMMON TRENCH
- E — ABOVEGROUND ELECTRIC LINE
- UE — UNDERGROUND ELECTRIC LINE
- W — WATERMAIN
- NGAS — NATURAL GAS LINE
- FO — FIBER OPTIC LINE
- X — FENCE LINE
- INTERCEPTOR TRENCH
- 4G — HEAT EXTRACTION EFFLUENT PIPING
- HEAT EXTRACTION INFLUENT PIPING
- EXISTING EVOH GEOMEMBRANE
- BUILDING
- HAUL ROAD
- TOE DRAIN
- PS-30 — PERIMETER SUMP
- TRENCH DRAIN
- TRENCH DRAIN SUMP RISER
- STRIP DRAIN

STATE OF MISSOURI ... NUMBER E-22655 ... PROFESSIONAL ENGINEER

9/30/16

NOTES:

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PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

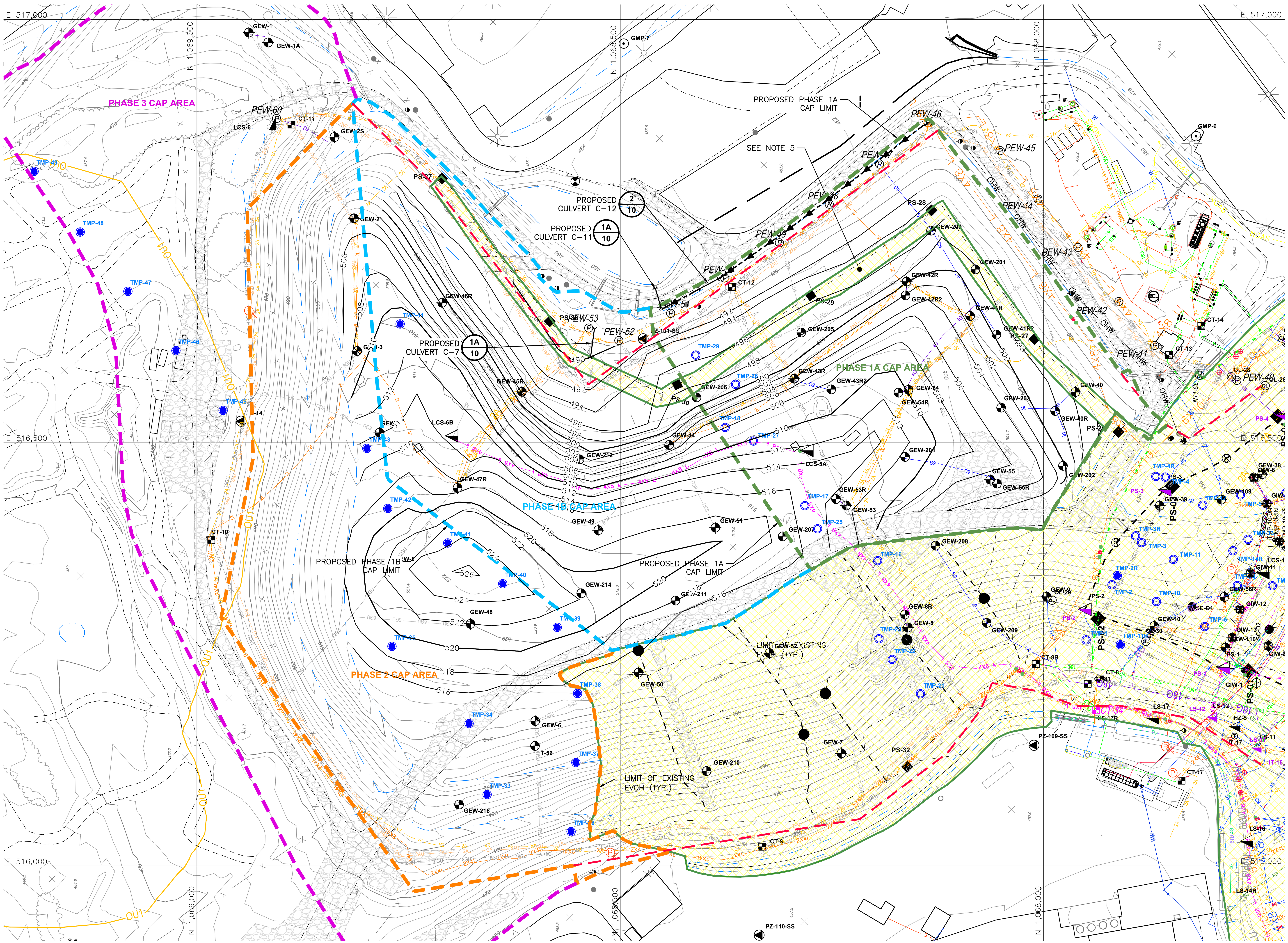
BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
EXISTING CONDITIONS - PROPOSED EVOH COVER AREA

SHEET NO. 2

PROJECT NO. 160512

File: W:\PROJECTS\BRIDGETON (MO)\160512 - NORTH QUARRY EVOH COVER DESIGN



0 60 120
SCALE IN FEET

LEGEND

- SOLID WASTE BOUNDARY
- PHASE 1A CAP BOUNDARY
- PHASE 1B CAP BOUNDARY
- PHASE 2 CAP BOUNDARY
- PHASE 3 CAP BOUNDARY
- 480 — EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- 480 — PROPOSED SUBGRADE 10' CONTOUR
- PROPOSED SUBGRADE 2' CONTOUR
- GMP-4 — GAS MONITORING PROBE
- PZ-204-AS — PIEZOMETER MONITORING WELL
- GEW-38 — GAS EXTRACTION WELL
- ITS1 — INTERCEPTOR TRENCH SUMP
- SEW-63 — SURFACE EXTRACTION WELL
- PEW-20 — PERIMETER GAS EXTRACTION WELL
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- PS-15 — PERIMETER SUMP
- LCS-2D — LEACHATE COLLECTION SUMP
- SC-B1 — SURFACE COLLECTOR
- TMP-9 — TEMPERATURE MONITORING PROBE
- GC-3 — SUBSURFACE RCP WELLS
- ET-2 — TRENCH SUMP
- IT-7 — INTERCEPTION TRENCH RISER
- PL-7 — PERIMETER LEACHATE SUMP
- WELL HEAD RISER
- WB-1 — WELL BORE BOOT
- TS-1 — TRENCH SUMP
- OL-12 — OVER LINER TIE IN POINT
- GIW-1 — GAS INTERCEPTOR WELL
- GIW-4 — GAS INTERCEPTOR WELL/HEAT EXTRACTION POINT
- CO — CLEAN OUT
- GEW-38(S) — GAS EXTRACTION WELL WITH 4" STINGER
- P — POWER PANEL
- TMP-25 — EXISTING TEMPERATURE MONITORING PROBE
- TMP-47 — PROPOSED TEMPERATURE MONITORING PROBE
- L — LEACHATE COLLECTION PIPING
- L — DUAL CONTAINED LCS FORCEMAIN (SIZE VARIES)
- L — DUAL CONTAINED PERIMETER FORCEMAIN (SIZE VARIES)
- L — LEACHATE COLLECTION PIPING (SIZE VARIES)
- TOE DRAIN
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- 18G — 18" ABOVE GROUND LFG COLLECTION HEADER PIPING
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- 2" PRESSURIZED AIR/2" FORCEMAIN IN COMMON TRENCH
- E — ABOVEGROUND ELECTRIC LINE
- UE — UNDERGROUND ELECTRIC LINE
- W — WATERMAIN
- NGAS — NATURAL GAS LINE
- FO — FIBER OPTIC LINE
- X — FENCE LINE
- 4G — INTERCEPTOR TRENCH
- HEAT EXTRACTION EFFLUENT PIPING
- HEAT EXTRACTION INFLUENT PIPING
- EXISTING EVOH GEOMEMBRANE
- BUILDING
- HAUL ROAD
- EXISTING PERIMETER COLLECTION DRAIN
- PS-30 — EXISTING PERIMETER COLLECTION DRAIN SUMP
- EXISTING DOWNSLOPE STRIP DRAIN COLLECTOR
- EXISTING DOWNSLOPE STRIP DRAIN COLLECTOR SUMP RISER
- EXISTING STRIP DRAIN

STATE OF MISSOURI — ADAM STEVEN LARKY — NUMBER E-20655 — REGISTERED PROFESSIONAL ENGINEER

9/30/16

NOTES:

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4. CONTRACTOR TO COORDINATE WITH OWNER MANAGEMENT OF EXISTING GAS AND LEACHATE MANAGEMENT UTILITY COMPONENETS IN PREPARATION AND DURING CONSTRUCTION OF SUBGRADE, UNDERCAP AND CAP FEATURES AND TAKE NECESSARY PRECAUTIONS TO PREVENT DAMAGE TO THEM.
5. SEE DETAILS 1 AND 2, SHEET 6 FOR SUBGRADE MODIFICATIONS AT PERIMETER COLLECTION TRENCH AND SUMP.

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PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
EVOH COVER SUBGRADE GRADING PLAN

SHEET NO. 3

PROJECT NO. 160512

File: W:\PROJECTS\BRIDGETON (MO)\160512 – NORTH QUARRY EVOH COVER DESIGN_Plan Set_RESPONSE TO COMMENTS SEPT 2016\FHBL 2016 NQ 03-CIS SUBGRADE.dwg Layout: 03 UNDER CAP User: thierry.dechape Sep 30, 2016 – 3:08pm

1" 1/2" 0" 1"


LEGEND
SOLID WASTE PERMIT 118912 BOUNDARY
PHASE 1A CAP BOUNDARY
PHASE 1B CAP BOUNDARY
PHASE 2 CAP BOUNDARY
PHASE 3 CAP BOUNDARY
EXISTING 10' CONTOUR
EXISTING 2' CONTOUR
PROPOSED 10' CONTOUR
PROPOSED 2' CONTOUR
EXISTING LFG HEADER/LATERAL
EXISTING LEACHATE FORCEMAIN
EXISTING CONDENSATE DRAIN LINE
EXISTING AIR LINE
EXISTING UNDERGROUND ELECTRIC
EXISTING EVOH GEOMEMBRANE
EXISTING HAUL ROAD
EXISTING PERIMETER COLLECTION SUMP
EXISTING LFG EXTRACTION WELL
EXISTING LFG PERIMETER EXTRACTION WELL
EXISTING TEMPERATURE MONITORING PROBE
LEACHATE COLLECTION SUMP
EXISTING PERIMETER COLLECTION DRAIN
EXISTING PERIMETER COLLECTION DRAIN SUMP
EXISTING DOWNSLOPE STRIP DRAIN COLLECTOR
EXISTING DOWNSLOPE STRIP DRAIN COLLECTOR SUMP RISER
EXISTING STRIP DRAIN
PROPOSED GEOCOMPOSITE AREA FOR LIGHT DUTY ACCESS ROAD
PROPOSED STRIP DRAIN TOE COLLECTOR
PROPOSED DOWNSLOPE STRIP DRAIN COLLECTOR
PROPOSED STRIP DRAINS
PROPOSED DOWNSLOPE STRIP DRAIN COLLECTOR RISER STUB
PROPOSED CONTAINMENT SUMP PUMP STATION FOR TOE STRIP DRAIN
EXISTING TEMPERATURE MONITORING PROBE
PROPOSED TEMPERATURE MONITORING PROBE
SCALE IN FEET
PHASE 3 CAP AREA
PHASE 1B CAP AREA
PHASE 1A CAP AREA
PHASE 2 CAP AREA
EVOH GEOMEMBRANE COVER PHASE 1B SOUTH EDGE
EVOH GEOMEMBRANE COVER PHASE 1A EAST EDGE
EVOH GEOMEMBRANE COVER PHASE 1A SOUTH EDGE
GEOCOMPOSITE BASE LAYER FOR PROPOSED LIGHT DUTY ROADS
EXISTING PERIMETER COLLECTION DRAIN
DOWNSLOPE STRIP DRAIN COLLECTOR TERMINATION
PROPOSED CULVERT C-12
STRIP DRAIN TOE COLLECTOR
PROPOSED CULVERT C-11
DOWNSLOPE STRIP DRAIN COLLECTOR RISER STUB
DOWNSLOPE STRIP DRAIN COLLECTOR
STRIP DRAIN
PROPOSED CULVERT C-7
PHASE 1B NORTH QUARRY COVER TERMINATION
CONTAINMENT SUMP PUMP STATION FOR PERIMETER STRIP DRAIN

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4. THE EVOH COVER SUBGRADE SHALL BE PREPARED AS FOLLOWS:
   A. A QUALIFIED PROFESSIONAL ENGINEER OR LAND SURVEYOR HAS DETERMINED THAT LINES AND GRADES ARE IN SUBSTANTIAL CONFORMANCE WITH DESIGN PLAN AND ALLOW FOR DRAINAGE FROM THE AREA AND THAT PROPOSED SUBCAP DESIGN FEATURES HAVE BEEN COMPLETED;
   B. THE SURFACE TO BE LINED SHALL BE INSPECTED FOR CONDITIONS THAT COULD BE DAMAGING TO THE OVERLYING GEOSYNTHETICS;
   C. THE SURFACE OF THE SUPPORTING SOIL DOES NOT CONTAIN STONES WHICH MAY BE DAMAGING TO THE GEOMEMBRANE;
   D. THERE ARE NO AREAS EXCESSIVELY SOFTENED BY HIGH WATER CONTENT;
   E. THE SUBGRADE FOR THE AREA SHALL BE "TRACKED-IN" AND "BACK-DRAGGED" WITH A BULLDOZER TO PROVIDE A SMOOTH SURFACE. PRIOR TO INSTALLATION OF FML, A MIN 6 OZ/SY GEOTEXTILE CUSHION SHALL BE INSTALLED ON THE SOIL SUBGRADE SURFACE.
5. SEE SHEET 2 FOR EXISTING UTILITIES LEGEND.
6. SEE DETAIL 2, SHEET 6 FOR MODIFICATIONS TO THE PERIMETER COLLECTION TRENCH.

NOTES (CONT.):

7. SEE SHEETS 7 AND 8 FOR STRIP DRAIN AND COTAINMENT SUMP DETAILS.
8. SEE DETAIL 4, SHEET 7 FOR EAST PERIMETER DRAINAGE CHANNEL AND TOE STRIP DRAIN TO BE CONSTRUCTED BELOW CHANNEL. SEE DETAIL 7, SHEET 7 FOR SOUTH TOE STRIP DRAIN TO BE CONSTRUCTED AT EDGE OF EVOH COVER.
9. SEE DETAIL 1, SHEET 8 FOR GEOCOMPOSITE TO BE CONSTRUCTED BELOW EVOH COVER AT PROPOSED ACCESS ROAD LOCATIONS.
10. UNDERCAP FEATURES FOR PHASES 2 AND 3 OF THE EVOH COVER WILL BE DESIGNED FOR THOSE PHASES PRIOR TO CONSTRUCTION OF THOSE PHASES BASED ON FUTURE SITE CONDITIONS AT THAT TIME.

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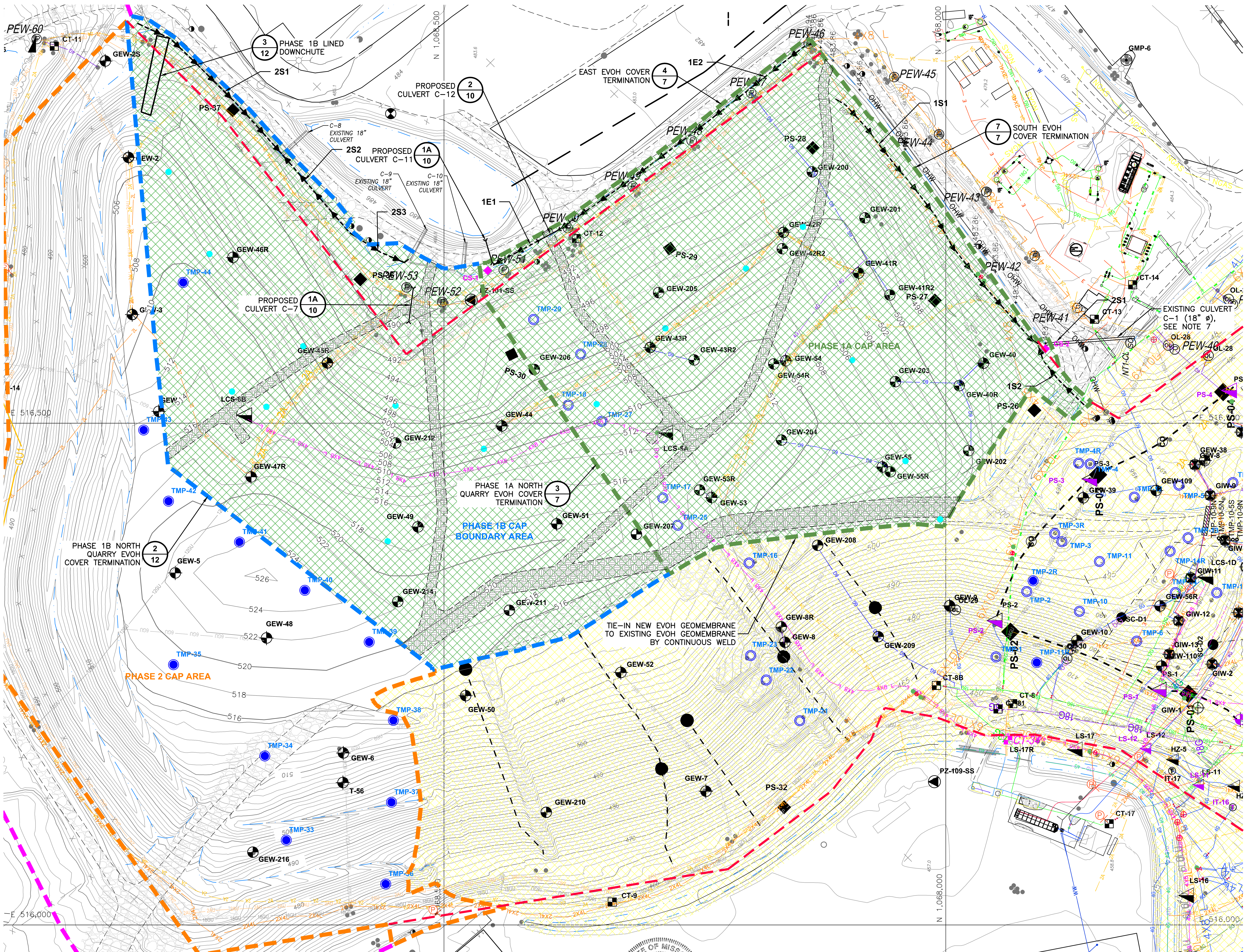
PREPARED BY: CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
EVOH COVER UNDERCAP PLAN

SHEET NO. 4
PROJECT NO. 160512



LEGEND

Symbol	Description
	SOLID WASTE PERMIT 118912 BOUNDARY
	PHASE 1A CAP BOUNDARY
	PHASE 1B CAP BOUNDARY
	PHASE 2 CAP BOUNDARY
	PHASE 3 CAP BOUNDARY
480	EXISTING 10' CONTOUR
	EXISTING 2' CONTOUR
480	PROPOSED 10' CONTOUR
	PROPOSED 2' CONTOUR
GW-7	EXISTING PERIMETER SUMP
GEW-81	EXISTING LFG EXTRACTION WELL
PEW-4	EXISTING LFG PERIMETER EXTRACTION WELL
TMP-1	EXISTING TEMPERATURE MONITORING PROBE
LCS-5	LEACHATE COLLECTION SUMP
	EXISTING PERIMETER COLLECTION DRAIN
PS-30	EXISTING PERIMETER COLLECTION DRAIN SUMP
	EXISTING DOWNSLOPE STRIP DRAIN COLLECTOR
	EXISTING DOWNSLOPE STRIP DRAIN COLLECTOR SUMP RISER
	EXISTING EVOH GEOMEMBRANE
	PROPOSED NORTH QUARRY EVOH GEOMEMBRANE
	EXISTING LIGHT-DUTY ACCESS ROADS
	LIGHT-DUTY ACCESS ROADS (SEE DETAIL 1/8)
	PROPOSED EVOH GEOMEMBRANE COVER LIMIT
	PROPOSED DRAINAGE CHANNEL
	PROPOSED DOWNSLOPE STRIP DRAIN COLLECTOR RISER STUB
CS-1	PROPOSED CONTAINMENT SUMP PUMP STATION FOR TOE STRIP DRAIN
TMP-25	EXISTING TEMPERATURE MONITORING PROBE
TMP-47	PROPOSED TEMPERATURE MONITORING PROBE

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4. THE PROPOSED EVOH CAP GEOMEMBRANE SHALL BE CONTINUOUSLY WELDED TO THE EXISTING EVOH GEOMEMBRANE.
5. SEE SHEET 2 FOR UTILITIES LEGEND.
6. SEE DETAIL 4, SHEET 7 FOR EAST PERIMETER DRAINAGE CHANNEL TO BE SLOPED AT 0.75% TO 30-INCH PROPOSED CULVERT C-11 SHOWN IN DETAILS 1A, SHEET 10.
7. SEE DETAIL 1, SHEET 8 FOR SOUTH DRAINAGE CHANNEL TO BE SLOPED AT 1.0% TO EXISTING 18-INCH CULVER C-1. THE PROPOSED EVOH LINER SHALL EXTEND AROUND A 5-FOOT HIGH SOIL BERM AROUND CULVERT C-1 AND BE BOOTED TO CULVERT C-1 TO DIRECT STORMWATER WITHIN A LINED AREA TO CULVERT C-1.
8. PROPOSED CULVERT C-12 SHALL BE CONSTRUCTED PER DETAIL 2, SHEET 10 AT THE PROPOSED ACCESS ROAD.
9. PROPOSED GAS LATERAL, AIR AND FORCEMAIN PIPING WILL TO BE CONSTRUCTED ABOVE EVOH AS REQUIRED TO CONNECT GAS EXTRACTION WELLS, PERIMETER SUMPS AND LEACHATE COLLECTION SUMP LCS-5A.
10. ALL PENETRATIONS OF THE PROPOSED EVOH COVER TO BE SEALED BY CONSTRUCTION OF WELDED BOOTS.
11. ABOVE CAP FEATURES FOR PHASES 2 AND 3 OF THE EVOH COVER WILL BE DESIGNED FOR THOSE PHASES PRIOR TO CONSTRUCTION OF THOSE PHASES BASED ON FUTURE SITE CONDITIONS AT THAT TIME.

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY
1	09/30/16	RESPONSE TO 09/02/16 USEPA COMMENTS	DAT	JGW	ASL	ASL

DATE OF ISSUE 06/27/16 | DRAWN BY DAT | DESIGNED BY JGW | CHECKED BY ASL | APPROVED BY ASL

STATE OF MISSOURI — ADAM STEVEN LOCY — NUMBER E-22655 — REGISTERED PROFESSIONAL ENGINEER

9/30/16

cornerstone environmental

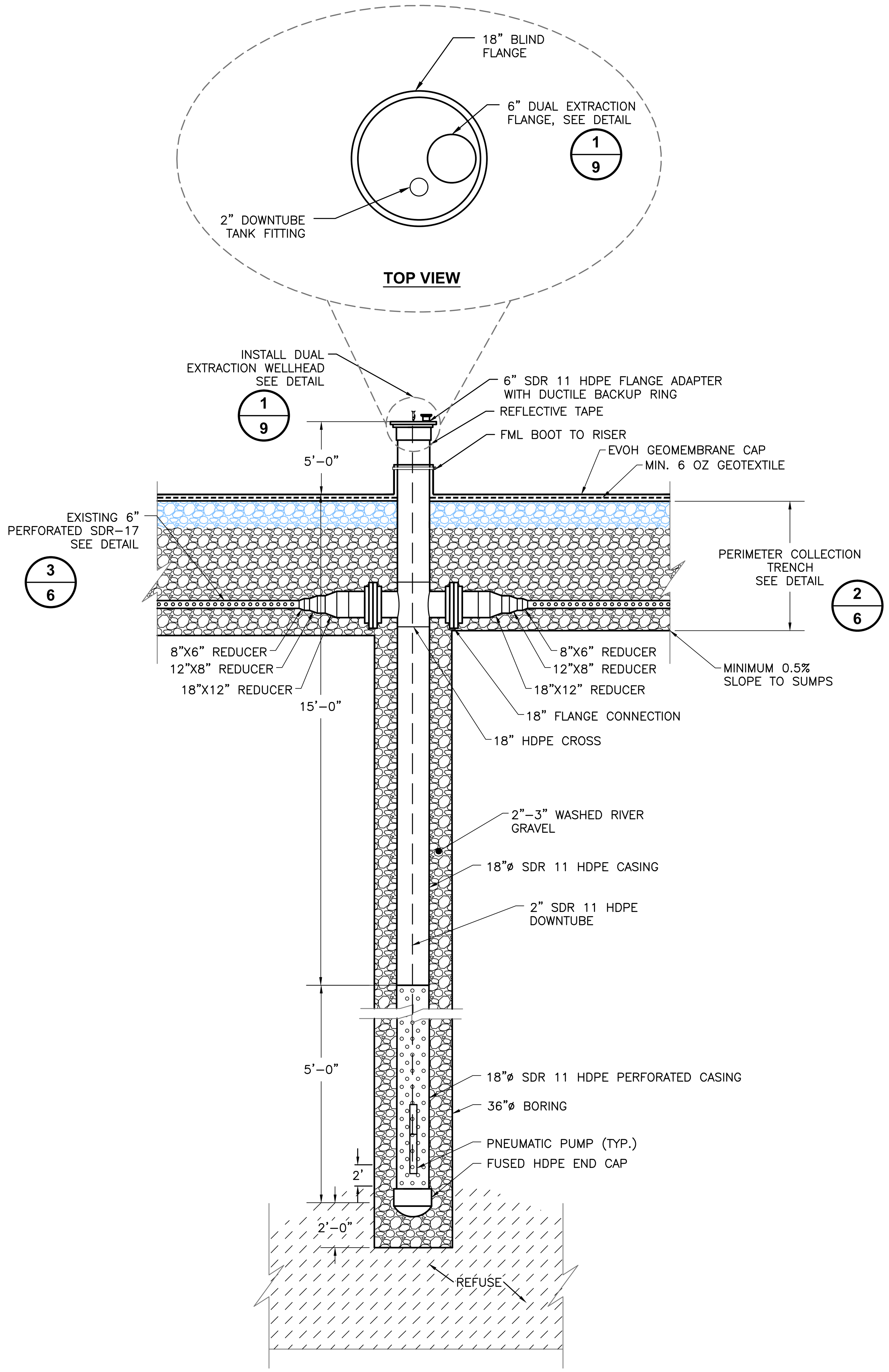
PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
EVOH COVER PLAN

SHEET NO. 5

PROJECT NO. 160512

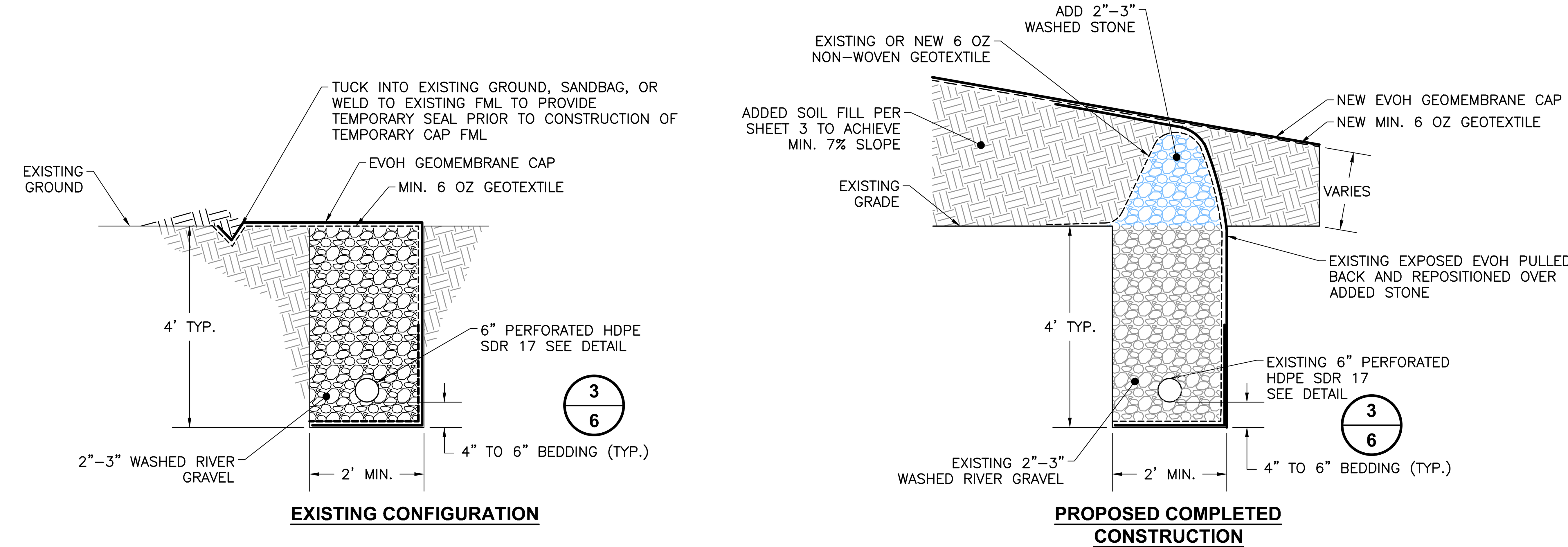


EXISTING PERIMETER COLLECTION SUMP

DETAIL 1/6
SCALE: NOT TO SCALE

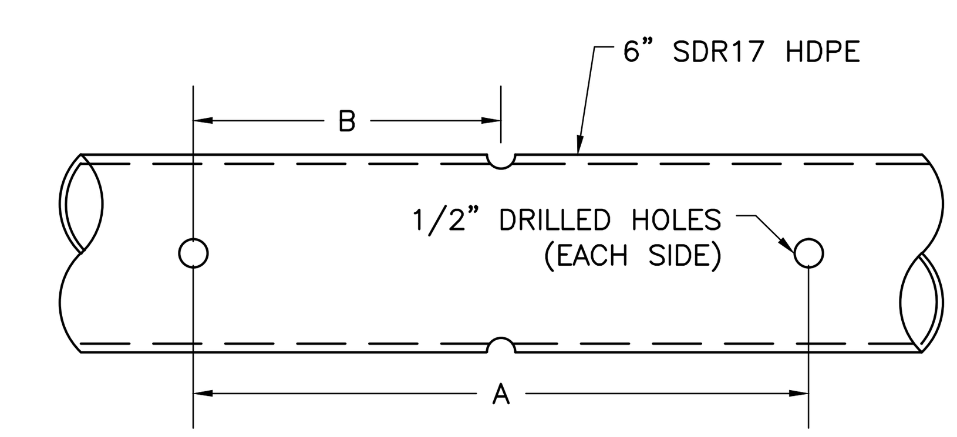
NOTE:

1. INSTALL DUAL EXTRACTION WELLHEAD AS NEEDED FOR GAS AND LIQUIDS MANAGEMENT.



PERIMETER COLLECTION TRENCH

DETAIL 2/6
SCALE: NOT TO SCALE



NOTES:

1. A=20"
   B=10"
   90° ROTATION BETWEEN ROWS
2. ALTERNATE PATTERN MAY BE USED WITH APPROVAL OF ENGINEER.

EXISTING PERIMETER COLLECTION PIPE

DETAIL 3/6
SCALE: NOT TO SCALE

STATE OF MISSOURI
ADAM STEVEN LOCK
NUMBER E-22655
PROFESSIONAL ENGINEER
9/30/16

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 06/27/16
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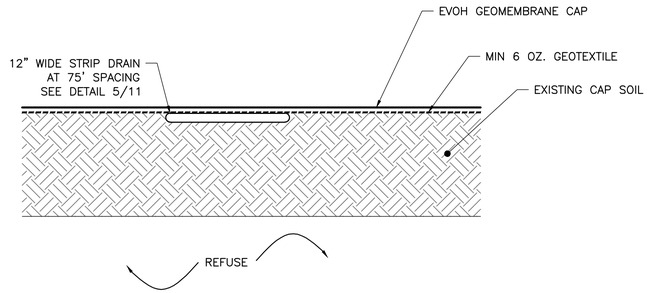
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
DETAILS

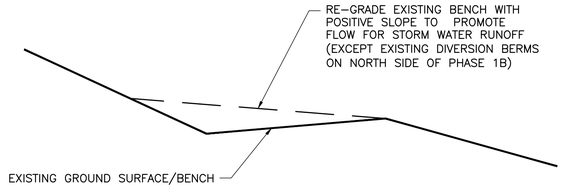
SHEET NO. 6

PROJECT NO. 160512



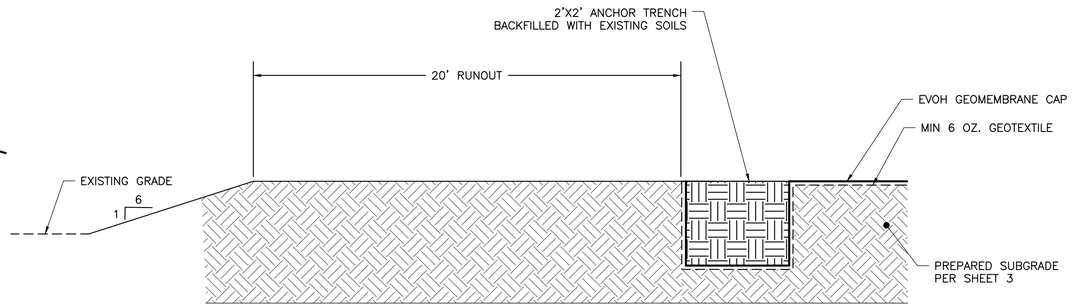
TYPICAL EVOH GEOMEMBRANE CAP

DETAIL 1/7
SCALE: NOT TO SCALE



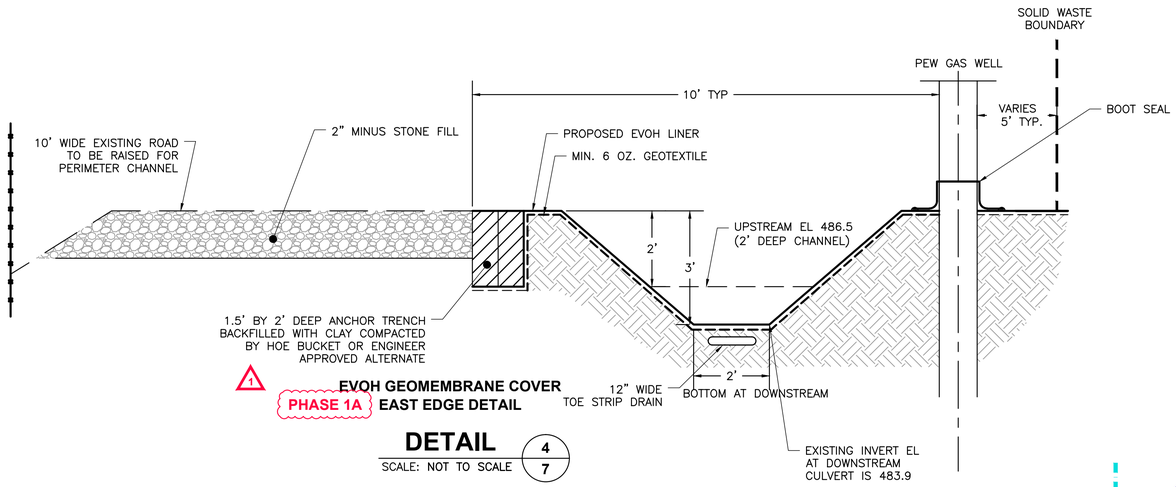
EXISTING BENCH RE-GRADE

DETAIL 2/7
SCALE: NOT TO SCALE



1 **PHASE 1A**
NORTH QUARRY EVOH COVER ~~INTERIM~~ TERMINATION

DETAIL 3/7
SCALE: NOT TO SCALE

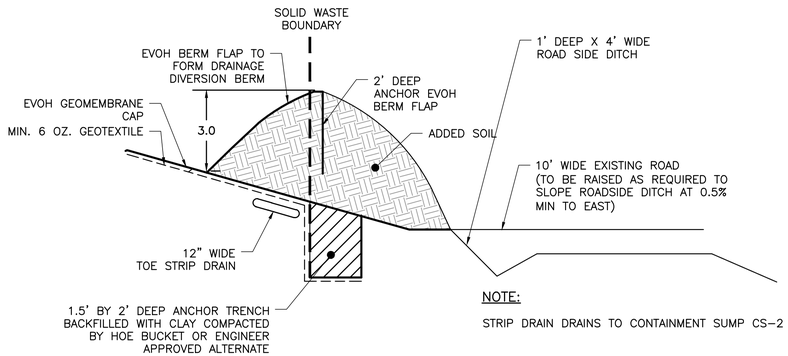


1 **EVOH GEOMEMBRANE COVER**
PHASE 1A EAST EDGE DETAIL

DETAIL 4/7
SCALE: NOT TO SCALE

NOTE:

STRIP DRAIN DRAINS TO CONTAINMENT SUMP CS-1

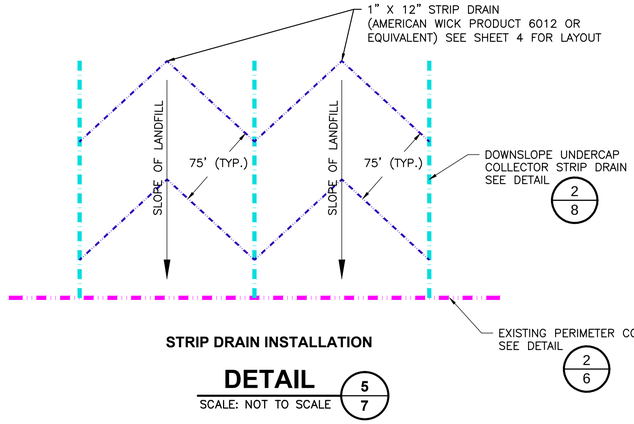


NOTE:

STRIP DRAIN DRAINS TO CONTAINMENT SUMP CS-2

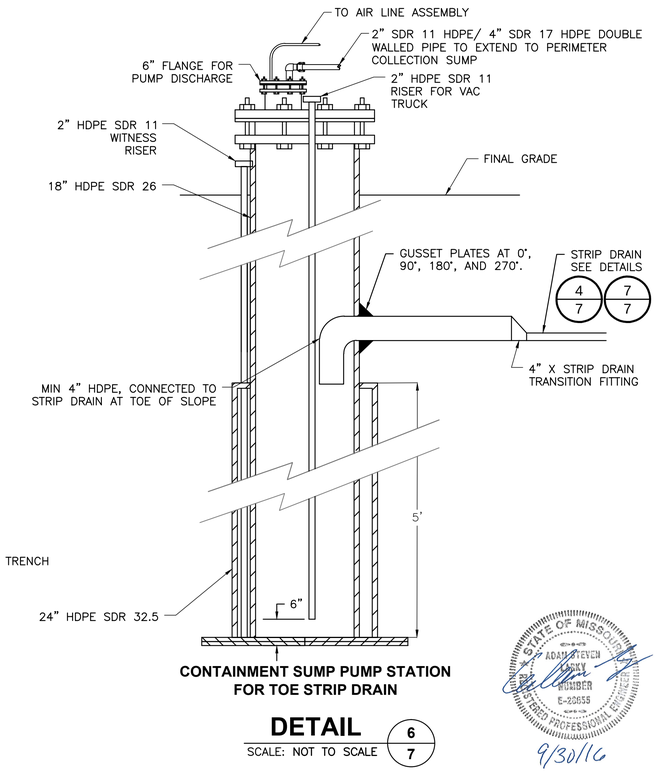
1 **EVOH GEOMEMBRANE COVER**
PHASE 1A SOUTH EDGE DETAIL

DETAIL 7/7
SCALE: NOT TO SCALE



STRIP DRAIN INSTALLATION

DETAIL 5/7
SCALE: NOT TO SCALE



CONTAINMENT SUMP PUMP STATION FOR TOE STRIP DRAIN

DETAIL 6/7
SCALE: NOT TO SCALE

STATE OF MISSOURI
ADAM L. STEVEN
NOTARY NUMBER
E-22655
NOTARY PUBLIC
ENTERED PROFESSIONAL ENGINEER
9/30/16

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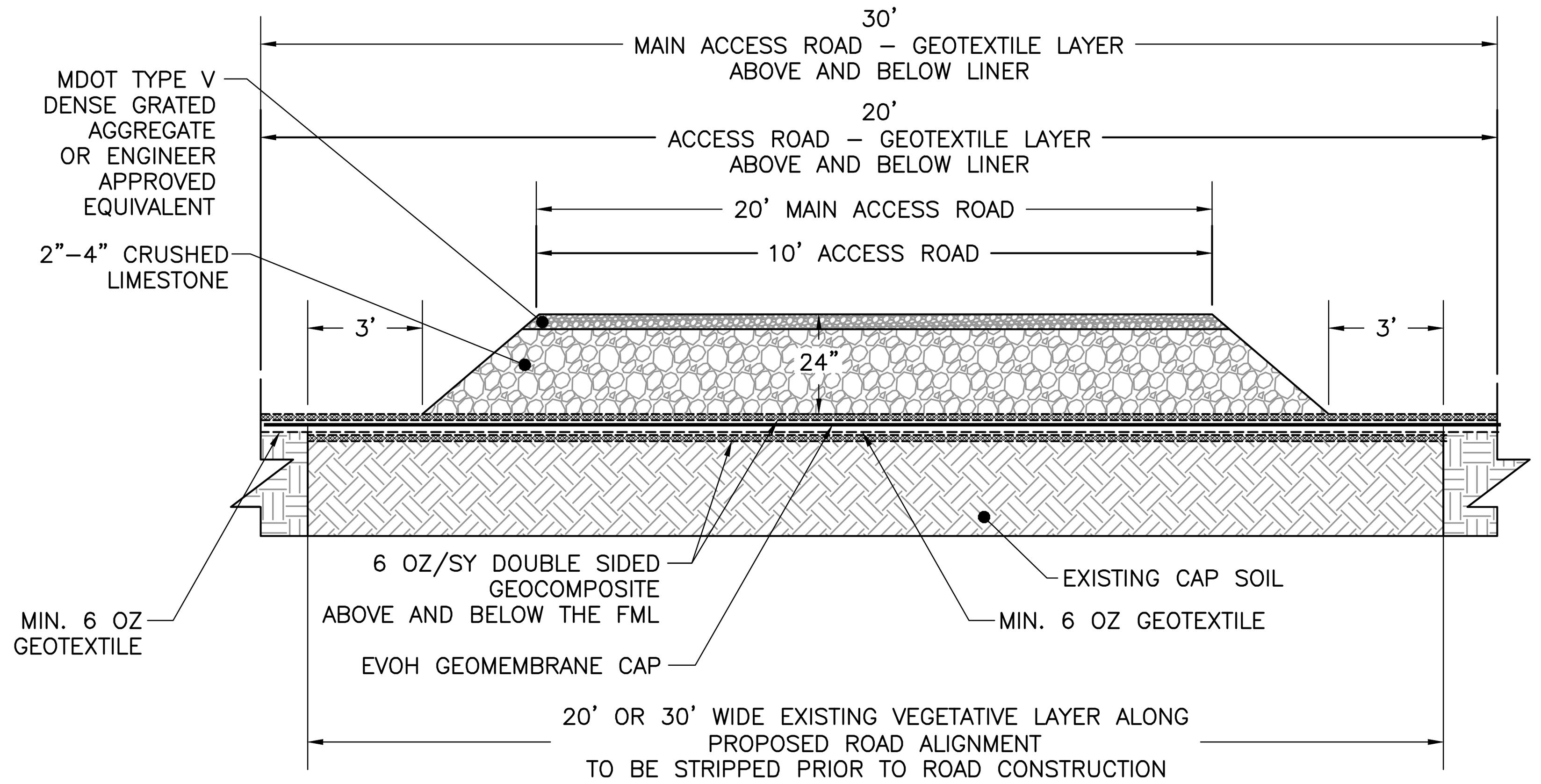
CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
DETAILS

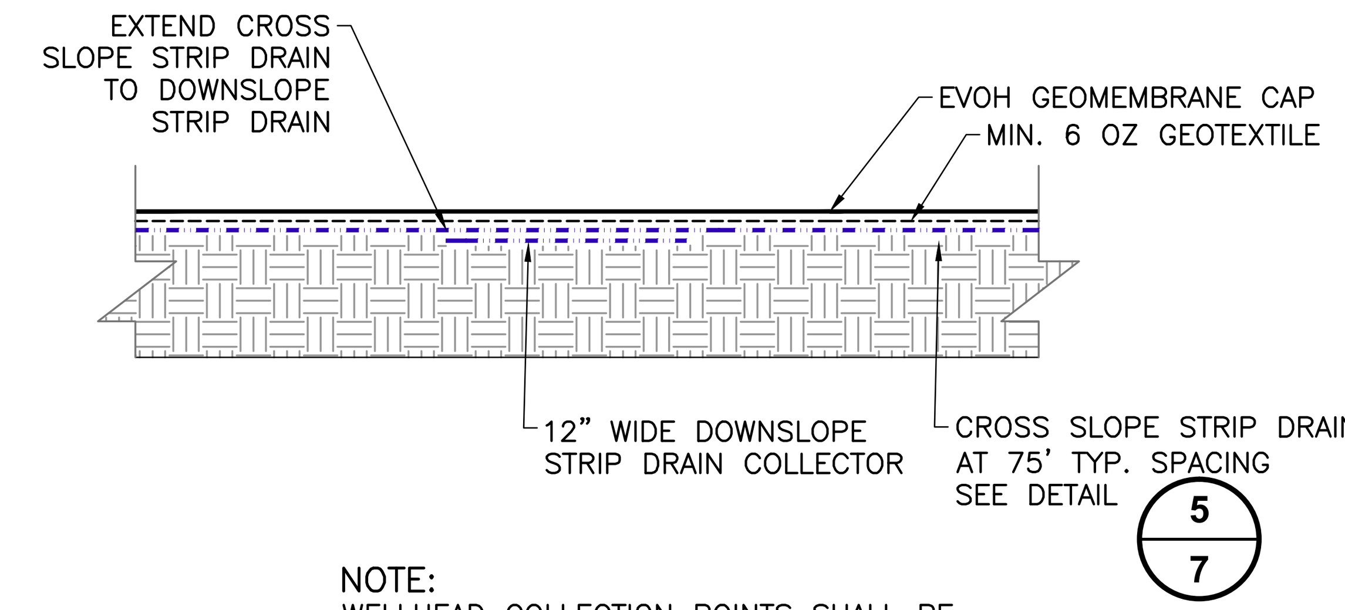
SHEET NO. **7**
PROJECT NO. 160512

1" 1/2" 0" 1"



LIGHT-DUTY ACCESS ROAD

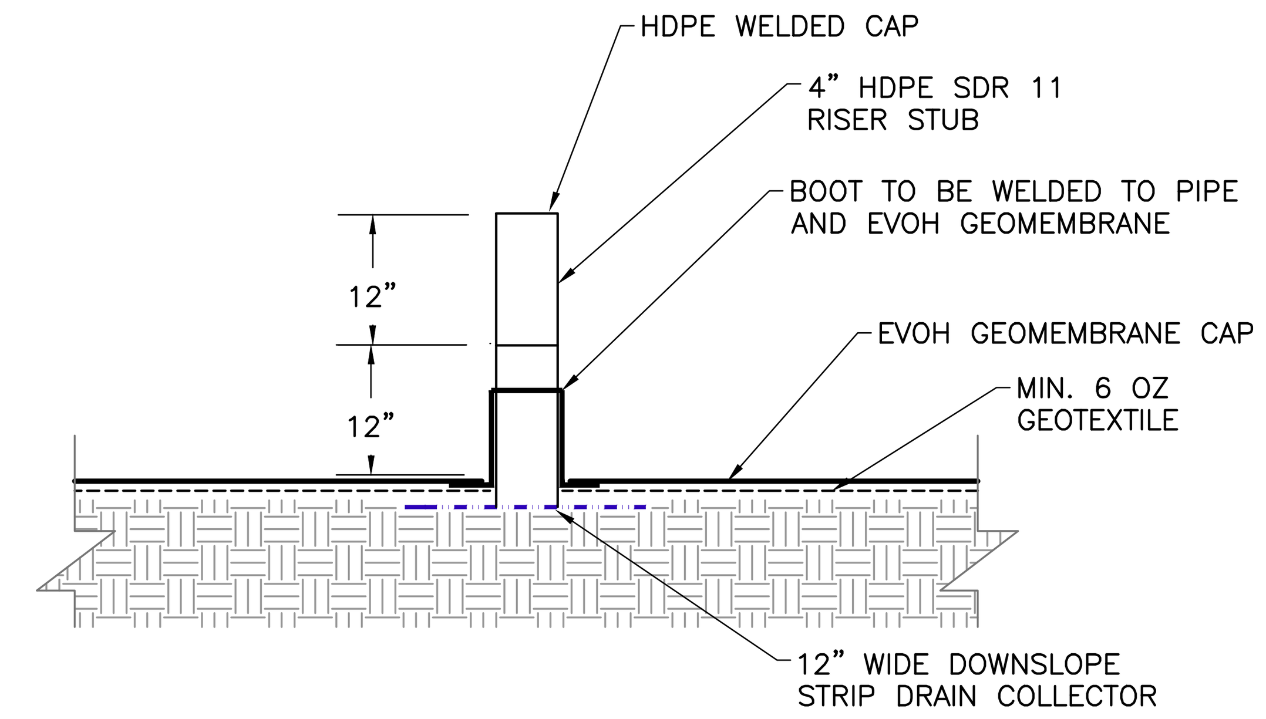
DETAIL 1/8
SCALE: NOT TO SCALE



NOTE:
WELLHEAD COLLECTION POINTS SHALL BE INSTALLED AT MAXIMUM 500' SPACING

12" WIDE DOWNSLOPE STRIP DRAIN COLLECTOR

DETAIL 2/8
SCALE: NOT TO SCALE

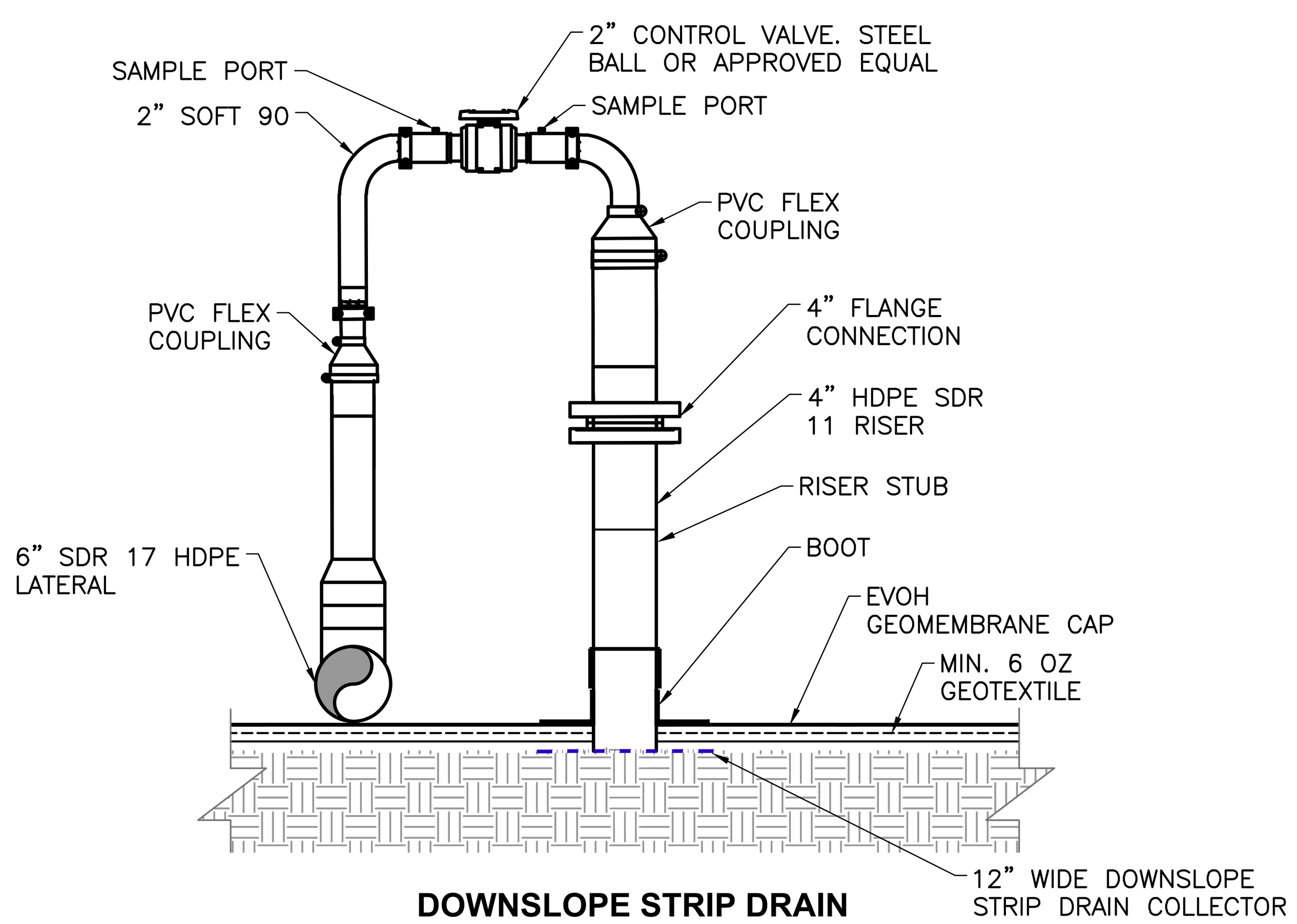


NOTES:

1. WELLHEAD COLLECTION POINTS TO BE INSTALLED AT MAXIMUM 500' SPACING.
2. SEE SHEET 4 FOR RISER STUB LOCATIONS.

DOWNSLOPE STRIP DRAIN COLLECTOR RISER STUB

DETAIL 3/8
SCALE: NOT TO SCALE

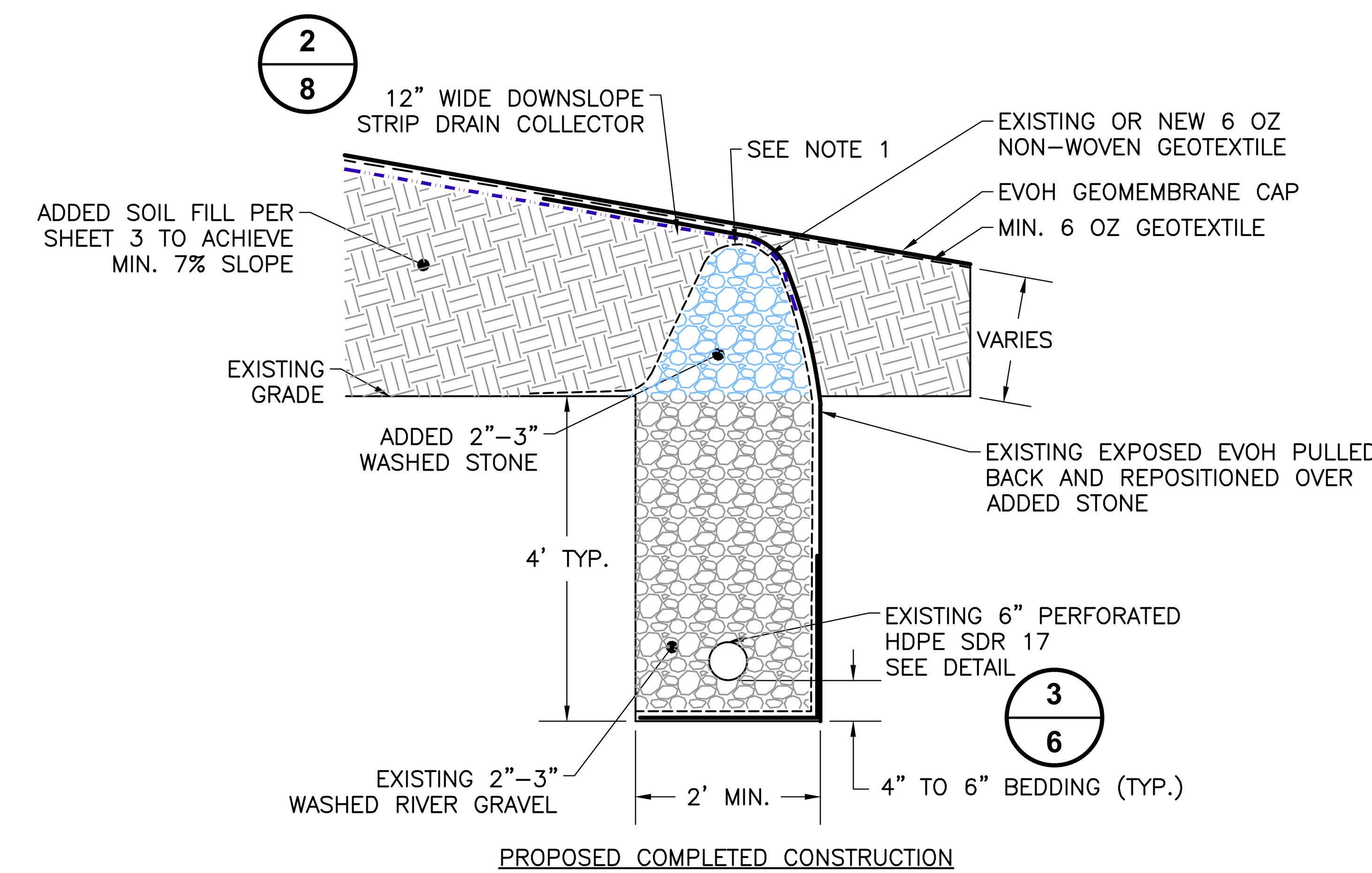


DOWNSLOPE STRIP DRAIN COLLECTOR WITH CONNECTED RISER

DETAIL 4/8
SCALE: NOT TO SCALE

NOTE:

1. GAS COLLECTION PIPING TO BE INSTALLED ONLY AS NEEDED FOR GAS OR LIQUIDS MANAGEMENT.

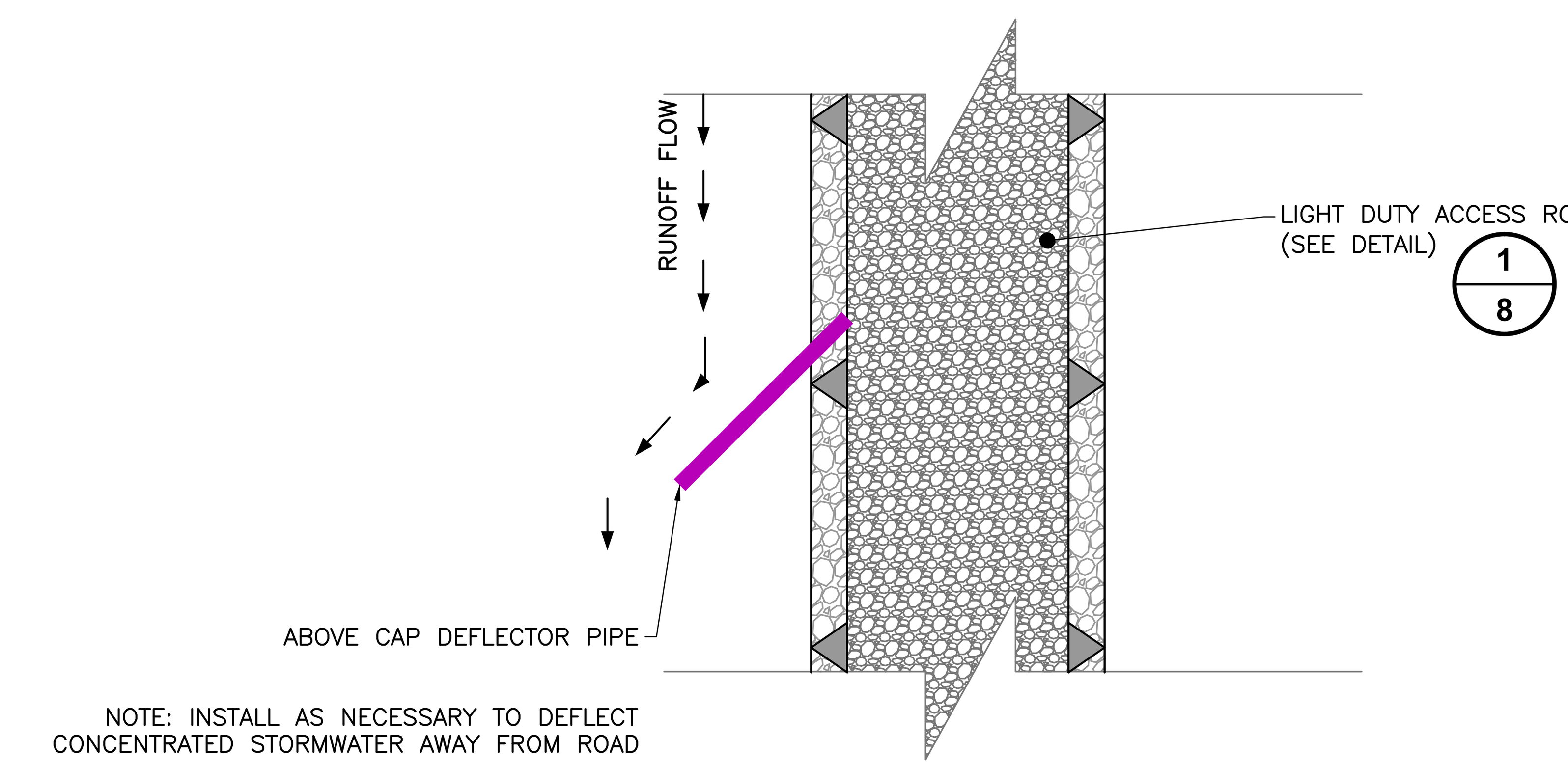


DOWNSLOPE STRIP DRAIN COLLECTOR TERMINATION

DETAIL 5/8
SCALE: NOT TO SCALE

NOTE:

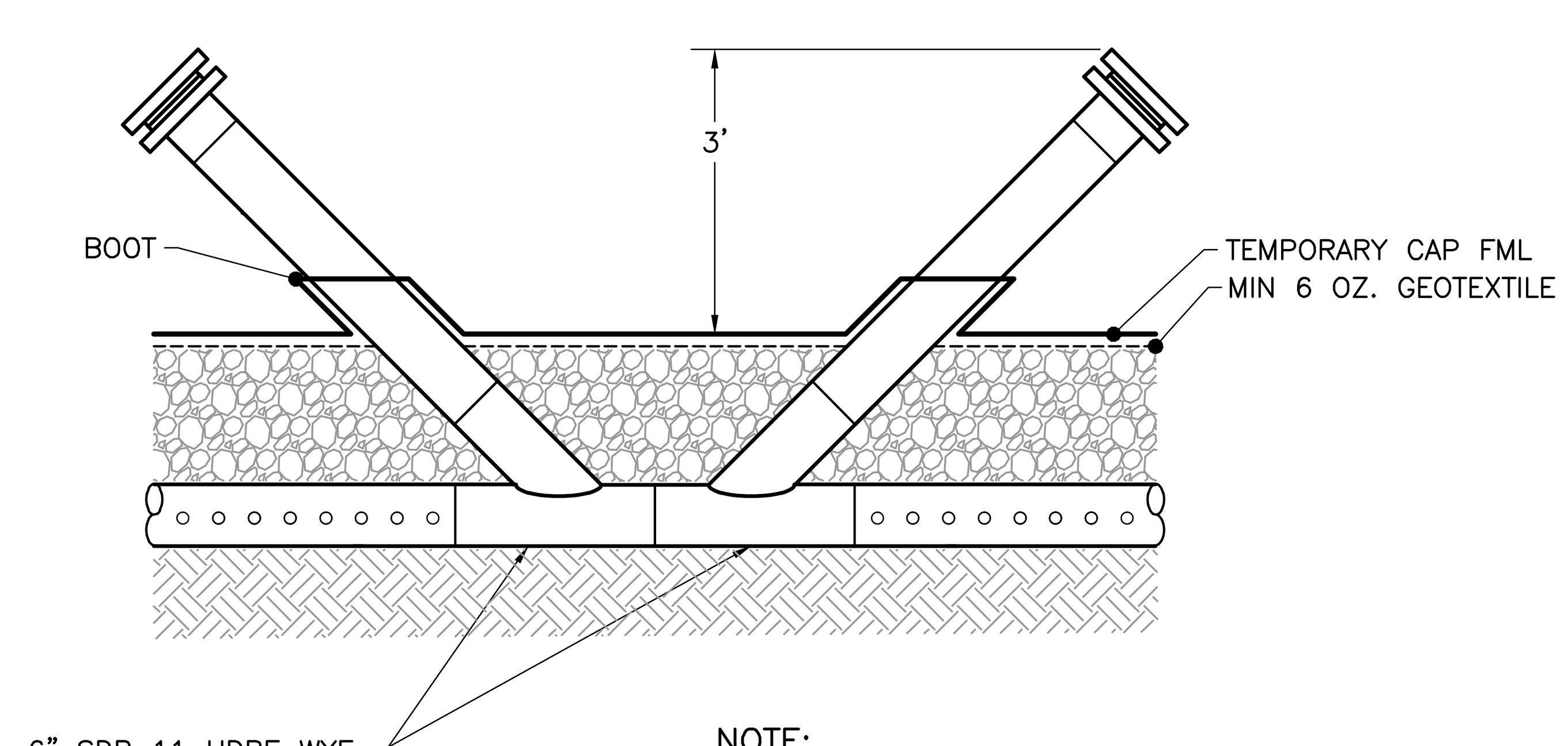
1. CUT GEOTEXTILE AND TIE–IN DOWNSLOPE COLLECTOR STRIP DRAIN INTO ADDED STONE.



NOTE: INSTALL AS NECESSARY TO DEFLECT CONCENTRATED STORMWATER AWAY FROM ROAD

DEFLECTOR PIPE PLAN

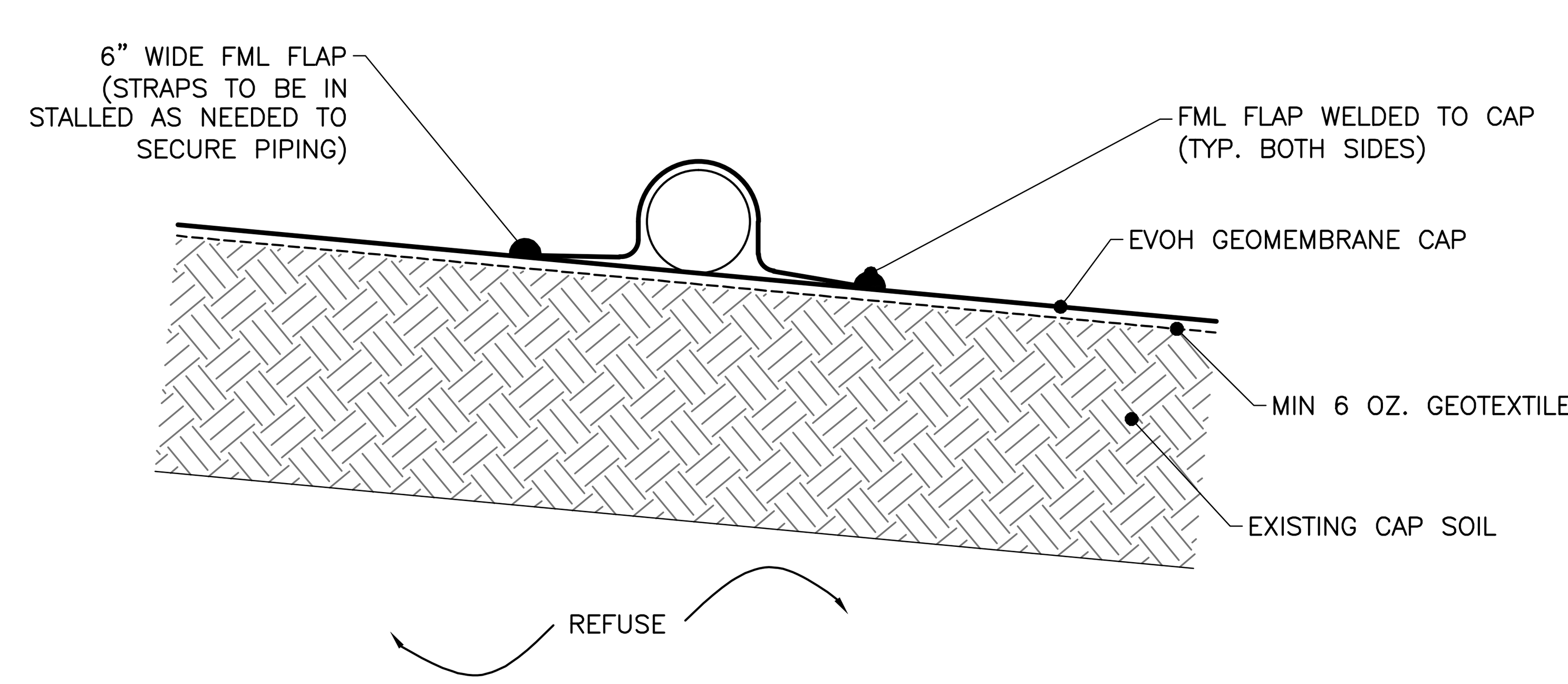
DETAIL 8/8
SCALE: NOT TO SCALE



NOTE:
INSTALL AT 500' INTERVAL OR MID–POINT BETWEEN SUMPS.

PERIMETER COLLECTOR TRENCH CLEANOUT RISERS

DETAIL 6/8
SCALE: NOT TO SCALE



ABOVE CAP DEFLECTOR PIPE

DETAIL 7/8
SCALE: NOT TO SCALE

STATE OF MISSOURI — ADAM STEVEN [illegible] — NUMBER E-20655 — REGISTERED PROFESSIONAL ENGINEER
9/30/16

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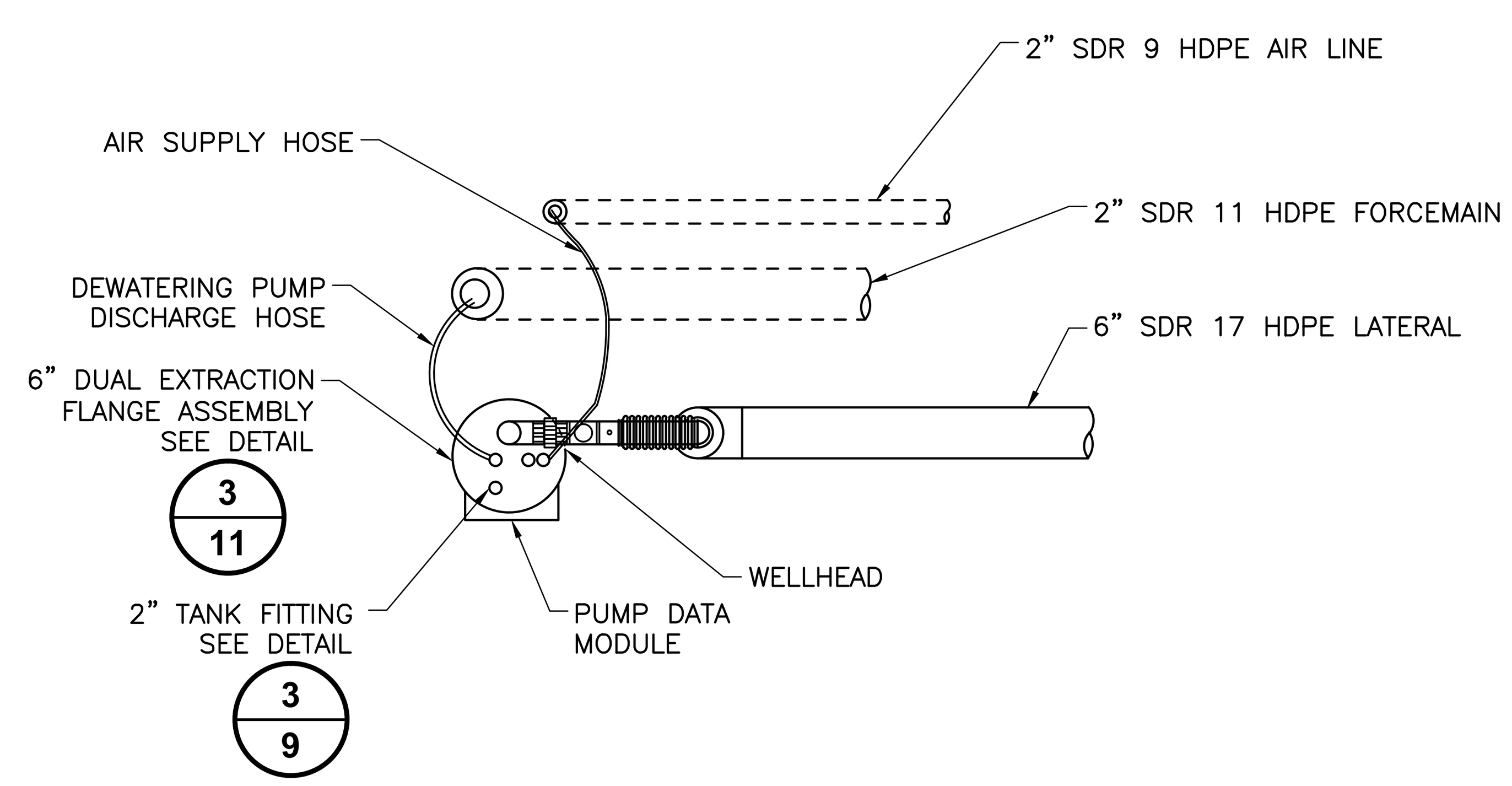
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

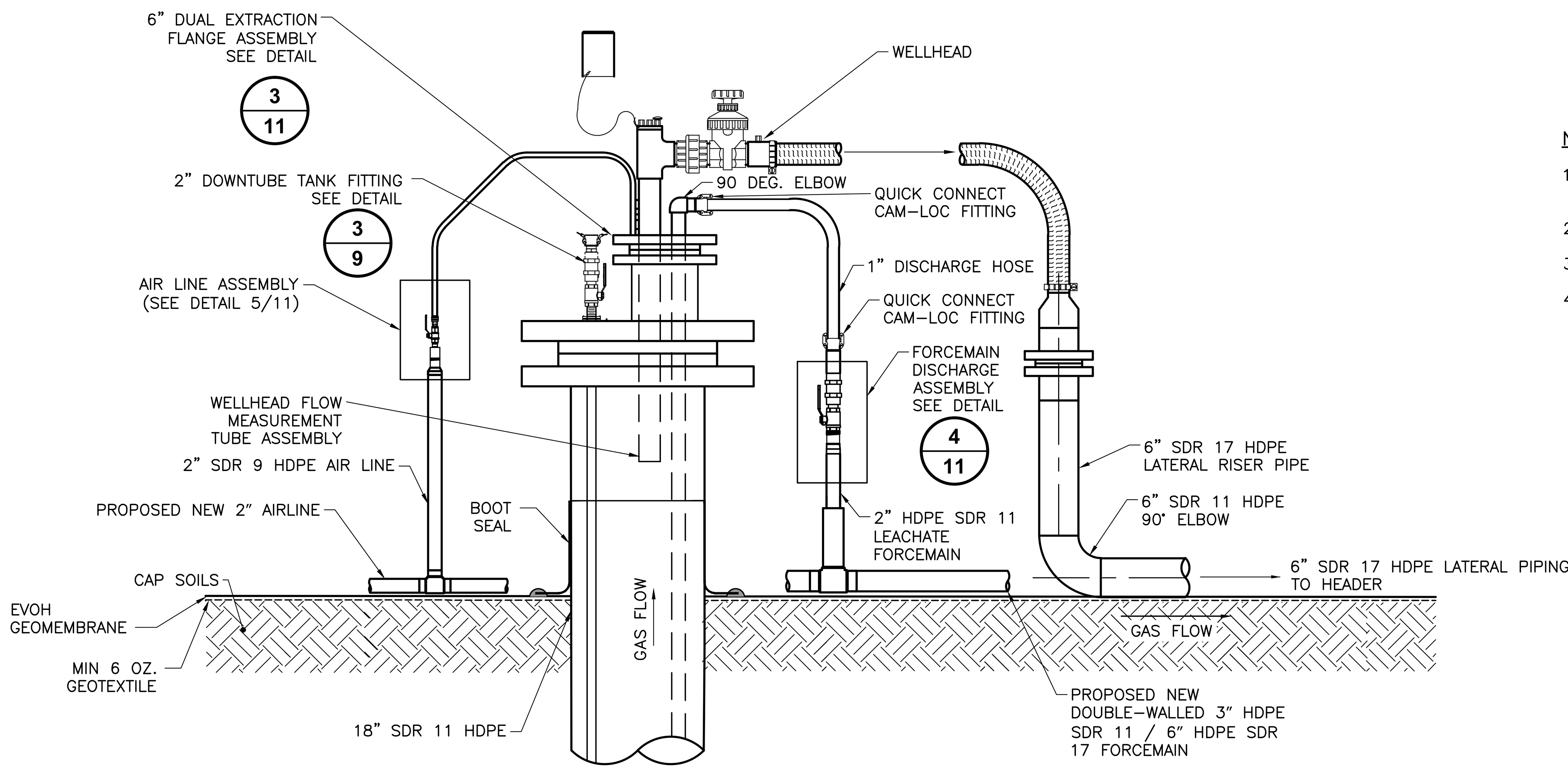
NORTH QUARRY - EVOH COVER DESIGN
DETAILS

SHEET NO. 8
PROJECT NO. 160512

File: W:\PROJECTS\BRIDGETON (MO)\160512 – NORTH QUARRY EVOH COVER DESIGN_Plan Set_RESPONSE TO COMMENTS SEPT 2016\FNBL 2016 NQ 06–12 DETS.dwg Layout: 08– DETAILS User: thierry.dechope Sep 29, 2016 – 4:44pm



TOP VIEW



PROFILE VIEW

PERIMETER COLLECTION SUMP WELLHEAD

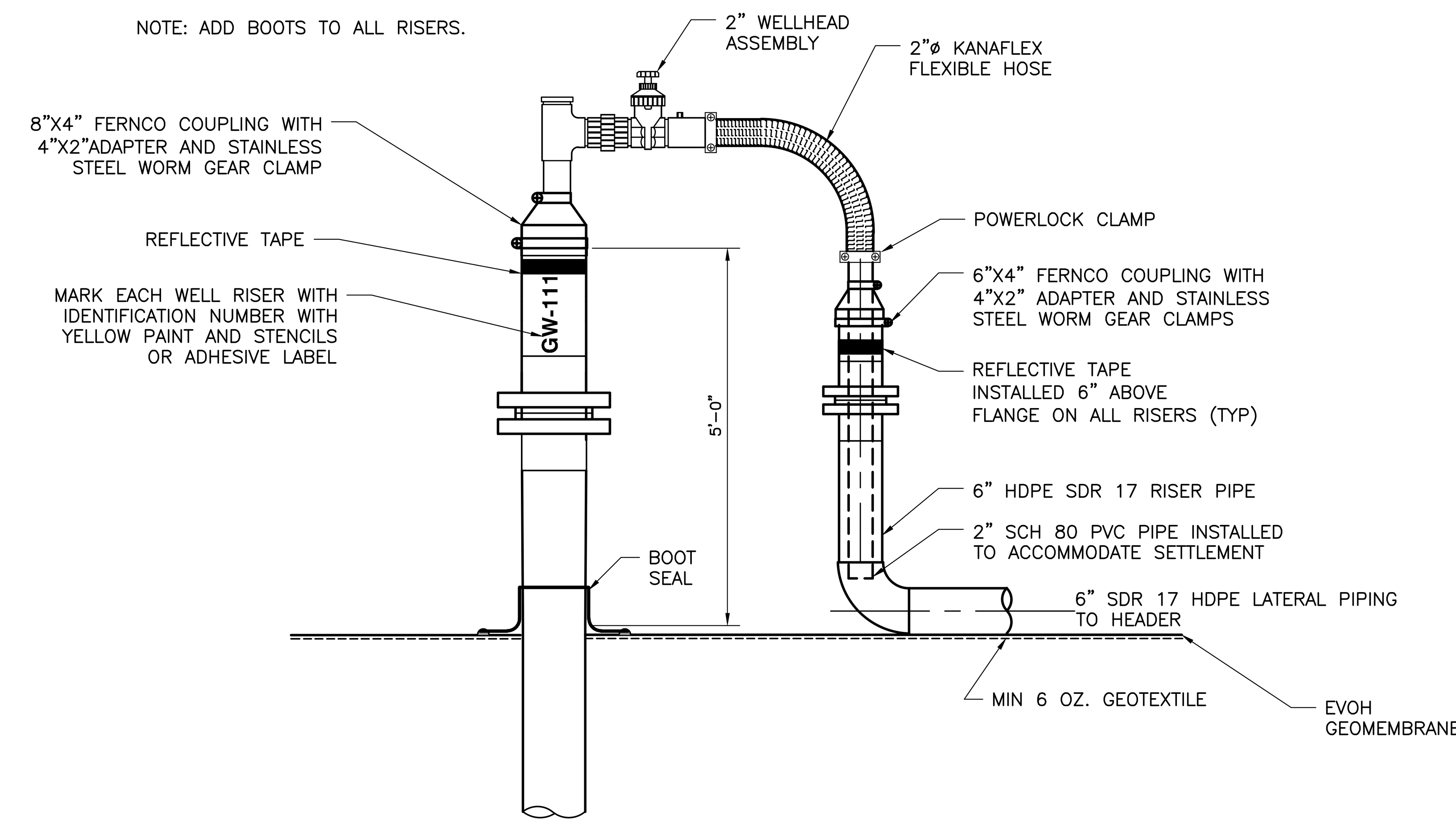
DETAIL 1 / 9

SCALE: NOT TO SCALE

NOTES:

1. CONTRACTOR TO UTILIZE OWNER-APPROVED WELLHEAD ASSEMBLY. CONTRACTOR TO OBTAIN OWNER PREFERENCE FOR WELLHEAD ASSEMBLY.
2. PROVIDE HIGH VISIBILITY TAPE OR PAINT AROUND TOP 1-FOOT OF WELL CASING AND LATERAL PIPE.
3. AIR AND FORCEMAIN RISERS TO BE INSTALLED TO WITHIN 2' FROM SUMP.
4. INSTALL CHECK VALVE ON LEACHATE FOREMAIN WHERE REQUIRED TO PREVENT BACKFLOW INTO SUMP.

NOTE: ADD BOOTS TO ALL RISERS.



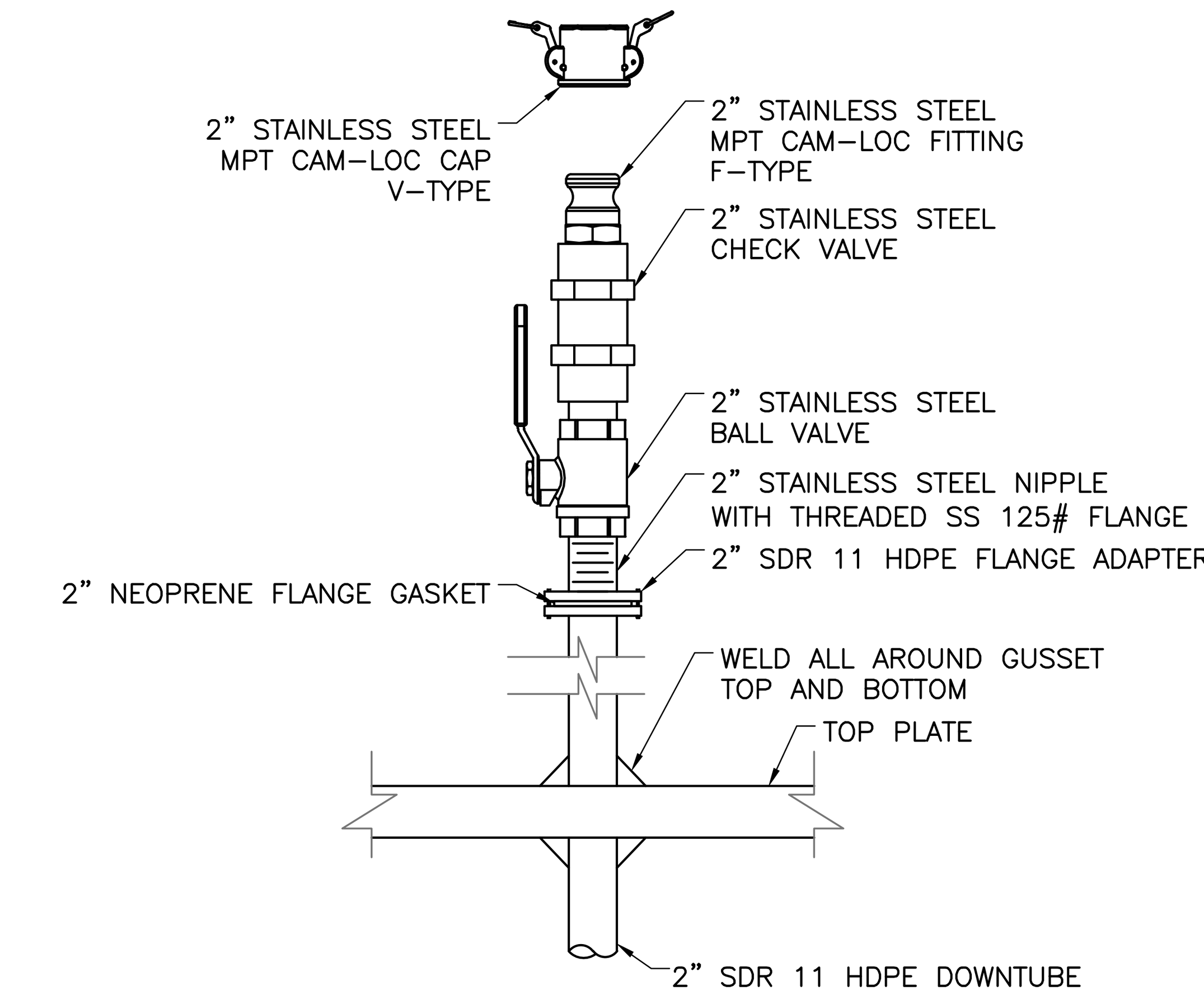
WELLHEAD

DETAIL 2 / 9

SCALE: NOT TO SCALE

NOTES:

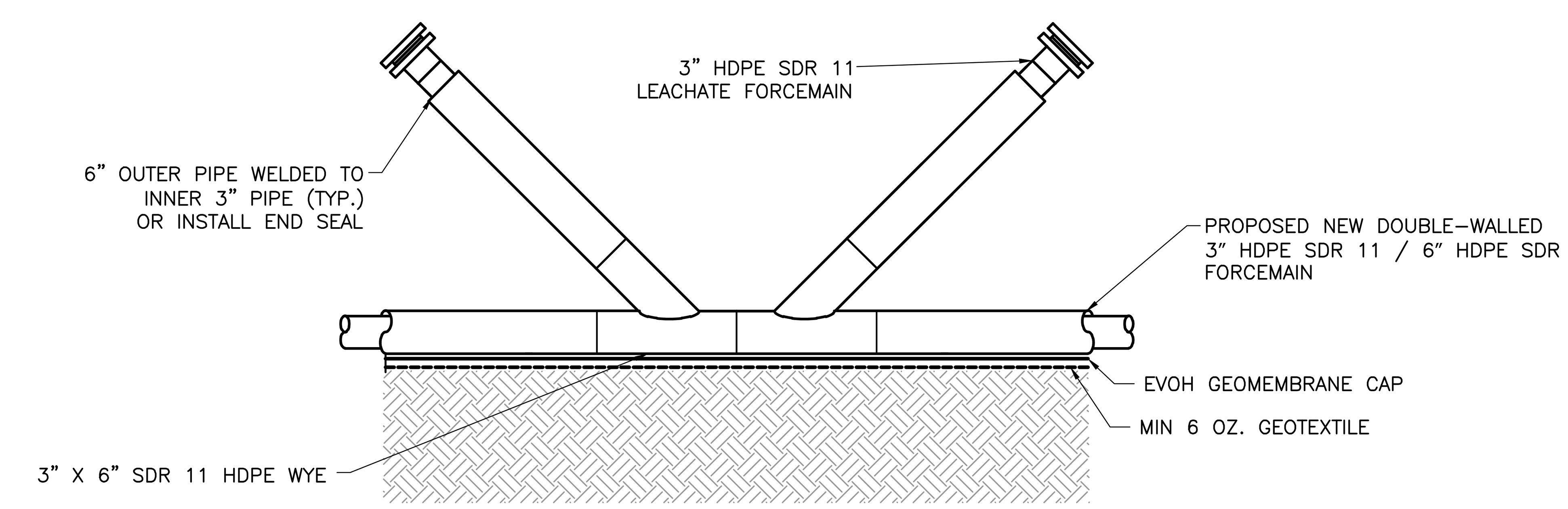
1. CONTRACTOR TO UTILIZE OWNER-APPROVED WELLHEAD ASSEMBLY. CONTRACTOR TO OBTAIN OWNER PREFERENCE FOR WELLHEAD ASSEMBLY.
2. PROVIDE HIGH VISIBILITY TAPE OR PAINT AROUND TOP 1-FOOT OF WELL CASING AND LATERAL PIPE.
3. CONTRACTOR TO INSURE DRAINAGE OF SURFACE WATER AWAY FROM THE WELLHEAD.
4. LATERAL PIPING MUST DRAIN TO THE MAIN HEADER, AWAY FROM THE WELLHEAD, AT A MINIMUM SLOPE OF 3%.



2" DOWNTUBE TANK FITTING

DETAIL 3 / 9

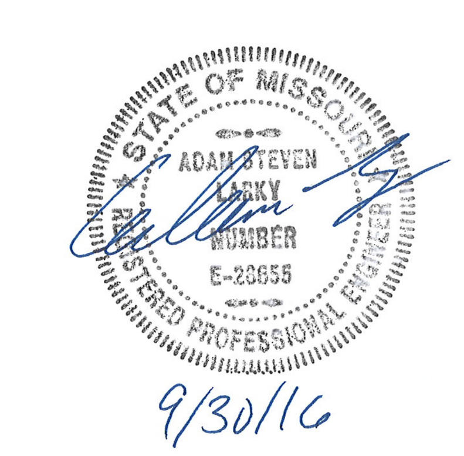
SCALE: NOT TO SCALE



FORCEMAIN CLEANOUT RISERS

DETAIL 4 / 9

SCALE: NOT TO SCALE



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BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
DETAILS

SHEET NO. 9

PROJECT NO. 160512

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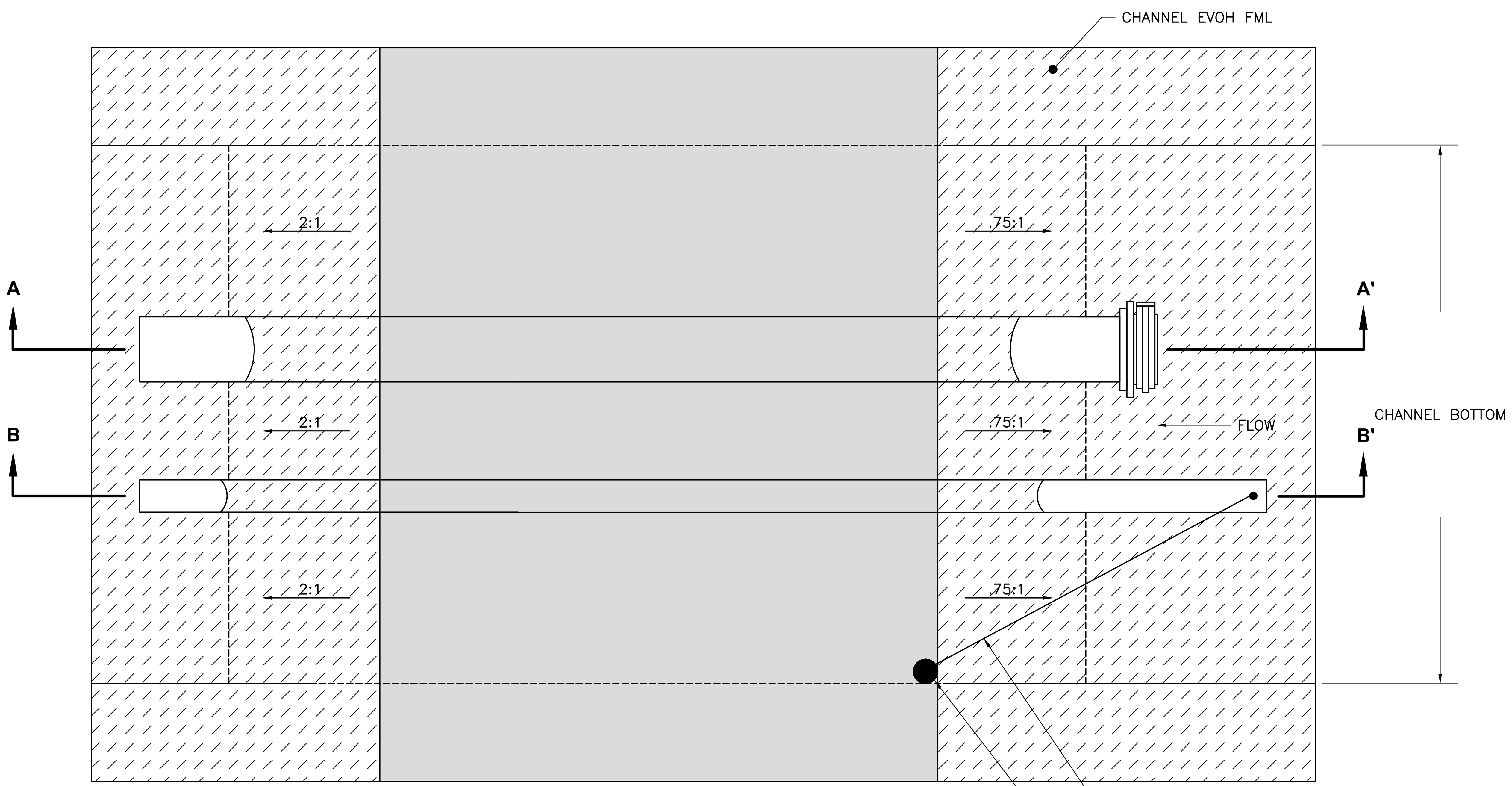
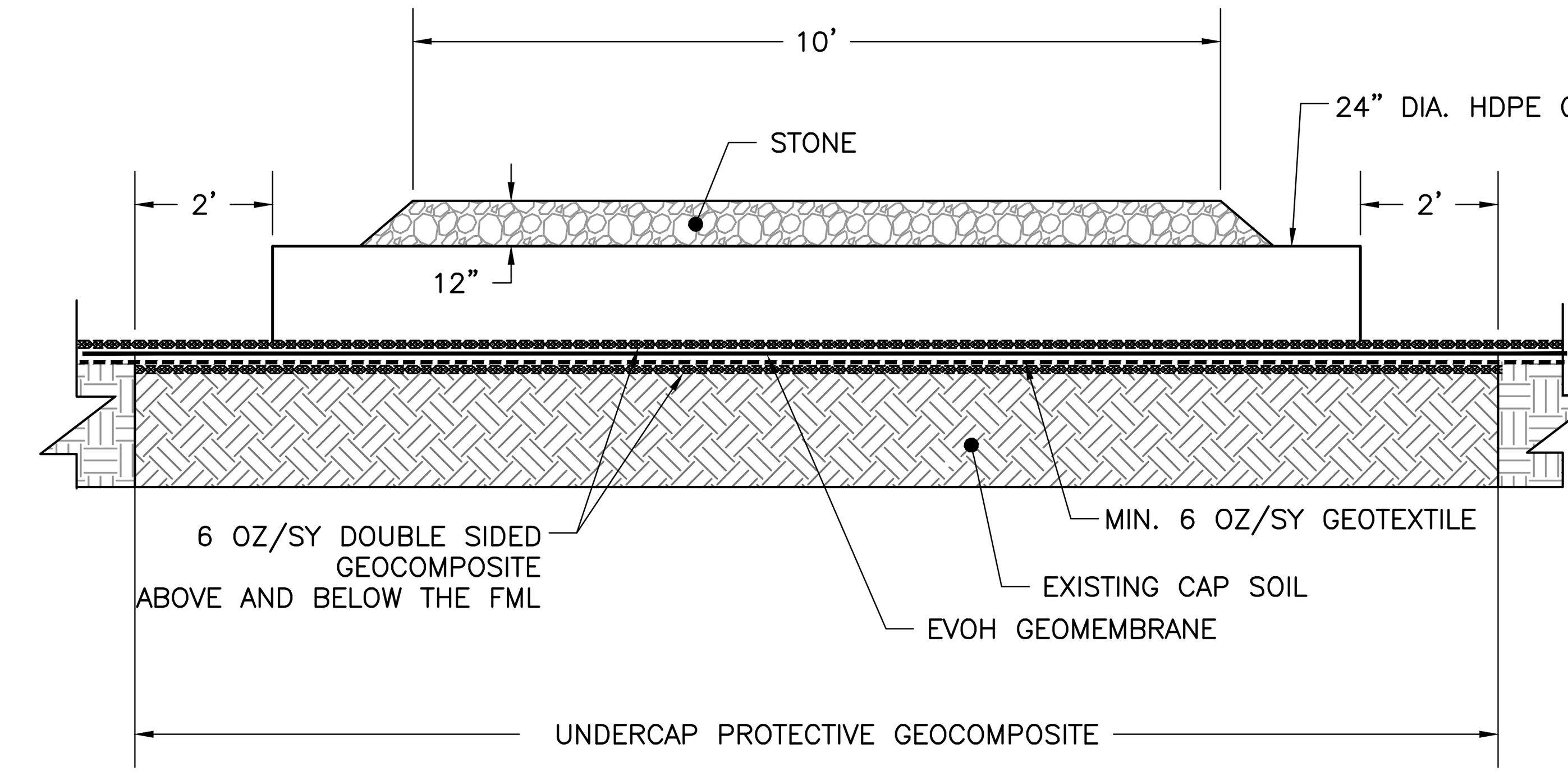


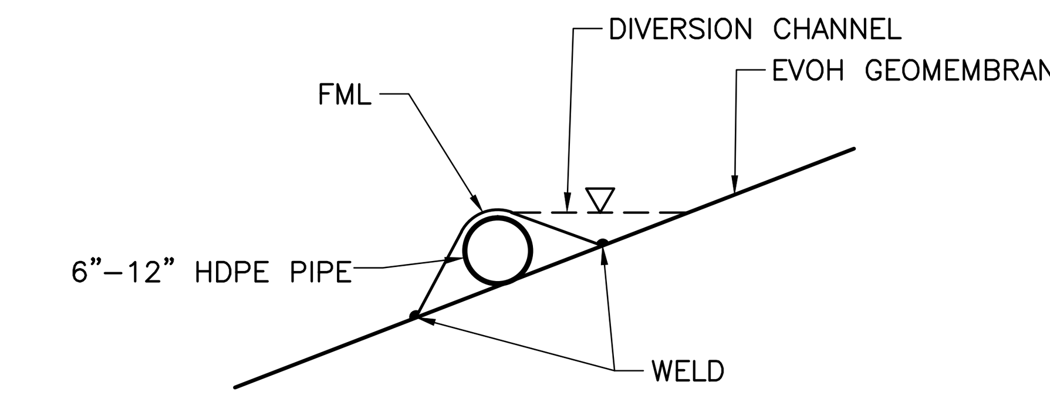
CULVERT C-11 CROSSING PLAN VIEW

DETAIL 1A/10
SCALE: NOT TO SCALE



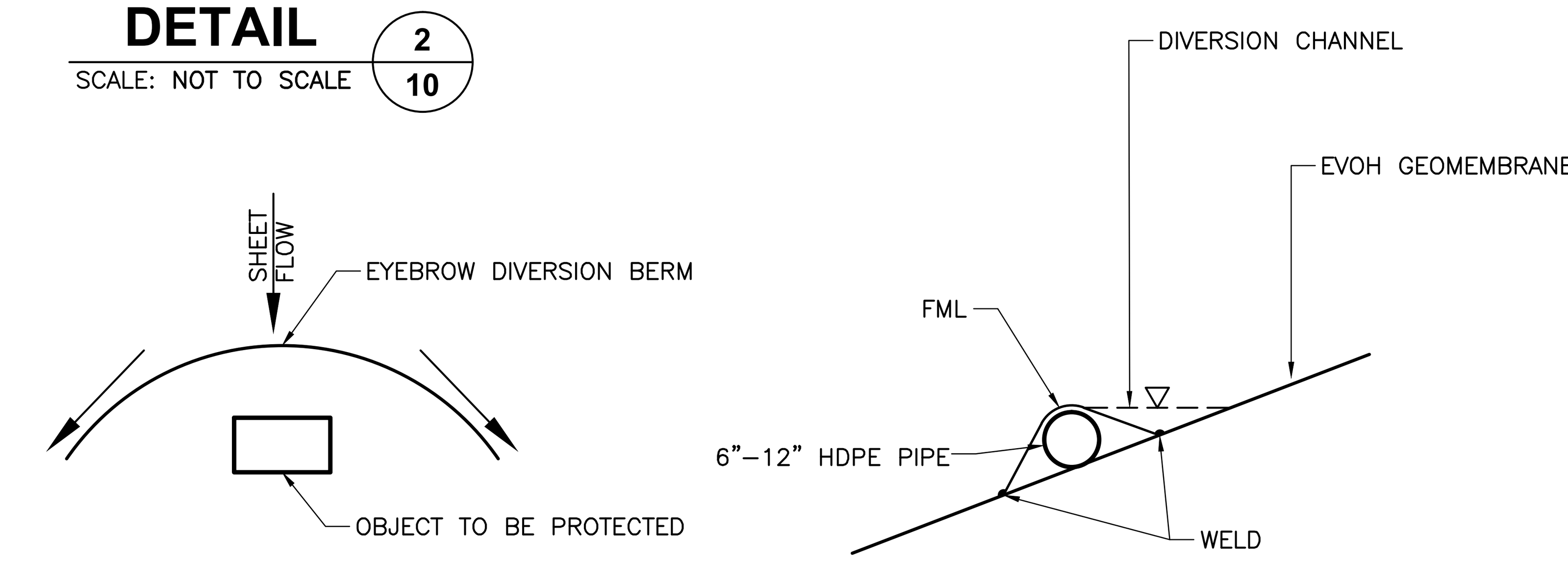
CULVERT C-12 CROSSING AT LIGHT-DUTY ACCESS ROAD

DETAIL 2/10
SCALE: NOT TO SCALE



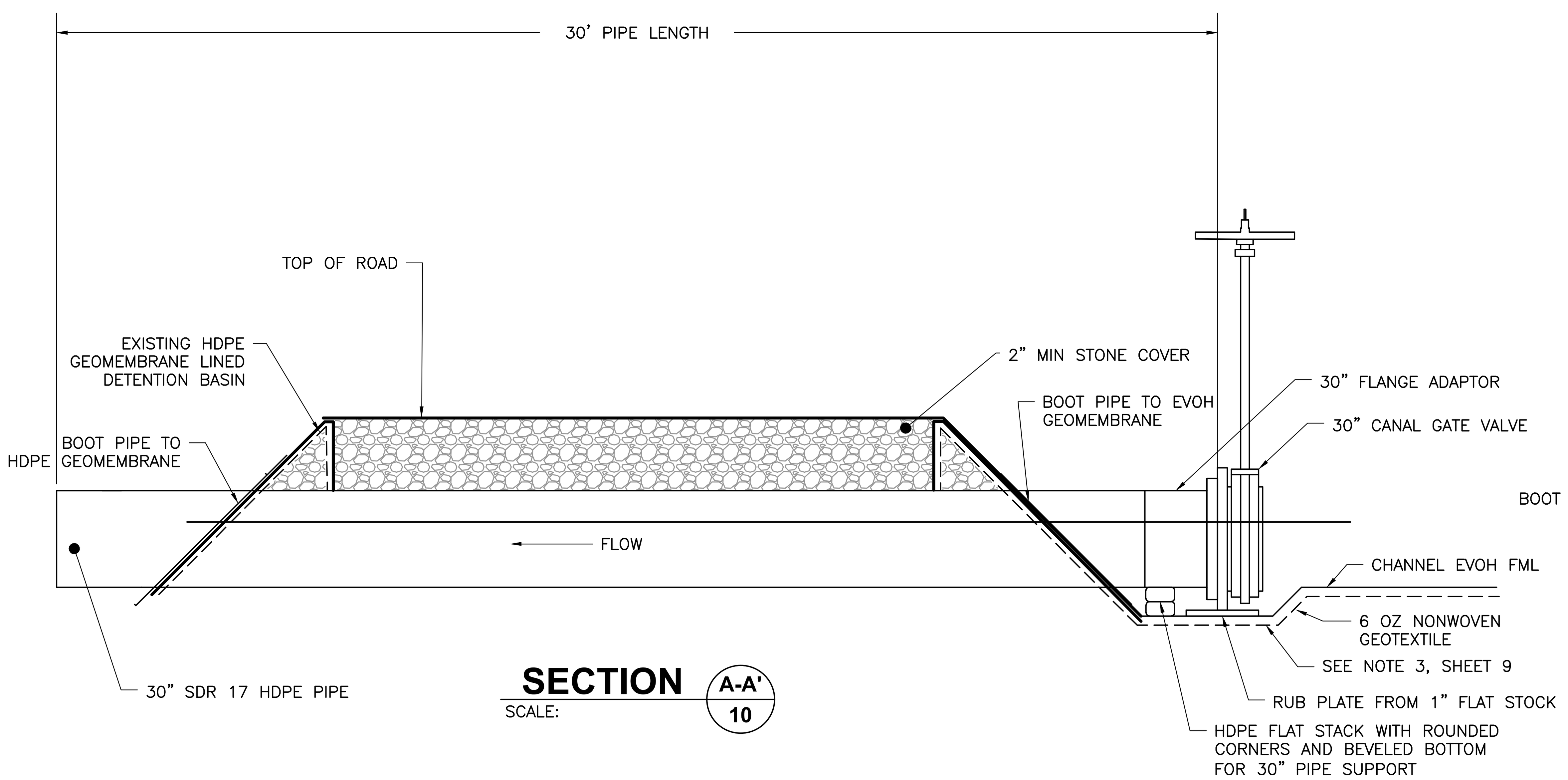
ENERGY DISSIPATER DIVERSION BERM

DETAIL 3/10
SCALE: NOT TO SCALE

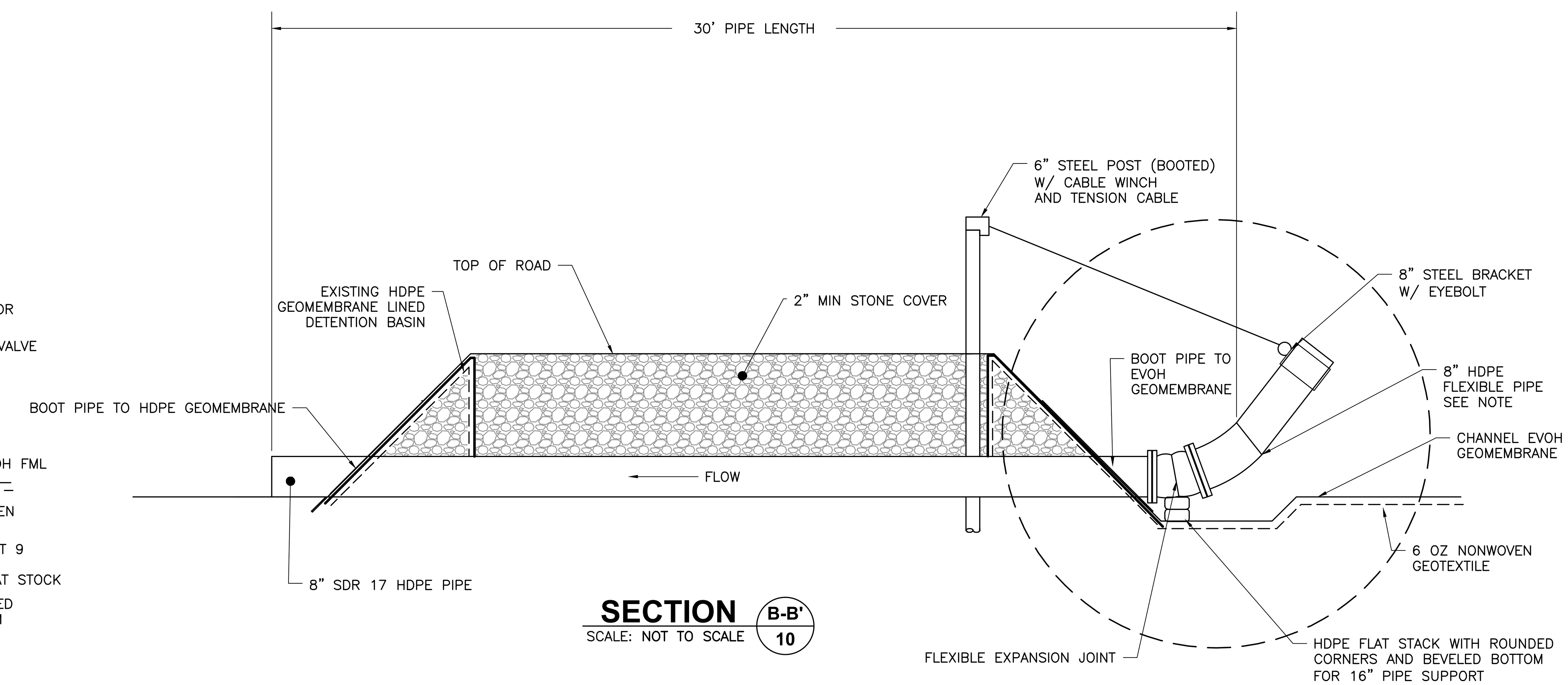


EYEBROW DIVERSION BERM

DETAIL 4/10
SCALE: NOT TO SCALE



SECTION A-A'/10
SCALE:



SECTION B-B'/10
SCALE: NOT TO SCALE

STATE OF MISSOURI — ADAM STEVEN LUCKY — NUMBER E-20555 — PROFESSIONAL ENGINEER
9/30/16

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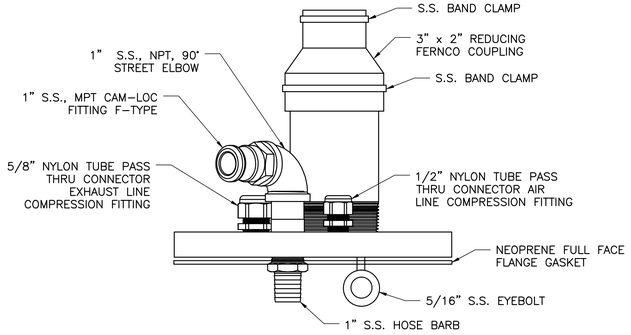
BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
DETAILS

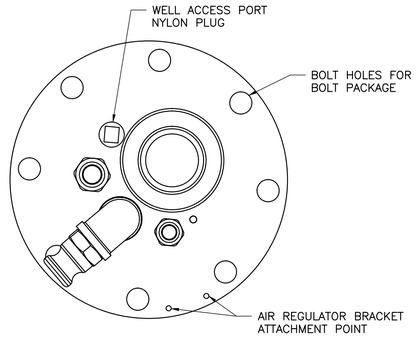
SHEET NO. **10**
PROJECT NO. 160512

File: W:\PROJECTS\BRIDGETON (MO)\160512 – NORTH QUARRY EVOH COVER DESIGN_Plan Set_RESPONSE TO COMMENTS SEPT 2016\FINAL 2016 NQ 06-12 DETS.dwg Layout: 10- DETAILS User: thierry.dechape Sep 29, 2016 – 5:09pm

1" 1/2" 0" 1"



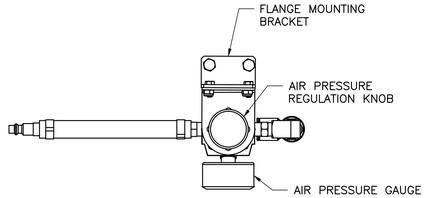
SIDE VIEW



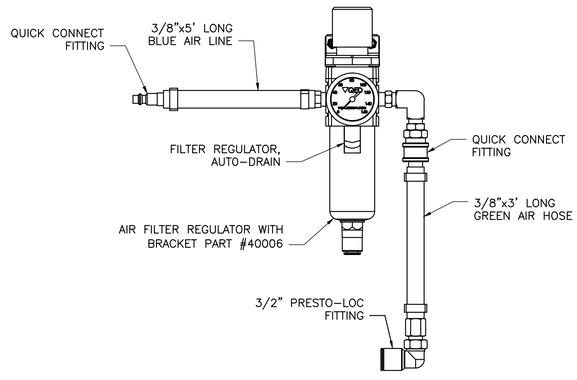
PLAN VIEW

DUAL EXTRACTION FLANGE COMPONENTS

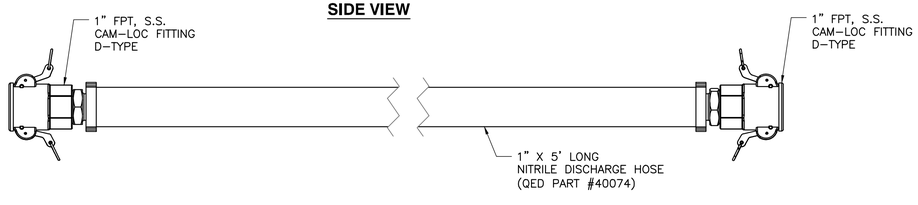
DETAIL 1/11
SCALE: NOT TO SCALE



PLAN VIEW

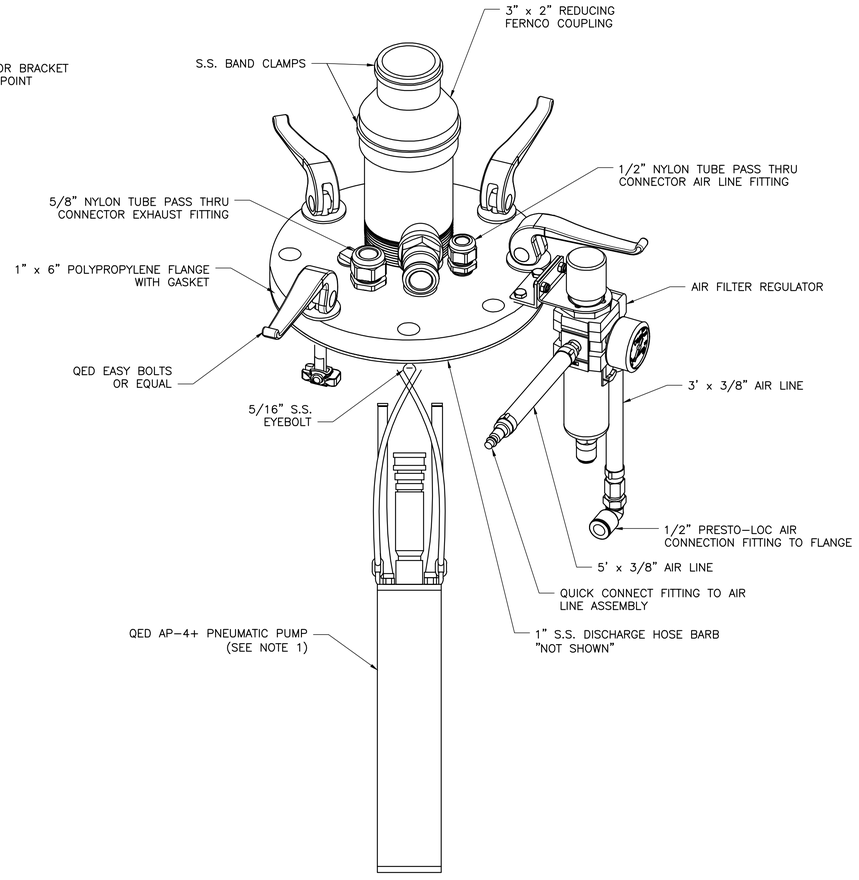


SIDE VIEW



DUAL EXTRACTION WELL AIR REGULATOR AND DISCHARGE LINE

DETAIL 2/11
SCALE: NOT TO SCALE

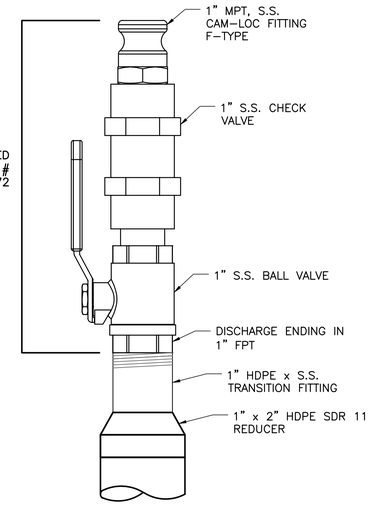


CONDENSATE EXTRACTION FLANGE ASSEMBLY (COLD CLIMATE PACKAGE)

DETAIL 3/11
SCALE: NOT TO SCALE

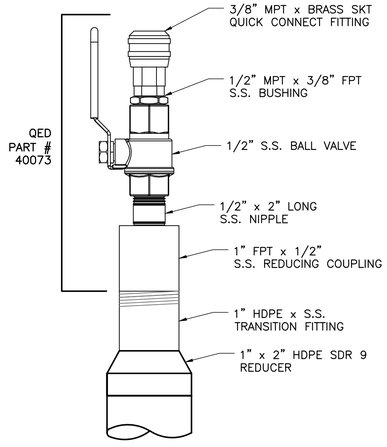
NOTES:

1. QED AP–4+ PNEUMATIC PUMP SHOWN FOR REFERENCE PURPOSES ONLY. PUMP IS NOT INCLUDED WITH FLANGE PACKAGE.
2. AIR LINE AND FORCE MAIN ASSEMBLIES TO BE CONFIGURED FOR COLD CLIMATES.
3. PUMP TO BE SET 1–FT OFF THE BOTTOM OF THE SUMP.
4. PUMP EXHAUST PORTS TO BE FITTED WITH THROTTLING NEEDLE VALVE.



PUMP DISCHARGE ASSEMBLY

DETAIL 4/11
SCALE: NOT TO SCALE



AIR SUPPLY LINE VALVE

DETAIL 5/11
SCALE: NOT TO SCALE

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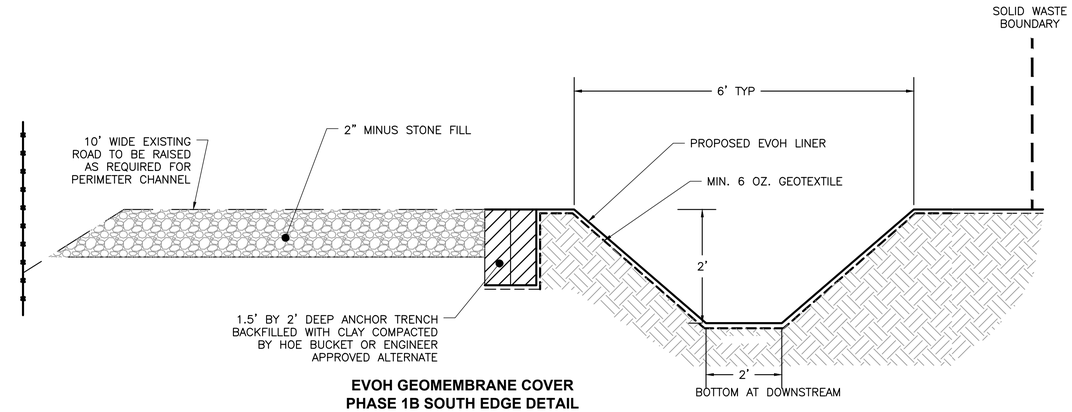
CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
DETAILS

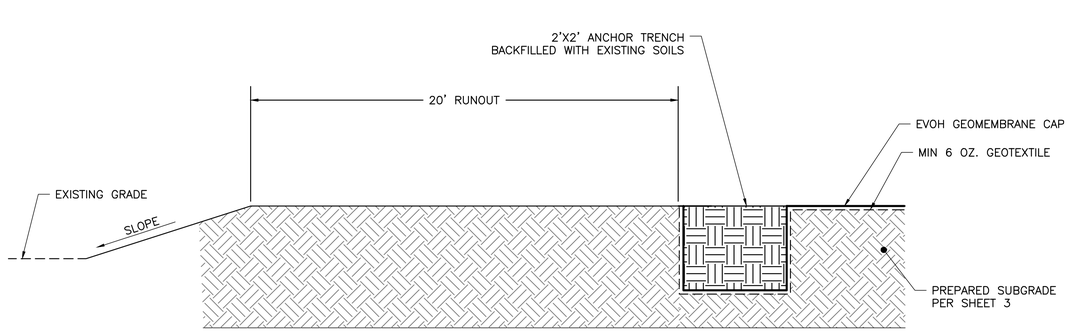
SHEET NO. 11
PROJECT NO. 160512

1" 1/2" 0" 1"



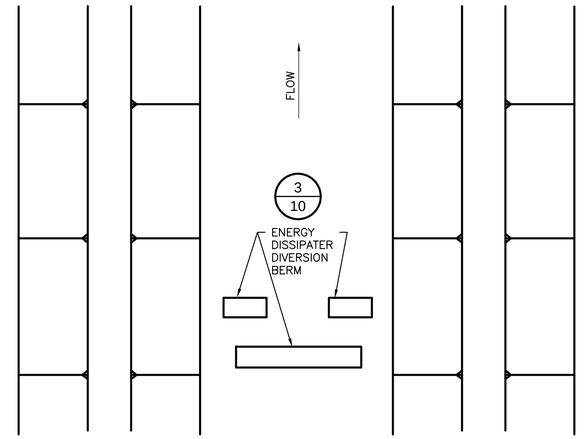
EVOH GEOMEMBRANE COVER
PHASE 1B SOUTH EDGE DETAIL

DETAIL 1/12
SCALE: NOT TO SCALE

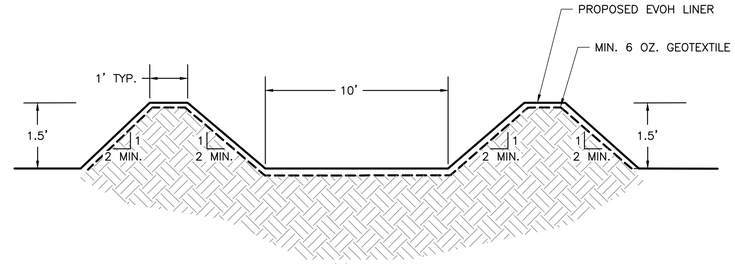


PHASE 1B NORTH QUARRY EVOH COVER TERMINATION

DETAIL 2/12
SCALE: NOT TO SCALE



PLAN



SECTION

PHASE 1B LINED DOWNCHUTE

DETAIL 3/12
SCALE: NOT TO SCALE

STATE OF MISSOURI
ADAM STEVEN LESKY
NUMBER E-23655
REGISTERED PROFESSIONAL ENGINEER
9/30/16

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 09/30/16
DRAWN BY MJB
DESIGNED BY JGW
CHECKED BY ASL
APPROVED BY ASL

cornerstone environmental

PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
DETAILS

SHEET NO. 12
PROJECT NO. 160512

1" 1/2" 0" 1"

File: W:\PROJECTS\BRIDGETON (MO)\160512 - NORTH QUARRY EVOH COVER DESIGN_Plan Set_RESPONSE TO COMMENTS SEPT 2016\APRIL 2016 NQ 06-12 DETS.dwg Layout: 12-DETAILS User: MHenry Saved: Sep 29, 2016 - 5:09pm

APPENDIX B

MANUFACTURER'S INFORMATION FOR EVOH GEOMEMBRANE

RAVEN
INDUSTRIES

TO: Republic Services

SUBJECT: Raven X60FC1 QA testing methods and frequency (rev. 3)

DATE: April 12, 2013

IN REFERENCE TO: Bridgeton Landfill project, Bridgeton, MO

Raven X60FC1 geomembrane and its components undergo an extensive array of testing and measurement during the manufacturing process. The required tests, methods, and sampling frequency are based on the requirements set forth in GRI GM 13 ('Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes')

The minimum test values for X60FC1 using these test methods are listed the table provided with this letter.

Clint Boerhave

Clint Boerhave
Quality Manager
Raven Industries - Engineered Films Division

RAVEN
INDUSTRIES

STATEMENT OF PERFORMANCE

SUBJECT: Raven X60FC1

IN REFERENCE TO: Seam testing minimum values and material separation in plane (SIP)
Republic Services Landfill cap project - Bridgeton, Missouri
SO# 195942-195948, 195950-195954

DATE: April 5, 2013

Absolute Barrier™ X60FC1 is a seven layer co-extruded textured geomembrane consisting of polyethylene with a core layer designed specifically as a barrier against radon, methane and VOCs on brownfield sites, residential and commercial buildings, and geomembrane containment and covering systems. A robust stabilization package provides long-term protection from thermal oxidation and ultraviolet degradation in exposed applications.

Due to the multilayer construction and the presence of a barrier core in this product, some separation in plane may occur during destructive seam testing. This is normal and should not be of concern as long as the tested peel and shear results meet the minimum values for this product:

Hot Wedge Seams	Minimum value
Shear Strength (lb/in)	80
Peel Strength (lb/in)	60
Extrusion Fillet Seams	
Shear Strength (lb/in)	80
Peel Strength (lb/in)	52

Clint Boerhave

Clint Boerhave
Quality Manager
Engineered Films Division

Test methods, minimum values, and test frequency for Raven X60FC1

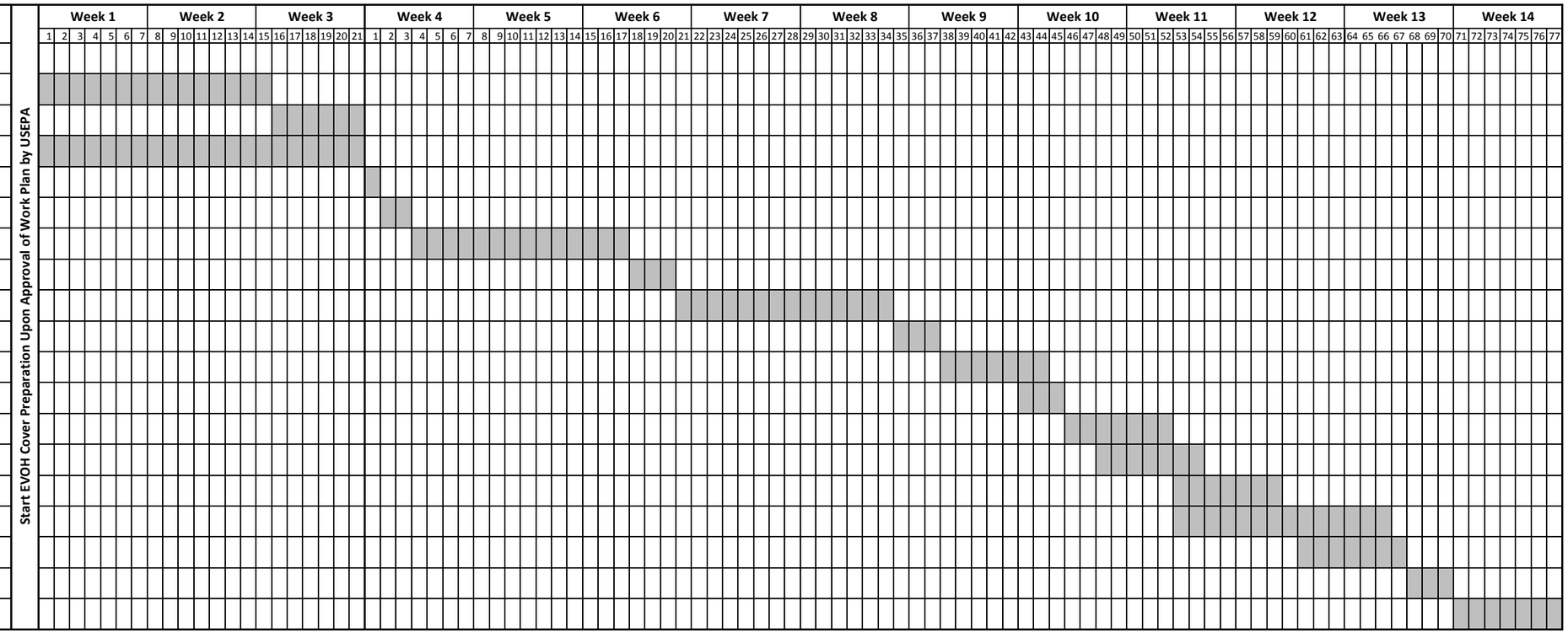
Properties	Test Method	Test Value	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	50 mils 45 mils 35 mils	per roll
Asperity Height mils (min. ave.)	GM 12	10 mils	per roll
Tensile Properties (3) (min. ave.) • break strength – lb/in. • MD break elongation - % (min. avg.) • TD break elongation - % (min. avg.)	6693 Type IV	 75 200 30	20,000 lb
Tear Resistance – lb (min. ave.)	D 1004	27	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	55	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 400	200,000 lb

APPENDIX C

STEPS AND TIMEFRAMES FOR THE INSTALLATION OF THE EVOH COVER

Bridgeton Landfill
Steps and Timframes for Installation of the Phase 1A EVOH Cover

Task #	Task	Time (days)
1	Approval of Work Plan by USEPA	To Be Determined
2	Select contractor	14
3	Select CQA	7
4	Procure materials	21
5	Preconstruction meeting	1
6	Stakeout construction features	2
7	Prepare GCCS components	14
8	Strip existing vegetation	3
9	Add soil fill for 5% minimum slope	14
10	Prepare subgrade	3
11	Install undercap components	7
12	Anchor trench	3
13	Geotextile cushion	7
14	Install EVOH geomembrane	7
15	Access roads / EVOH cover ballast	7
16	Install above cap gas and leachate piping	14
17	Stormwater structures	7
18	Conduct as-built survey	3
19	Prepare and submit certification report	7



Note: Estimated Times are Weather Dependent.

Bridgeton Landfill
Steps and Timframes for Installation of the Phase 1B EVOH Cover

Task #	Task	Time (days)
1	Spring 2017 (Weather Dependent)	Start
2	Select contractor	14
3	Select CQA	7
4	Procure materials	21
5	Preconstruction meeting	1
6	Stakeout construction features	2
7	Prepare GCCS components	14
8	Strip existing vegetation	3
9	Add soil fill for 5% minimum slope	14
10	Prepare subgrade	3
11	Install undercap components	7
12	Anchor trench	3
13	Geotextile cushion	7
14	Install EVOH geomembrane	7
15	Access roads / EVOH cover ballast	7
16	Install above cap gas and leachate piping	14
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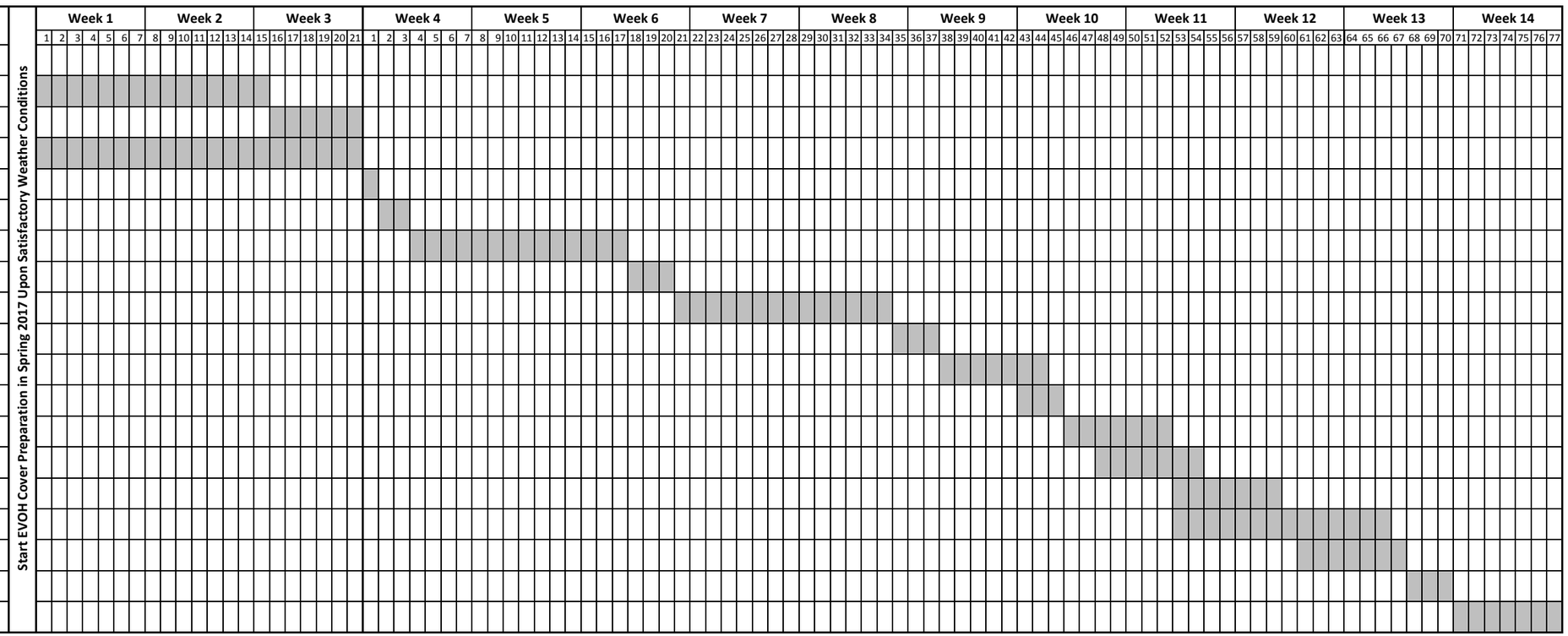

Note: Estimated Times are Weather Dependent.

Bridgeton Landfill
Steps and Timframes for Installation of the Phases 2 and 3 EVOH Cover

Steps and Timeframes for Installation of the Phase 2 EVOH Cover are dependent upon EPA's decision regarding a potential thermal isolation barrier and will be determined in the future upon issuance of that decision

Steps and Timeframes for Installation of the Phase 3 EVOH Cover are dependent upon EPA's decision regarding a potential thermal isolation barrier and remedial actions for Operable Unit-1 and will be determined in the future upon those decisions by EPA

APPENDIX D

TEMPORARY CAP AND CAP INTEGRITY SYSTEM CONSTRUCTION QUALITY ASSURANCE PLAN STEPS

WEAVER
BOOS
CONSULTANTS

Project No.: 0120-131-17-02
May 7, 2013

Mr. Craig Almanza
Area Environmental Manager
Republic Services, Inc.
12978 St. Charles Rock Road
Bridgeton, MO 63044

Re: Response to Comments
Temporary Cap & Cap Integrity System CQA Plan
Bridgeton Landfill

Dear Mr. Almanza:

The following are responses to MDNR and the St. Louis County Health Department comments regarding the Temporary Cap and Cap Integrity System CQA Plan for the Bridgeton Landfill. The MDNR and the St. Louis County Health Department comments were received via email on May 1, 2013.

Comment 1: Section 3.1.1 Manufacturing, please verify if there will be specific manufacturing testing and requirements for the EVOH material/resin itself in addition to the product as a whole.

As part of the manufacturing process, the EVOH material source resin is tested to verify and document conformance with the material specifications. The CQA Manager shall be provided with this testing data to verify conformance with the CQA Plan. Section 3.1.1 of the CQA Plan has been revised accordingly.

Comment 2: Section 3.1.5 Surface Preparation, due to the proposed design of the cap, standard surface preparation and approval as specified may not be plausible. If necessary, please include more site specific preparation plans for your CQA Monitor.

The subgrade for the temporary cap area shall be "tracked-in" and "back-dragged" with a bulldozer to provide a smooth surface. Prior to installation of FML, a cushion geotextile will be installed on the subgrade surface. Section 3.1.5 of the CQA plan has been revised accordingly.

WEAVER
BOOS
CONSULTANTS

Project No.: 0120-131-17-02
May 7, 2013

Mr. Craig Almanza
Area Environmental Manager
Republic Services, Inc.
12978 St. Charles Rock Road
Bridgeton, MO 63044

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Temporary Cap & Cap Integrity System CQA Plan
Bridgeton Landfill

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Comment 3: Section 3.1.8.3 Overlapping, please specify the minimum panel overlap for the flexible membrane liner (FML).

The FML panels shall have a minimum overlap of 4 to 6 inches for fusion welding. For extrusion welding, the FML shall overlap a minimum of 6 inches on each side. Section 3.1.8.3 of the CQA plan has been revised accordingly.

Comment 4: Section 3.1.8.7 Test Seams, states "Test seams will be made at the beginning of each seaming period and a minimum of once every five hours of continuous welding for each seaming apparatus used that day." Please specify if the test seams will be each seaming apparatus/operator combination.

Section 3.1.8.7 of the CQA plan has been revised to specify that tests seams are required for each seaming apparatus/operator combination.

Comment 5: Section 3.4.6 Perimeter Collection Sumps/Rock Chimneys, please remove rock chimneys from the section title.

Rock Chimneys have been removed from section title. Section 3.4.6 of the CQA Plan has been revised accordingly.

Comment 6: The literature provided in Appendix A states the testing requirements and specifications for the selected FML material is a 50 mil textured LLDPE. Previous submittals and correspondences have indicated that the outer layers of the FML will consist of 60 mil textured HDPE. Please explicitly state what the FML cap material will be made of and submit the accompanying testing information accordingly. This information must be consistent with each submittal.

During the preliminary material selection discussions for the geomembrane to be utilized on this project, an EVOH geomembrane with a "nominal" thickness of 60 mil was discussed. The final product chosen for this project consists of a geomembrane with an EVOH core layer for vapor control and outer layers of HDPE for UV protection in an exposed application. This geomembrane will have a minimum average thickness of 50 mil which includes the EVOH layer and the

other layers of HDPE. There was an incorrect identification in the Raven Industries correspondence for this material in the previous submission. Appendix A contains the revised letter along with the testing requirements for the EVOH with HDPE outer layers (X60FC1).

We trust that the information provided in this response is sufficient for your needs. For your convenience, an updated copy of the proposed CQA plan has been attached.

Sincerely,

Weaver Boos Consultants

Mark A. Moyer
Senior Project Manager

Ali Hashimi, P.E.
Certifying Engineer

Encl: Temporary Cap and Cap Integrity System CQA Plan, Revision No. 1

TEMPORARY CAP AND CAP INTEGRITY SYSTEM CONSTRUCTION QUALITY ASSURANCE PLAN

BRIDGETON LANDFILL
Bridgeton, Missouri

APRIL 2013
REVISION 1: MAY 7, 2013

Revised 9-30-16 Section 3.4.1 on page 24 per 9-02-16 EPA comment

Prepared For:
Bridgeton Landfill, LLC
12978 St. Charles Rock Road
Bridgeton, Missouri 63044

TEMPORARY CAP AND CAP INTEGRITY SYSTEM
CQA PLAN
BRIDGETON REGIONAL LANDFILL

TABLE OF CONTENTS

400 ANN ST. NW, SUITE 201A
GRAND RAPIDS, MICHIGAN 49504
PHONE: (616)458-8052

400 ANN ST. NW, SUITE 201A
GRAND RAPIDS, MICHIGAN 49504
PHONE: (616)458-8052

1.0 INTRODUCTION

The Missouri Department of Natural Resources Solid Waste Management Program (MDNR-SWMP) requires construction quality assurance (CQA) and construction quality control (CQC) on landfill components to document quality landfill construction. CQA is typically performed by a third-party independent to the owner and contractor to document the quality of construction on key landfill components. CQC procedures are typically performed by the contractor and/or owner throughout construction to document that landfill components are constructed in accordance with applicable construction standards and specifications. The technical guidance document entitled Quality Assurance and Quality Control for Waste Containment Facilities (EPN600/R-93/182) produced by the U.S. Environmental Protection Agency specifically defines the roles that CQA and CQC play during landfill construction:

- CQA: A planned system of activities that provides the owner and permitting agency assurance that the facility was constructed as specified in the design. CQA includes inspections, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility. CQA refers to the measures taken by the CQA organization to assess if the contractor or installer is in compliance with the plans and specifications for a project.
- CQC: A planned system of inspections that is used to directly monitor and control the quality of a construction project. CQC is normally performed by the contractor and is necessary to achieve quality in the constructed system. CQC refers to measures taken by the contractor or installer to determine compliance with the requirements for material and workmanship as stated in the plans and specifications for the project.

This CQA Plan is specific to the CQA activities to be completed by an independent third- party, and addresses the temporary cover integrity system to be constructed for the Bridgeton Landfill in Bridgeton, Missouri. The facility is owned and operated by Bridgeton Landfill, LLC. This CQA Plan has been prepared in general conformance with the Missouri Solid Waste Management Rules.

A copy of this CQA Plan is to be maintained at the Bridgeton Landfill for use during landfill temporary cover construction. Any revisions to the design or the approved CQA Plan shall require a permit modification to be reviewed by the MDNR-SWMP and St. Louis County Department of Health (DOH). The MDNR-SWMP and St. Louis County DOH must be kept

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informed throughout landfill construction projects. The MDNR-SWMP and St. Louis County DOH will review all records and results from the implementation of the CQA Plan.

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PHONE: (616)458-8052

2.0 GENERAL CONDITIONS

2.1 Responsibility and Authority

Bridgeton Landfill, LLC will be responsible for the implementation of this CQA Plan. The following is a list of responsible personnel:

Owner's Representative

A representative of Bridgeton Landfill, LLC shall be responsible for coordination between the landfill owner, Bridgeton Landfill, LLC, the construction crew, and the third-party CQA Engineer. With the MDNR-SWMP's prior approval, the owner/operator shall delegate authority, and correspondingly, shall be responsible to see that the CQA Plan is followed.

CQA Engineer

A professional engineer licensed to practice in Missouri shall be retained by Bridgeton Landfill, LLC to perform on-site construction oversight and quality assurance testing, and to prepare a final report demonstrating that the requirements of this CQA Plan are met. In addition, the CQA Engineer or his designee shall coordinate with the contractor(s) and/or installer(s) and their CQC personnel for the purposes of sharing CQA and CQC information. Should it become apparent to the CQA Engineer or his designee that construction quality is substandard, the CQA Engineer shall inform the Owner's Representative of the apparent deficiencies such that adjustments can be made. The CQA Engineer must be employed by an organization that operates independently of the landfill contract operator, construction contractor, Bridgeton Landfill, LLC, and the permit holder. The CQA Engineer will be responsible for certifying that construction was completed in general accordance with the permit requirements and the construction engineering design plans and specifications.

CQA Inspector

If the CQA Engineer cannot serve to provide on-site inspection of the temporary cover construction activities and reporting, the CQA Engineer shall designate a CQA Inspector to perform those duties. The CQA Inspector shall be an individual that represents the CQA Engineer and provides on-site construction oversight, quality assurance testing, and general observance and documentation of construction. The CQA Inspector will document on-site construction activities on a Daily Field Activities Report. An example of this report form is included in Appendix A.

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PHONE: (616)458-8052

2.2 Inspection and Testing

This CQA Plan describes the inspection and testing requirements for the construction of the landfill temporary cover system. Section 3.0 outlines the minimum requirements and guidelines to be followed to execute the CQA Plan.

2.3 Project Meetings

Throughout the construction activities, communication will play a major role in completing a successful construction project and achieving the requirements of the approved plans and specifications and permit documents. At a minimum, the following communications guidelines will be met:

Pre-Construction Meeting: A meeting involving Bridgeton Landfill, LLC and the Owner's Representative, CQA personnel including the CQA Engineer and CQA Inspector, and the contractor(s) shall take place prior to the start of construction. This meeting should include discussion of the following:

- Each party's responsibilities;
- Lines or means of communication;
- Procedures for changes or problems;
- CQA procedures and requirements;
- Level of the MDNR-SWMP's involvement; and
- Other issues as they pertain to the construction project.

Daily Progress Meetings: Regularly scheduled, daily meetings between CQA personnel and the contractor(s) shall take place to review and discuss such topics as previous work, future work, construction problems, schedule revisions, and other issues that require attention on a frequent basis.

- Other Meetings: Unscheduled meetings shall take place as required to address issues such as construction progress and changed conditions as circumstances dictate.

Under all circumstances, the MDNR-SWMP and St. Louis County DOH will be given seven (7) days advance notification prior to the initiation of landfill temporary cover system construction.

3.0 CONSTRUCTION QUALITY ASSURANCE PROCEDURES

3.1 Temporary Cover Flexible Membrane Liners (FML)

3.1.1 Manufacturing

The Manufacturer will provide the CQA Manager with the following information for the FML to be used at the Bridgeton Landfill:

- Written certification accompanying all material shipments stating that their product meets manufacturing specifications and passes QA/QC requirements as identified by the manufacturer. The Manufacturer shall also provide Quality Control documentation and results of testing that the resin supplied for the production of this material specified in this section shall meet or exceed the requirements of the specifications and CQA Plan.
- A copy of the quality control certificates issued by the Resin Supplier;
- Summary reports of the test results, including the test frequency used by the manufacturer to verify the quality of each resin batch used to manufacture FML rolls assigned to the project. At a minimum, one series of tests will be conducted for each resin batch.

Based on the data supplied by the Manufacturer, the CQA Manager will notify the Owner of any deviation from the project specifications or CQA Plan.

3.1.2 FML Rolls

The Manufacturer will provide the Owner or CQA Manager with a written certification accompanying all material shipments stating that their product meets manufacturing specifications and passes QA/QC requirements as identified by the manufacturer for the geomembrane produced, and that the geomembrane supplied under this plan will meet the requirements shown in Appendix A.

The Manufacturer will provide the Owner or CQA Manager with a quality control certificate for all the FML rolls shipped to the site. The quality control certificate should be signed by a responsible party employed by the Manufacturer. The quality control certificate shall include:

- Roll number, identification, and;
- Sampling procedures and testing frequency of quality control tests as well as test results shall be in accordance with the requirements of Appendix A.

The CQA Manager will:

- Obtain conformance test samples, at the place of manufacture or as the rolls are delivered to the site, if required by Owner,
- Review the quality control certificates, test methods used, and the measured roll properties for conformance to the specifications; and,
- Verify that the quality control certificates have been provided for all rolls.

3.1.3 Acceptance Criteria

Acceptable criteria for tests to be performed on geomembrane rolls are shown in Appendix A and only the Owner or the CQA Manager can authorize retesting of geomembrane rolls because of failure to meet any of the requirements.

For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance. The following procedure will be used for interpreting results:

- If the value meets the stated specification, then the roll and the lot will be accepted for use in the liners for the job site.
- If the result does not meet the specification, then the roll and the lot may be retested on samples either from the original roll sample or from another sample collected by the CQA Consultant and forwarded to the Manufacturer. Two additional tests must be performed for the failed test procedure. If both of the retests are acceptable, then the roll and lot will be considered acceptable. If either of the two additional tests fail, then both the roll and lot are unsuitable and shall be rejected.

The Manufacturer may request that another round of tests be performed on samples collected by the CQA Consultant and tested by the Manufacturer. Under this procedure, the average value used for the purpose of determining acceptance will be based on the average value of all specimens tested, including those from the failed round.

3.1.4 Transportation, Handling, and Storage

Transportation of the FML is the responsibility of the Manufacturer, the Installer, or other party as decided by the Owner. All handling on-site after unloading is the responsibility of the Installer. The CQA Monitor will monitor and document the following with regard to the geomembrane:

- Each FML roll is labeled with an identification number and a batch (lot) number;
- FML delivered to the site is free from defects and/or damage.
    - The FML must have no striations, roughness (except for where the textured geomembrane is specified), or bubbles on the surface.
    - The FML must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.
- The adequacy of on-site handling of equipment to minimize risk of damage to both the FML and underlying geosynthetic or subgrade materials; and,
- The careful handling of the FML by the Installer's personnel.

The CQA Monitor will indicate/report to the Owner any FML or portions thereof, which in the opinion of the CQA Monitor should be rejected and removed from the site because of visually obvious flaws; or rolls that include flaws, which may be repairable.

Selected samples of the FML material may be obtained by the CQA Manager for physical testing to document that the FML material tested satisfies the minimum material property requirements established in Section 5.1.3.

3.1.5 Surface Preparation

The Owner or Contractor will be responsible for preparing the supporting soil according to the plans and specifications. The CQA Monitor will document that:

- A qualified Professional Engineer or Land Surveyor has determined that lines and grades are in substantial conformance with design plan and allow for drainage from the area;
- The surfaces to be lined will be inspected for conditions that could be damaging to the overlying geosynthetics;
- The surface of the supporting soil does not contain stones which may be damaging to the geomembrane; and
- There are no areas excessively softened by high water content.
- The subgrade for the temporary cap area shall be “tracked-in” and “back-dragged” with a bulldozer to provide a smooth surface. Prior to installation of FML, a cushion geotextile will be installed on the subgrade surface.

The FML Installer will certify in writing that the surface on which the geomembrane will be installed is acceptable. This certification of acceptance will be reported daily by the FML Installer to the CQA Monitor prior to commencement of the FML installation.

After the surface has been accepted by the FML Installer, it will be the FML Installer's responsibility to indicate to the Owner or CQA Monitor any change in the surface conditions that may require repair work. If the CQA Monitor concurs with the FML Installer, then the CQA Monitor will identify the necessary repair work to be performed by the Owner or Contractor.

At any time prior to or during the FML installation, the CQA Monitor will notify the Owner or Contractor of locations, which, in the opinion of the CQA Monitor, will require corrective action prior to the geomembrane installation.

3.1.6 Anchorage System

The anchor trenches will be excavated to the lines and depth shown on the temporary cap and corer integrity system construction drawings prior to the FML placement. The CQA Monitor will document the anchor trench construction.

Rounded corners shall be provided in the trenches where the FML enters the trench to allow the FML to be uniformly supported by the subgrade and to avoid sharp bends in the FML. Precautions shall be taken to minimize loose soil in the anchor trenches. FML should be seamed completely to the ends of all panels to minimize the potential for tear propagation along the seam. Backfilling of the anchor trenches will be conducted using soils that will not damage the underlying geosynthetics and shall be placed with compactive effort.

3.1.7 FML Placement

3.1.7.1 Panel Identification

A panel is the unit area of FML that is seamed in the field. The unit area can consist of a full roll or a portion of the roll cut in the field.

Prior to or during the initial meeting, the FML Installer will provide the Owner and CQA Manager with a drawing of the cell to be lined showing the orientation of the FML panels. The CQA Manager will review the panel layout and document that it is consistent with the accepted state of practice.

Each panel will be given an "identification code" (number or letter-number) consistent with the layout plan. This identification code will be agreed upon by the FML Installer and the CQA

Monitor. This identification code shall be simple and logical (note that roll numbers established in the manufacturing plant may be cumbersome and are unrelated to location in the field).

The CQA Monitor will establish a table or chart showing correspondence between roll numbers and panel identification codes. The panel identification codes will be used for all quality assurance records.

3.1.7.2 Panel Placement

The CQA Monitor will document that panel installation is consistent with regard to locations indicated in the FML Installer's layout plan, as approved or modified at the initial meeting.

Installation:

- Only those panels that can be reasonably expected to be anchored or seamed together in one day are to be unrolled. Panels may be installed using any of the following schedules:
    - All panels placed prior to field seaming;
    - Panels placed one at a time and each panel seamed immediately after its placement;
    - Any combination of the above.
- The CQA Monitor will record on a drawing the identification code, location, and date of installation of each FML panel. The location of FML panels and intersections will be surveyed in for certification.
- Deployment of the FML can be accomplished through the use of lightweight, rubber tired equipment such as a 4-wheel all terrain vehicle (ATV), provided the ATV makes no sudden stops, starts, or turns on the geosynthetic. ATV traffic on the geosynthetics shall be minimized.

If a decision is reached to place all panels prior to field seaming, care should be taken to facilitate drainage in the event of precipitation and anchoring for winds. Scheduling decisions must be made during placement in accordance with varying conditions. The CQA Monitor will evaluate changes in the schedule proposed by the Installer and will advise the Owner and the CQA Manager on the acceptability of that change. The CQA Monitor will document that the condition of the supporting soil has not changed detrimentally during installation.

Weather Conditions:

- FML panel deployment or seaming shall not take place during any precipitation, in the presence of excessive moisture (e.g. fog, dew), in an area of ponded water, or in the presence of high winds.
- The CQA Monitor will inform the Owner when the above conditions are not fulfilled or has observed subgrade damage caused by adverse weather conditions.
- The FML Installer will inform the Owner if the weather conditions are not acceptable for FML deployment or seaming.
- The Installer shall provide suitable wind protection as necessary to maintain the integrity of the installation.

The CQA Monitor will:

- Observe equipment damage to the FML as a result of handling, traffic, leakage of hydrocarbons, or other means;
- Observe deviations from the requirement that no one is permitted to smoke, wear damaging shoes, or engage in other activities which could damage the FML;
- Observe scratches, crimps, or wrinkles in the FML and any damage to the subgrade; and,
- Observe damage caused by loading necessary to prevent uplift by wind.

The CQA Monitor will inform the Owner of the above conditions.

After placement, the CQA Monitor will observe each panel for damage. The CQA Monitor will advise the FML Installer and Owner which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked and their removal from the work area recorded by the CQA Monitor. Repairs should be made according to procedures described in Section 3.1.10.

3.1.8 Field Seaming

3.1.8.1 Seam Layout

The FML Installer will provide the Owner and CQA Manager with drawings of the cell to be lined showing field seams in a manner which differentiates the seam types, if any. The CQA Manager will review the seam layouts.

In general, seams shall be oriented parallel to the line of maximum slope; i.e., oriented up and down, not across, the slope.

It is anticipated that cross seams on the slope will be required. Cross seams on adjacent panels should be staggered so that they are separated a distance greater than the width of a panel.

A seam numbering system compatible with the panel numbering system should be agreed upon at the initial meeting.

3.1.8.2 Requirement of Personnel

All personnel performing seaming operations must be qualified by experience or by successfully passing seaming tests. At least one seamer will have a minimum of 1,000,000 ft² of FML seaming experience using the same type of seaming apparatus in use at the site. The Owner or CQA Monitor has the right to reject a seamer if they cannot demonstrate suitable experience and qualifications.

3.1.8.3 Overlapping

The CQA Monitor will observe that FML panels were properly overlapped for fusion welding and extrusion welding. The FML panels shall have a minimum overlap of 4 to 6 inches for fusion welding. For extrusion welding, the FML shall overlap a minimum of 6 inches on each side.

3.1.8.4 Seam Preparation

Seams must be prepared so that:

- Prior to seaming, the seam area will be clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- Seam overlap grinding (for extrusion welding only) will be completed according to the Manufacturer's instructions and in a way that does not damage the FML.
- Seams will be aligned with the fewest possible number of wrinkles and "fishmouths".

3.1.8.5 Seaming Equipment

The approved processes for field seaming of the FML is double track fusion or extrusion welding. Proposed alternate processes will be documented and submitted to the Owner or CQA Consultant for concurrence.

The apparatus used for welding the major seams will be equipped with gauges indicating the temperature in the apparatus or at the application point. The CQA Monitor will observe apparatus temperatures and ambient temperatures prior to the machine beginning a new seam.

The CQA Monitor will observe that:

- Equipment used for seaming is not likely to damage the FML;
- The extruder is purged prior to beginning a seam until the heat-degraded extrudate has been removed from the barrel;
- The electric generator is placed on a smooth base such that minimal damage occurs to the FML;
- A smooth insulating plate or fabric is placed beneath the welding apparatus after usage;
- The FML is protected from damage in heavily trafficked areas.
- One spare operable seaming device shall be maintained on site at all times.
- A small movable piece of FML may be used directly below the FML overlap that is to be seamed to prevent buildup of water and/or moisture between the FML sheets. The FML piece is slid along the overlap as the seaming progresses. This piece is removed when the seam is completed.

3.1.8.6 Weather Conditions for Seaming

The typical weather conditions required for seaming are as follows:

- No seaming shall be attempted above 104º F ambient air temperature or below 32º F ambient air temperature, without approval. Ambient temperature shall be measured 12 inches above the liner.
- In all cases, the FML shall be dry and protected from wind damage.
- The CQA Monitor will observe the seaming techniques appropriate for the prevailing weather conditions are employed and will advise the Owner or CQA Manager of deviations. The final decision as to whether or not seaming may be performed will be made by the Owner or CQA Manager.
- Seaming shall not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the FML areas for seaming from water and/or moisture.

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- Seaming shall not be performed in areas where ponded water has collected above or below the surface of the FML.

If the Installer wishes to use methods which may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams which are entirely equivalent to seams produced at temperatures above 32°F and below 104°F, and that the overall quality of the FML is not adversely affected.

The CQA Monitor will document the following items:

- Ambient temperature at which seaming is performed.
- Any precipitation events occurring at the site, including the time of such occurrences, the intensity, and the amount of the event.

The CQA Manager will inform the Owner if seaming during unsuitable weather conditions is being performed. The Owner will stop or postpone the FML seaming when conditions are unacceptable.

3.1.8.7 Test Seams

Test seams will be prepared each day prior to commencing FML field seaming. Test seams will be made at the beginning of each seaming period and a minimum of once every five hours of continuous welding for each seaming apparatus/operator combination used that day. Additional test seams may be required at the discretion of the CQA Manager.

The test seam sample will be at least three feet long by one foot wide with the seam centered lengthwise. Six adjoining one-inch wide specimens will be die cut from the seam sample. The specimens will be immediately tested by the FML installer with a tensiometer in the field for both peel (3 specimens) and shear (3 specimens). If any of the test seam specimens for FML fail to meet the acceptance requirement in Appendix A then the entire operation will be repeated. If the additional test seam fails, the seaming apparatus will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Test seam failure is defined as failure of any one of the specimens tested in shear or peel. The CQA Monitor will observe all test seam procedures.

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3.1.8.8 General Seaming Procedure

Unless otherwise specified, the general seaming procedure used by the FML Installer shall be as follows:

- If required, a moveable protective layer of plastic may be placed directly below each overlap of FML that is to be seamed. The purpose of the protective layer is to prevent any moisture build-up between the sheets to be welded. No protective layers may be left beneath the FML
- Seaming shall extend to the outside edge of panels to be placed in anchor trenches.
- If required, a firm substratum should be provided by using a flat board or similar hard surface directly under the seam overlap to achieve proper support.
- Fish mouths or large differential wrinkles at the seam overlaps should be cut along the ridge of the wrinkle to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed over the entire length and will then be patched with an oval or round patch of the same type of FML extending a minimum of 6 inches beyond the cut in all directions.
- If seaming operations are to be conducted at night, adequate illumination will be provided.

The CQA Monitor will observe that the above seaming procedures (or any other procedures agreed upon) are followed, and will inform the Owner and CQA Manager if they are not.

3.1.9 Seam Testing

The FML Installer will non-destructively test all field seams over their full length for continuity. Continuity testing shall be performed ASTM D5820 using seam pressure tests for double track fusion welded seams in accordance with. Vacuum box tests shall be performed for single track fusion welded seams, and extrusion welded seams in accordance with ASTM D5641. The purpose of this testing is to check the continuity of seams; it does not provide information on seam strength. Continuity testing will be done as the seaming work progresses. The CQA Monitor will:

- Observe all continuity testing;
- Record location, date, test unit number, name of tester, and outcome of all testing; and,
- Inform the FML Installer of any required repairs.

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PHONE: (616)458-8052

The FML Installer will complete any required repairs in accordance with Section 3.1.10. If repairs are required, the CQA Monitor will:

- Observe the repair and the retesting of the repair;
- Mark on the FML that the repair has been made; and,
- Document the repair, location and retesting results.

All seams must be constructed in a fashion that allows them to be non-destructively tested. Any patches, seams around liner penetrations, or seams near sharp corners must be capped or patched with FML of sufficient size to allow non-destructive testing of the seams. Boots and collars may be inspected visually.

The seam number, date of observation, name of tester, and outcome of the test or observation will be recorded by the CQA Monitor.

Seam Pressure Test Procedure:

- The seam pressure test is designed to detect leaks of double-wedge thermally welded seams where an air chamber exists between the seams. After the seam has been fabricated for a given length, both ends of the air chamber are sealed. A needle attached to a pressure gauge/air valve assembly is inserted into the air chamber and air pressure is applied. The gauge is monitored for drop in air pressure over time as an indicator of seam leaks. Seams shall be tested using the minimum acceptance criteria listed in Appendix A.
- The initial starting pressure may be read after a two minute "relaxing" period, which will allow the air within the chamber to reach ambient liner temperature. The final pressure will then be read at the conclusion of the test. If the pressure loss does not exceed the acceptance criteria listed in Appendix A, then the seam is considered to have passed the nondestructive test. The end of the seam opposite the pressure gauge will then be cut open to observe that the entire seam length has been tested. If the pressure does not drop upon the opposing end being cut the blockage will be found to identify the section of seam tested. The remainder of the seam will then be tested as stated above.
- If failure occurs (i.e., pressure reduction over the scheduled time period is greater than the maximum allowable), the end seals will be checked and the seam retested. If failure recurs, the exposed fusion area will be visually observed and a soapy solution shall be

applied over the pressurized seams to locate leaks. If leak areas are located, these areas will be patched and pressure tested on both sides of the patched area. The patched area will be vacuum tested.

Vacuum Box Test Equipment consists of:

- A vacuum box assembly of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a port hole or valve assembly, and a vacuum gauge;
- A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections;
- A rubber pressure/vacuum hose with fittings and connections; and,
- A soapy solution (mild detergent).

The following procedures shall be performed for vacuum testing:

- Energize the vacuum pump.
- Wet a strip of FML to be tested with the soapy solution.
- Place the vacuum box over the wetted area.
- Close the bleed valve and open the vacuum valve.
- Maintain a vacuum pressure of at least 5 psig.
- Check that a leak tight seal is created.
- For a period of not less than 10 seconds, examine the FML through the viewing window for the presence of soap bubbles.
- If no bubble(s) appears after 10 seconds, close the vacuum valve and open the bleed valve. Move the box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.
- All areas where leaks are observed will be marked and repaired in accordance with Section 3.1.10.

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3.1.9.1 Destructive Seam Strength Testing

Locations and Frequency:

- The CQA Monitor will select the locations where seam samples are to be cut for laboratory testing. The sampling should be established as follows:
    - A minimum frequency of one test location per 500 feet of production seam length per welding machine.
    - Additional test locations may be selected during seaming at the discretion of the CQA Manager. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of inadequate welding.
- The FML Installer will not be informed in advance of the locations where the seam samples will be taken.

Sampling Procedures:

- Samples will be die cut by the FML Installer as the seaming progresses to have laboratory test results before completion of liner installation. The CQA Monitor will:
    - Observe sample cutting;
    - Assign a number to each sample and mark it accordingly;
    - Record the sample location on a layout drawing; and,
    - Observe field tensiometer testing performed by the FML Installer and record test data.
- Holes in the FML resulting from destructive seam sampling will be immediately repaired by the FML Installer in accordance with repair procedures described in Section 3.1.10. The continuity of the new seams in the repaired area will be tested according to Section 3.1.9.

Size of Samples:

- The samples will be a minimum of 12 inches wide by approximately 42 inches long with the seam centered lengthwise. The sample will be cut into three parts and distributed as follows:
    - One portion to the FML Installer for testing, 12 in. x 12 in.

- One portion for CQA Manager for laboratory testing, 12 in. x 18 in.
- One portion to the Owner for archive storage, 12 in. x 12. in.
- Samples will be cut by the FML Installer at the locations designated by, and under the observation of, the CQA Monitor as the seaming progresses to obtain laboratory test results prior to completion of liner installation.

- The CQA Monitor will witness field tests and mark samples with their number. The CQA Monitor will also log the date, number of seaming unit, and pass or fail description.

Testing Requirements:

- Laboratory testing of seams will commence as soon as possible after the destructive seam samples are received. A minimum of five specimens should be tested each for shear and peel, for a total of ten destructive tests per destructive sample. The shear and peel testing of the seams should be conducted according to ASTM D-6392.
- Pass/Fail Criteria for FML for destructive samples can be found in Appendix A.

Procedures for Destructive Test Failure:

- The following procedures will apply whenever a sample fails the field destructive test. The FML Installer shall cap strip the seam between the failed location and two passed laboratory test locations using the procedures described in Section 3.1.10. Cap-stripping involves applying a strip of FML, a minimum distance of 6 inches on all sides of the defective seams, and seaming it to the sheet material by extrusion welding.
- All acceptable reconstructed seams must be bounded by two passing laboratory test locations, (i.e., the above procedure should be followed in both directions from the original failed location). The only exception is if all seams produced by the defective welder have been reconstructed to a point it can no longer be followed in the failing direction. One laboratory test must be taken within the reconstructed area if the failed length exceeds 250 feet.
- The CQA Monitor will observe and note actions taken in conjunction with destructive test failures.

3.1.10 Defects and Repairs

3.1.10.1 Identification

Seams and non-seam areas of the FML will be evaluated by the CQA Monitor for identification of defects, holes, blisters, undispersed raw materials, and signs of contamination by foreign matter. Because light reflected by the FML aids in the detection of defects, the surface of the FML shall be clean at the time of visual observation. The FML surface should be broomed or washed if the amount of dust or mud inhibits observation and testing.

3.1.10.2 Evaluation

Each suspect location, both in seam and non-seam areas, will be non-destructively tested. Each location that fails the non-destructive testing will be marked by the CQA Monitor and repaired by the FML Installer.

3.1.10.3 Repair Procedures

Any portion of the FML exhibiting a flaw, or failing a destructive or nondestructive test shall be repaired. Repair procedures should be agreed upon between the Owner, the FML Installer, and the CQA Manager. Unless otherwise agreed, the repair procedures will be as follows:

- Defective seams will be repaired by reconstruction.
- Tears or holes will be repaired by patching.
- Pinholes will be repaired by applying an extrudate bead to the prepared surface.
- Blisters, larger holes, undispersed raw materials, and contamination by foreign matter will be repaired by patching.
- Patches shall be round or oval in shape, made of the same material as the FML, and extend a minimum of 6 inches beyond all edges of the defect. Patches will be applied using the approved method as required in the specifications.
- All seams made in repairing defects will be subjected to the same non-destructive test procedures as outlined for all other seams.

3.1.10.4 Seam Reconstruction Procedures

Seam sections that need repair due to overheating, burn holes, and unseamed areas shall be reconstructed by cap stripping with the same FML material. Cap stripping involves applying a strip of FML, respectively, a minimum distance of 6 inches on all sides of the defective seams, and seaming it to the sheet material by extrusion welding. Large caps may be of sufficient extent

to require destructive seam sampling and testing, at the discretion of the CQA Monitor. The FML below large caps should be appropriately cut to avoid water or gas collection between the two sheets.

3.1.10.5 Documentation of Repairs

Each repair will be non-destructively tested using the methods described in Section 3.1.9, as appropriate. Repairs, which pass the non-destructive test, will be taken as an indication of an adequate repair. Repairs, which fail, will be redone and retested until a passing test is achieved. The CQA Monitor will observe all non-destructive testing of repairs.

3.2 Non-Woven Geotextile

Every roll of geotextile delivered to the site must be manufactured and inspected by the Geotextile Manufacturer, according to the following requirements:

- The geotextile must be properly labeled.
- The geotextile must be free of holes and any other sign of contamination by foreign matter.

Each geotextile roll, for use at the landfill facility, shall be marked by the Geotextile Manufacturer with the following information and in the following manner:

- Name of Manufacturer (or supplier)
- Style and type number
- Roll length and width
- Batch (or lot) number
- Date of manufacture
- Roll number

The Geotextile Manufacturer must provide a written certification accompanying all material shipments stating that their product meets all manufacturing specifications and passes all requirements and specifications listed in this CQA Plan. The Manufacturer shall also provide Quality Control documentation and results of testing that the material specified in this section meets or exceeds the requirements of the specifications and CQA Plan.

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3.2.1 Transportation, Handling, and Storage

Transportation of the geotextile is the responsibility of the Manufacturer, the Installer, or other party as decided by the Owner. All handling on-site after unloading is the responsibility of the Installer. The CQA Monitor will monitor or document the following with regard to the geotextile:

- Each geotextile roll is labeled with a roll number and a batch (lot) number;
- Rolls delivered to the site are free from defects and/or damage;
- The adequacy of on-site handling of equipment to minimize risk of damage to both the geotextile and underlying geosynthetic materials; and,
- The careful handling of the geotextile by the Installer's personnel.

The CQA Monitor will indicate/report to the Owner any rolls or portions thereof, which in the opinion of the CQA Monitor should be rejected and removed from the site because of visually obvious flaws; or rolls that include flaws, which may be repairable.

Selected samples of the geotextile material may be obtained by the CQA Manager for physical testing to document that the geotextile material tested satisfies the minimum material property requirements established in Appendix B.

3.2.2 Installation

Placement of the geotextile shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Manager.

The Geotextile Installer shall install the geotextile in such a manner that it is not damaged in any way.

The CQA Monitor shall observe and document that each of the above steps are performed by the Installer. Any noncompliance with the above requirements shall be reported by the CQA Monitor to the CQA Manager.

3.2.3 Geotextile Seaming

Seaming of the geotextile may be performed by one of three methods: sewing, thermal bonding or approved gluing.

3.2.4 Damage Repair

Any tears or other defects in the geotextile will be repaired by placing a patch extending a minimum of 12 inches beyond the edges of the hole or tear. The patch will be secured by heat tacking. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geotextile material. The CQA Monitor will examine and document that the repair of any geotextile is performed according to the above procedure.

3.3 Double-Sided Geocomposite

3.3.1 Transportation, Handling, and Storage

Every roll of geocomposite delivered to the site must be manufactured and inspected by the Geocomposite Manufacturer, according to the following requirements:

- The geocomposite must be properly labeled.
- The geocomposite must be free of holes and any other sign of contamination by foreign matter.

Each geocomposite roll, for use at the landfill facility, shall be marked by the Geocomposite Manufacturer with the following information and in the following manner:

- Name of Manufacturer (or supplier)
- Style and type number
- Roll length and width
- Batch (or lot) number
- Date of manufacture
- Roll number

The Geocomposite Manufacturer must provide a written certification accompanying all material shipments stating that their product meets manufacturing specifications and passes requirements and specifications listed in this CQA Plan. The Manufacturer shall also provide Quality Control documentation and results of testing that the material specified in this section meets or exceeds the requirements of the specifications and CQA Plan.

Transportation of the geocomposite is the responsibility of the Manufacturer, the Installer, or other party as decided by the Owner. All handling on-site after unloading is the responsibility of

the Installer. The CQA Monitor will monitor or document the following with regard to the geocomposite:

- Each geocomposite roll is labeled with a roll number and a batch (lot) number;
- Rolls delivered to the site are free from defects and/or damage;
- The adequacy of on-site handling of equipment to minimize risk of damage to both the geocomposite and underlying geosynthetic; and,
- The geocomposite is handled in a manner to minimize damage.

The CQA Monitor will indicate/report to the Owner any rolls or portions thereof, which in the opinion of the CQA Monitor should be rejected and removed from the site because of visually obvious flaws; or rolls that include flaws, which may be repairable.

Selected samples of the geocomposite material may be obtained by the CQA Manager for physical testing to document that the geocomposite material tested satisfies the minimum material property requirements established in Appendix C.

3.3.2 Installation

Placement of the geocomposite shall be conducted in accordance with the manufacturer's recommendations and with the direction provided herein. Any deviations from these procedures must be pre-approved by the CQA Manager.

- The Geocomposite Installer shall install the geocomposite in such a manner so that it is not damaged in any way.
- The panels will be orientated in the direction of the slope to minimize seams on the slope
- Panels will be overlapped in the direction of flow to facilitate drainage.
- If the cover material is a geomembrane or other geosynthetic, precautions shall be taken to prevent damage to the geocomposite by restricting heavy equipment traffic. Unrolling the geosynthetic can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the geocomposite, provided the ATV makes no sudden stops, starts, or turns.

The CQA Monitor shall observe and document that each of the above steps are performed by the Installer. Any noncompliance with the above requirements shall be reported by the CQA Monitor to the CQA Manager.

3.3.3 Geocomposite Panel Seaming

The following requirements shall be met with regard to overlapping and joining of geocomposite rolls:

- Adjacent rolls shall be overlapped a minimum of 4 inches.
- The overlaps will be shingled to facilitate drainage.
- The overlaps shall be secured by tying to each other at a minimum of five foot spacing.
- The overlap at butt seams will be 12 inches and the geocomposite will be secured by tying at 6-inch spacing.
- Plastic fasteners shall be used to tie the geonet component. The plastic ties shall be white or brightly colored for easy identification. Metallic ties shall not be used in any circumstances.
- The geotextile portion of the geocomposite will be sewn together using a contrasting colored thread for easy inspection.

3.3.4 Damage Repair

Any tears or other defects in the geocomposite will be repaired by placing a patch extending a minimum of 2 feet beyond the edges of the hole or tear. The patch will be secured to the original geocomposite by tying every 6 inches. If the tear or other defect width is more than 50 percent of the roll width, the damaged area will be cut out and replaced with new geocomposite material. The CQA Manager will examine and document that the repair of any geocomposite is performed according to the above procedure.

3.4 Cap Integrity System

3.4.1 Below-Cap Stone Collectors

Stone collectors shall be a 2”-3” washed river gravel with the minimum dimensions indicated on the approved construction drawings. Location of the stone corridors is indicated on the approved construction drawings. Each proposed stone collector will be located by survey prior to construction. Record surveys will be completed on each stone corridor after installation is complete. ~~GLOBAL CHANGE – just say approved construction drawings~~

3.4.2 Cap Integrity Piping

The piping material shall meet the specifications as described in the approved construction drawings to include material type, diameter, and wall thickness. Piping shall be installed in

accordance with industry standards and the approved construction drawings. Location of the piping is indicated on the approved construction drawings. Location of the piping shall be located by survey prior to installation, with record survey completed after installation.

3.4.3 Strip Drains

The strip drains shall be a 1" by 12" strip drain as indicated on the approved construction drawings. Strip drains shall be placed at approximate 75 foot spacing or as indicated on the approved construction drawings. Strip drains shall be installed in accordance with industry standards and the approved construction drawings. Location of the strip drains shall be located by survey prior to installation, with an as-built survey completed after installation.

3.4.4 Access Roads

The access roads will have a top deck width of approximately 10 feet with a minimum stone thickness of 24 inches and shall be constructed in accordance with the temporary cap and cover integrity system construction drawings. Access roads shall be installed on locations indicated on the temporary cap and cover integrity system construction drawings with corresponding stripping areas (approximately 20 feet wide) below the geosynthetics. Location of the access roads shall be located by survey prior to installation, with record survey completed after installation.

3.4.5 Perimeter Collection Trench

A Perimeter Collection Trench shall be excavated around the project limits as shown on the approved construction drawings. The trench will be excavated to a "typical" depth of 4 feet but may vary to support positive drainage. The trench will be backfilled with the 2"-3" washed river gravel. Location of the Perimeter Collection Trench will surveyed and recorded on the record drawings. Trench depths will be documented on an approximated 100' spacing.

3.4.6 Perimeter Collection Sumps

With the Perimeter Collection Trench, a series of Collection Sumps will be installed at locations shown on the approved construction drawings. Locations and depths will be documented and included on record drawings.

Collection Sumps will be installed using an excavator and backfilled with 2"-3" washed river gravel. The collection sumps shall also have an access pipe for installation of a pump for removal of liquids as shown on the approved construction drawings.

3.5 Storm Water Management

The approved construction drawing has an approved storm water management plan prepared by Cornerstone Environmental Group.

The CQA firm shall document that the storm water management system is constructed in accordance with the approved plan. Components of documentation should include culvert location, sizes, storage ponds, ditches and other features required by the approved plan. Information shall be included in the record drawings.

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APPENDIX A
TEMPORARY COVER FLEXIBLE MEMBRANE LINER

RAVEN
INDUSTRIES

TO: Republic Services

SUBJECT: Raven X60FC1 QA testing methods and frequency (rev. 3)

DATE: April 12, 2013

IN REFERENCE TO: Bridgeton Landfill project, Bridgeton, MO

Raven X60FC1 geomembrane and its components undergo an extensive array of testing and measurement during the manufacturing process. The required tests, methods, and sampling frequency are based on the requirements set forth in GRI GM 13 ('Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes')

The minimum test values for X60FC1 using these test methods are listed the table provided with this letter.

Clint Boerhave

Clint Boerhave
Quality Manager
Raven Industries - Engineered Films Division

Test methods, minimum values, and test frequency for Raven X60FC1

Properties	Test Method	Test Value	Testing Frequency (minimum)
Thickness mils (min. ave.) • lowest individual for 8 out of 10 values • lowest individual for any of the 10 values	D 5994	50 mils 45 mils 35 mils	per roll
Asperity Height mils (min. ave.)	GM 12	10 mils	per roll
Tensile Properties (3) (min. ave.) • break strength – lb/in. • MD break elongation - % (min. avg.) • TD break elongation - % (min. avg.)	6693 Type IV	 75 200 30	20,000 lb
Tear Resistance – lb (min. ave.)	D 1004	27	45,000 lb
Puncture Resistance – lb (min. ave.)	D 4833	55	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) (a) Standard OIT — or — (b) High Pressure OIT	 D 3895 D 5885	 100 400	200,000 lb

RAVEN INDUSTRIES

STATEMENT OF PERFORMANCE

SUBJECT: Raven X60FC1

IN REFERENCE TO: Seam testing minimum values and material separation in plane (SIP)
Republic Services Landfill cap project - Bridgeton, Missouri
SO# 195942-195948, 195950-195954

DATE: April 5, 2013

Absolute Barrier™ X60FC1 is a seven layer co-extruded textured geomembrane consisting of polyethylene with a core layer designed specifically as a barrier against radon, methane and VOCs on brownfield sites, residential and commercial buildings, and geomembrane containment and covering systems. A robust stabilization package provides long-term protection from thermal oxidation and ultraviolet degradation in exposed applications.

Due to the multilayer construction and the presence of a barrier core in this product, some separation in plane may occur during destructive seam testing. This is normal and should not be of concern as long as the tested peel and shear results meet the minimum values for this product:

Hot Wedge Seams	Minimum value
Shear Strength (lb/in)	80
Peel Strength (lb/in)	60
Extrusion Fillet Seams	
Shear Strength (lb/in)	80
Peel Strength (lb/in)	52

Clint Boerhave

Clint Boerhave
Quality Manager
Engineered Films Division

APPENDIX B
NON-WOVEN GEOTEXTILE

6 oz/sy Nonwoven Geotextile
Conformance Testing Summary

Properties	Test Method	Manufacturer QC Test Frequency(2)	Conformance QA Test Frequency	Required Test Values
Mass/Unit Area (min. ave.)	ASTM D5261	1 per 100,000 sf	N/A	6.0 oz/sy
Apparent Opening Size (max.)	ASTM D4751	1 per 540,000 sf	N/A	0.212 mm 70 (U.S. Sieve)
Grab Strength (min. ave.)	ASTM D4632	1 per 100,000 sf	N/A	160 lbs
Puncture Strength (min. ave.)	ASTM D4833/D6241	1 per 100,000 sf	N/A	95 lbs
UV Resistance	ASTM D4355	1 per resin formulation	N/A	70% (3)
Permittivity (min.)	ASTM D4491	1 per 540,000 sf	N/A	1.63 sec^{-1}

Notes:

(1) AOS and Permittivity shall only be tested for geotextiles used in filter applications.
(2) Manufacturer may elect to provide certification of values for geotextiles.
(3) After 500 hours of exposure.

APPENDIX C
DOUBLE-SIDED GEOCOMPOSITE

Geocomposite
Conformance Testing Summary

Properties	Test Method	Manufacturer QC Test Frequency	Conformance QA Test Frequency	Required Test Values
Geonet Component:				
Transmissivity, (min)	ASTM D4716	1 per 100,000 sf	N/A	$2x10^{-3}$ m^2/sec
Thickness (min)	ASTM D5199	1 per 100,000 sf	N/A	220 mils
Density (min)	ASTM D1505	1 per 100,000 sf	N/A	0.94 g/cm^2
Tensile Strength (min)	ASTM D5035	1 per 100,000 sf	N/A	45 lb
Carbon Black Content (min)	ASTM D1603	1 per 100,000 sf	N/A	2 to 3 %
Geotextile Component:				
Nominal 6 oz/sy non-woven – see Appendix B for specifications				
Geocomposite:				
Transmissivity, (min)[(1)]	ASTM D4716	1 per 100,000 sf	N/A	$1x10^{-4}$ m^2/sec
Ply Adhesion, (min)	ASTM D7005	1 per 100,000 sf	N/A	0.5 lb/in

Notes:

Transmissivity shall be measured using a seat time of 15 minutes, a load of 10,000psf, and a gradient of 0.1.

Comment 3: Section 3.1.8.3 Overlapping, please specify the minimum panel overlap for the flexible membrane liner (FML).

The FML panels shall have a minimum overlap of 4 to 6 inches for fusion welding. For extrusion welding, the FML shall overlap a minimum of 6 inches on each side. Section 3.1.8.3 of the CQA plan has been revised accordingly.

Comment 4: Section 3.1.8.7 Test Seams, states "Test seams will be made at the beginning of each seaming period and a minimum of once every five hours of continuous welding for each seaming apparatus used that day." Please specify if the test seams will be each seaming apparatus/operator combination.

Section 3.1.8.7 of the CQA plan has been revised to specify that tests seams are required for each seaming apparatus/operator combination.

Comment 5: Section 3.4.6 Perimeter Collection Sumps/Rock Chimneys, please remove rock chimneys from the section title.

Rock Chimneys have been removed from section title. Section 3.4.6 of the CQA Plan has been revised accordingly.

Comment 6: The literature provided in Appendix A states the testing requirements and specifications for the selected FML material is a 50 mil textured LLDPE. Previous submittals and correspondences have indicated that the outer layers of the FML will consist of 60 mil textured HDPE. Please explicitly state what the FML cap material will be made of and submit the accompanying testing information accordingly. This information must be consistent with each submittal.

During the preliminary material selection discussions for the geomembrane to be utilized on this project, an EVOH geomembrane with a "nominal" thickness of 60 mil was discussed. The final product chosen for this project consists of a geomembrane with an EVOH core layer for vapor control and outer layers of HDPE for UV protection in an exposed application. This geomembrane will have a minimum average thickness of 50 mil which includes the EVOH layer and the

other layers of HDPE. There was an incorrect identification in the Raven Industries correspondence for this material in the previous submission. Appendix A contains the revised letter along with the testing requirements for the EVOH with HDPE outer layers (X60FC1).

We trust that the information provided in this response is sufficient for your needs. For your convenience, an updated copy of the proposed CQA plan has been attached.

Sincerely,

Weaver Boos Consultants

Mark A. Moyer
Senior Project Manager

Ali Hashimi, P.E.
Certifying Engineer

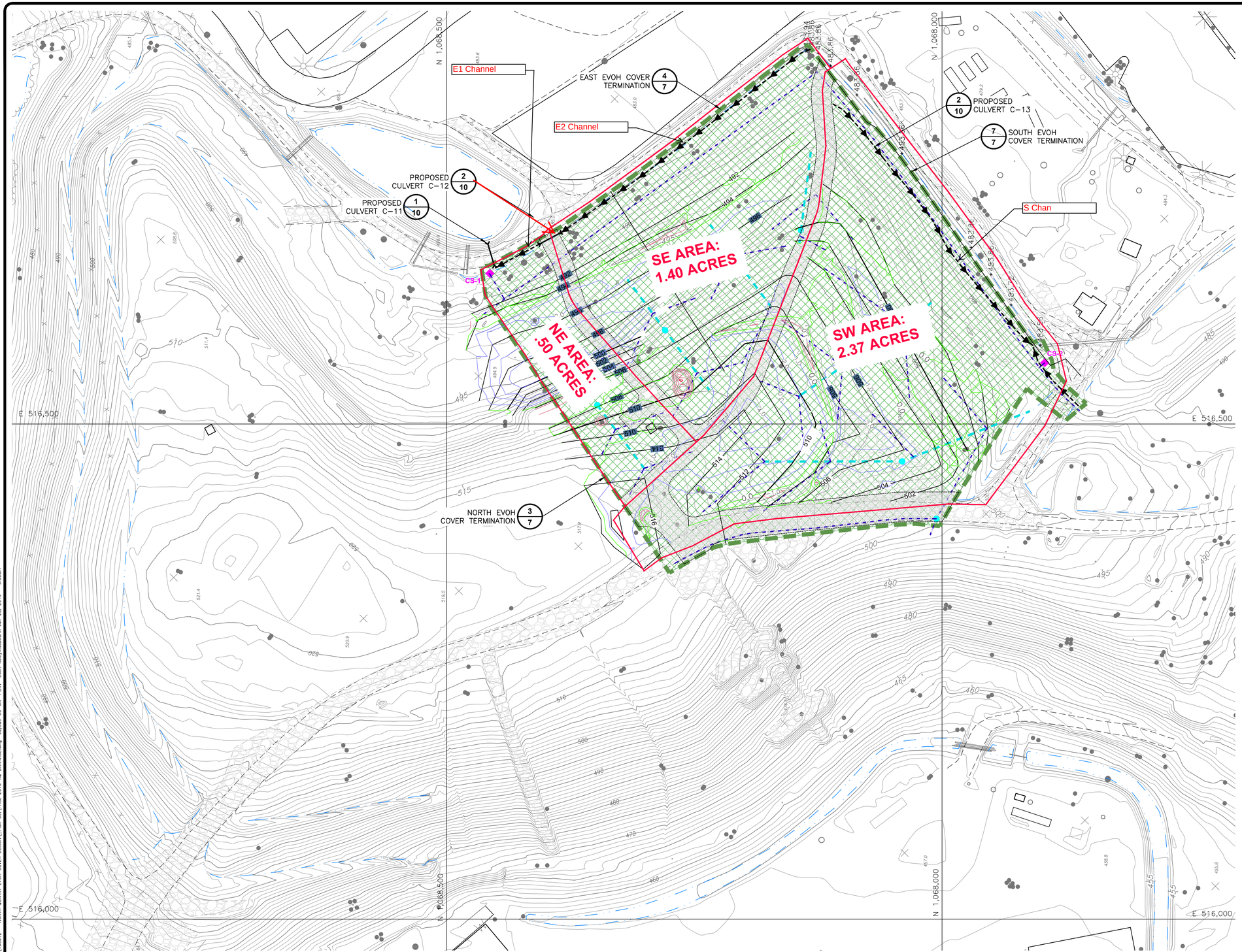
Encl: Temporary Cap and Cap Integrity System CQA Plan, Revision No. 1

APPENDIX E

STORMWATER MANAGEMENT CALCULATIONS

STORMWATER CALCULATIONS

FOR EVOH CAP PHASE 1A



N

0 50 100

SCALE IN FEET

LEGEND

- SOLID WASTE PERMIT 118912 BOUNDARY
- EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- GW–7 EXISTING PERIMETER SUMP
- EXISTING EVOH GEOMEMBRANE
- PROPOSED NORTH QUARRY EVOH GEOMEMBRANE
- EXISTING LIGHT–DUTY ACCESS ROADS
- LIGHT–DUTY ACCESS ROADS (SEE DETAIL 1/8)
- PROPOSED EVOH GEOMEMBRANE COVER LIMIT
- PROPOSED DRAINAGE CHANNEL
- DRAINAGE AREA BOUNDARY

NOTES:

1. THE 2016 TOPOGRAPHIC MAP WAS PROVIDED BY COOPER AERIAL SURVEY CO., PHOENIX, AZ. DATE OF PHOTO: 02/27/2016.
2. UTILITIES SHOWN TAKEN FROM FEEZOR ENGINEERING, INC., DRAWING TITLED "BRIDGETON LANDFILL 2016 Q1 SITE INFRASTRUCTURE", PROJECT BT–092, DATED APRIL 2016.
3. THE PROPERTY BOUNDARY, SOLID WASTE PERMIT BOUNDARIES AND QUARRY BOUNDARY WERE OBTAINED FROM A DWG FILE TITLED "BRIDGETON AND WESTLAKE LANDFILL PARCEL REFERENCE MAP" PREPARED BY SHERBUT–CARSON–CLAYTON LLC, DATED JUNE 2011.
4. THE PROPOSED EVOH CAP GEOMEMBRANE SHALL BE CONTINUOUSLY WELDED TO THE EXISTING EVOH GEOMEMBRANE.
5. SEE SHEET 2 FOR UTILITIES LEGEND.
6. SEE DETAIL 4, SHEET 7 FOR EAST PERIMETER DRAINAGE CHANNEL TO BE SLOPED AT 0.75% TO 24–INCH PROPOSED CULVERT C–11 SHOWN IN DETAILS 1A, SHEET 10.
7. SEE DETAIL 1, SHEET 8 FOR SOUTH DRAINAGE CHANNEL TO BE SLOPED AT 1.0% TO EXISTING 18–INCH CULVER C–1. THE PROPOSED EVOH LINER SHALL EXTEND AROUND A 3–FOOT HIGH SOIL BERM AROUND CULVERT C–1 AND BE BOOTED TO CULVERT C–1 TO DIRECT STORMWATER WITHIN A LINED AREA TO CULVERT C–1.
8. PROPOSED CULVERT C–12 SHALL BE CONSTRUCTED PER DETAIL 2, SHEET 10 AT THE PROPOSED ACCESS ROAD.

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 06/22/16

DRAWN BY TAD
DESIGNED BY JGW
CHECKED BY ASL
APPROVED BY ASL

cornerstone environmental

PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

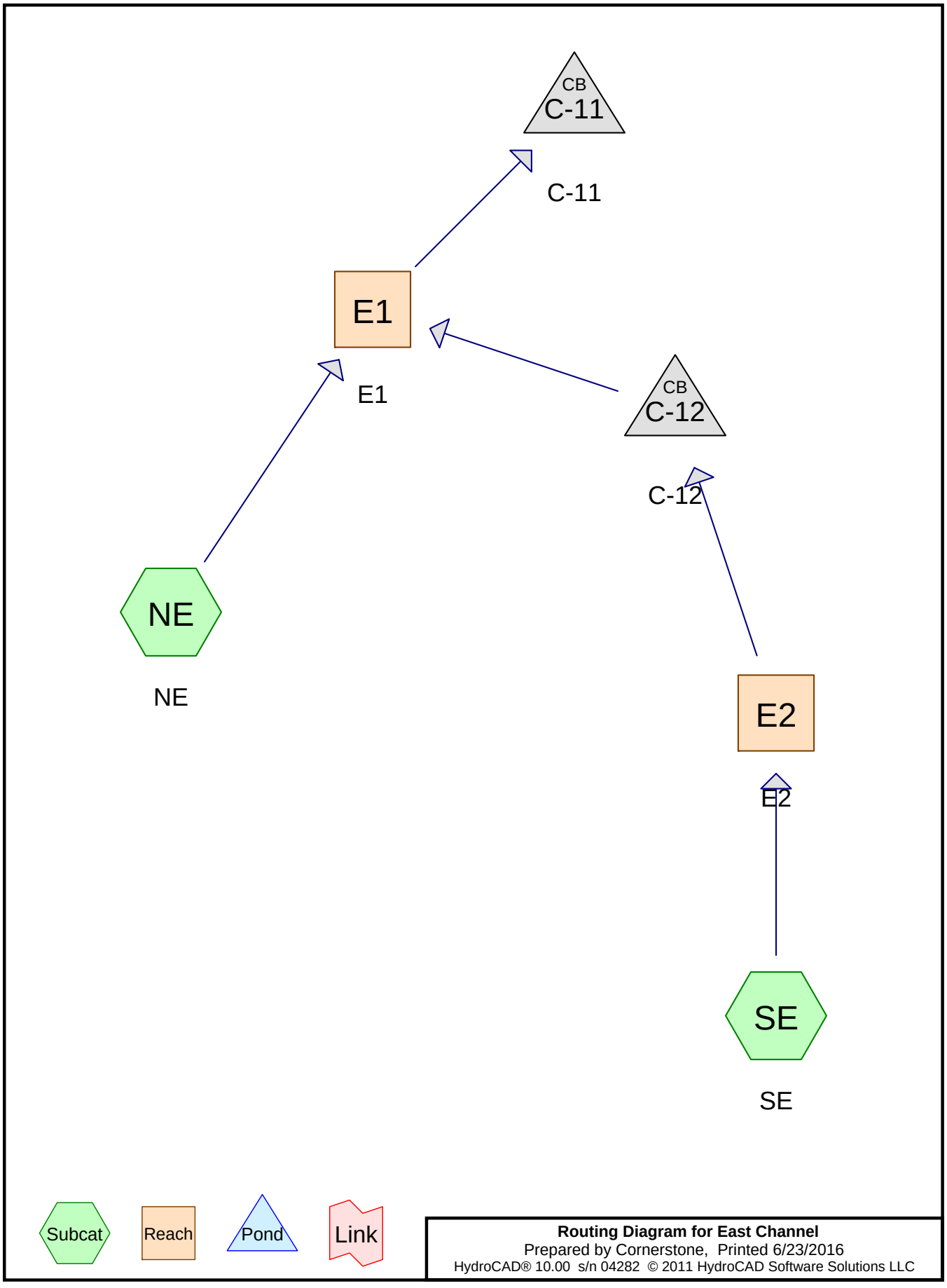
NORTH QUARRY - EVOH COVER DESIGN
DRAINAGE AREA MAP

FIGURE 1

PROJECT NO. 160512

1" 1/2" 0" 1"

File: K:\PROJECTS\BRIDGETON (MO)\160512 - NORTH QUARRY EVOH COVER DESIGN_Plan Set\FIG01 2016 NQ DRAINAGE.dwg Layout: 03-CAP PLAN User: kathy-adelsperger Jun 23, 2016 - 8:58am



Routing Diagram for East Channel
Prepared by Cornerstone, Printed 6/23/2016

Summary for Subcatchment NE: NE

Runoff = 4.88 cfs @ 11.92 hrs, Volume= 0.250 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.500	100	
	0.500		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	265	0.0490	2.50		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.50"

Summary for Subcatchment SE: SE

Runoff = 13.15 cfs @ 11.93 hrs, Volume= 0.700 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	1.400	100	
	1.400		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	35	0.1140	2.34		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.50"
2.9	310	0.0075	1.76		**Shallow Concentrated Flow, Lined Channel** Paved Kv= 20.3 fps
3.1	345	Total			

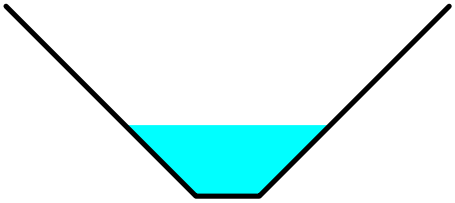
Summary for Reach E1: E1

Inflow Area = 1.900 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 17.55 cfs @ 11.93 hrs, Volume= 0.950 af
Outflow = 17.54 cfs @ 11.94 hrs, Volume= 0.950 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 7.37 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.21 fps, Avg. Travel Time= 0.5 min

Peak Storage= 143 cf @ 11.94 hrs
Average Depth at Peak Storage= 1.12'
Bank-Full Depth= 3.00' Flow Area= 12.0 sf, Capacity= 150.53 cfs

1.00' x 3.00' deep channel, n= 0.012
Side Slope Z-value= 1.0 '/' Top Width= 7.00'
Length= 60.0' Slope= 0.0075 '/'
Inlet Invert= 483.45', Outlet Invert= 483.00'



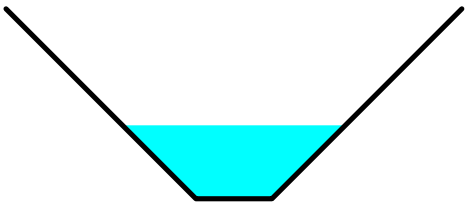
Summary for Reach E2: E2

Inflow Area = 1.400 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 13.15 cfs @ 11.93 hrs, Volume= 0.700 af
Outflow = 13.01 cfs @ 11.94 hrs, Volume= 0.700 af, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 6.84 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 1.99 fps, Avg. Travel Time= 2.6 min

Peak Storage= 589 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.97'
Bank-Full Depth= 2.50' Flow Area= 8.8 sf, Capacity= 99.14 cfs

1.00' x 2.50' deep channel, n= 0.012
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 310.0' Slope= 0.0075 '/'
Inlet Invert= 485.93', Outlet Invert= 483.60'



Summary for Pond C-11: C-11

Inflow Area = 1.900 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 17.54 cfs @ 11.94 hrs, Volume= 0.950 af
Outflow = 17.54 cfs @ 11.94 hrs, Volume= 0.950 af, Atten= 0%, Lag= 0.0 min
Primary = 17.54 cfs @ 11.94 hrs, Volume= 0.950 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 485.20' @ 11.94 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	483.00'	**30.0" Round Culvert** L= 30.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 483.00' / 482.70' S= 0.0100 '/' Cc= 0.900

n= 0.012, Flow Area= 4.91 sf

Primary OutFlow Max=17.49 cfs @ 11.94 hrs HW=485.19' (Free Discharge)
1=Culvert (Barrel Controls 17.49 cfs @ 5.11 fps)

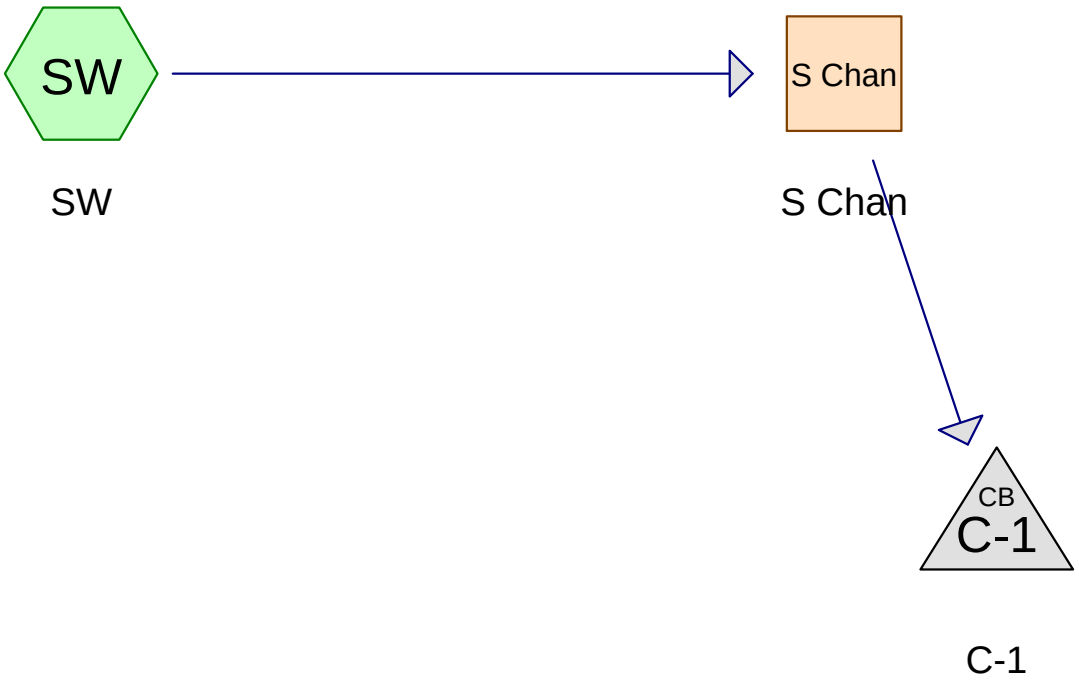
Summary for Pond C-12: C-12

Inflow Area = 1.400 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 13.01 cfs @ 11.94 hrs, Volume= 0.700 af
Outflow = 13.01 cfs @ 11.94 hrs, Volume= 0.700 af, Atten= 0%, Lag= 0.0 min
Primary = 13.01 cfs @ 11.94 hrs, Volume= 0.700 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 485.81' @ 11.94 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	483.60'	**24.0" Round Culvert** L= 20.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 483.60' / 483.45' S= 0.0075 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Primary OutFlow Max=12.98 cfs @ 11.94 hrs HW=485.80' TW=484.57' (Dynamic Tailwater)
1=Culvert (Barrel Controls 12.98 cfs @ 4.68 fps)



SW

S Chan

C-1

Subcat Reach Pond Link

Routing Diagram for NQ South Channel
Prepared by Cornerstone, Printed 6/22/2016

Summary for Subcatchment SW: SW

Runoff = 22.61 cfs @ 11.93 hrs, Volume= 1.185 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	2.370	100	
	2.370		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	320	0.0100	2.03		**Shallow Concentrated Flow, Concentrated Channel Flow** Paved Kv= 20.3 fps

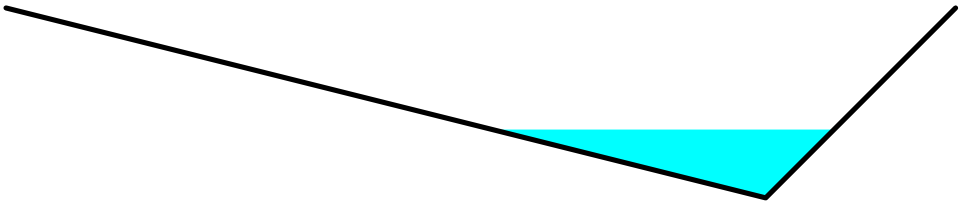
Summary for Reach S Chan: S Chan

Inflow Area = 2.370 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 22.61 cfs @ 11.93 hrs, Volume= 1.185 af
Outflow = 22.37 cfs @ 11.94 hrs, Volume= 1.185 af, Atten= 1%, Lag= 0.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.67 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 2.67 fps, Avg. Travel Time= 2.0 min

Peak Storage= 933 cf @ 11.94 hrs
Average Depth at Peak Storage= 1.08'
Bank-Full Depth= 3.00' Flow Area= 22.5 sf, Capacity= 341.08 cfs

0.00' x 3.00' deep channel, n= 0.012
Side Slope Z-value= 4.0 1.0 '/' Top Width= 15.00'
Length= 320.0' Slope= 0.0100 '/'
Inlet Invert= 489.20', Outlet Invert= 486.00'



Summary for Pond C-1: C-1

Inflow Area = 2.370 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 22.37 cfs @ 11.94 hrs, Volume= 1.185 af
Outflow = 22.37 cfs @ 11.94 hrs, Volume= 1.185 af, Atten= 0%, Lag= 0.0 min
Primary = 22.37 cfs @ 11.94 hrs, Volume= 1.185 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs

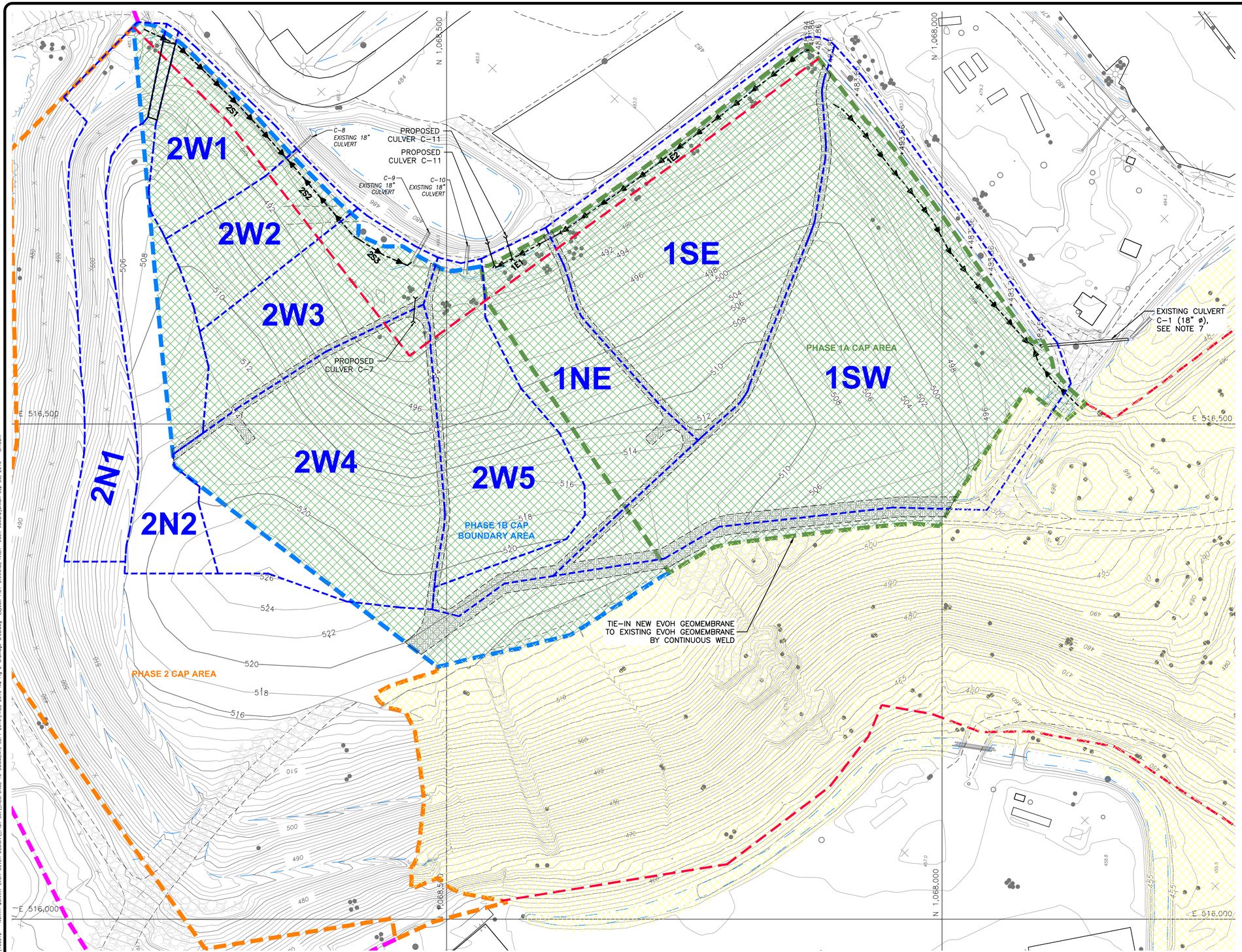
Peak Elev= 488.42' @ 11.94 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	483.91'	**24.0" Round Culvert** L= 90.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 483.91' / 482.43' S= 0.0164 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Primary OutFlow Max=22.30 cfs @ 11.94 hrs HW=488.40' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 22.30 cfs @ 7.10 fps)

STORMWATER CALCULATIONS

FOR EVOH CAP PHASES 1A AND 1B



0 50 100
SCALE IN FEET

LEGEND

- SOLID WASTE PERMIT 118912 BOUNDARY
- DRAINAGE AREA BOUNDARY
- PHASE 1A CAP BOUNDARY
- PHASE 1B CAP BOUNDARY
- PHASE 2 CAP BOUNDARY
- PHASE 3 CAP BOUNDARY
- EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- PROPOSED 10' CONTOUR
- PROPOSED 2' CONTOUR
- EXISTING EVOH GEOMEMBRANE
- PROPOSED NORTH QUARRY EVOH GEOMEMBRANE
- EXISTING LIGHT-DUTY ACCESS ROADS
- LIGHT-DUTY ACCESS ROADS (SEE DETAIL 1/8)
- PROPOSED EVOH GEOMEMBRANE COVER LIMIT
- PROPOSED DRAINAGE CHANNEL (1E2)

NOTES:

1. THE 2016 TOPOGRAPHIC MAP WAS PROVIDED BY COOPER AERIAL SURVEY CO., PHOENIX, AZ. DATE OF PHOTO: 02/27/2016.
2. SUB-AREAS 2N1 AND 2N2 WILL DRAIN TO PHASE 1B DRAINAGE CHANNELS AND CULVERTS. THESE AREAS WERE ASSUMED TO BE CAPPED FOR STORMWATER CALCULATIONS.

DRAINAGE SUB-AREA ID	AREA (ACRES)
2N1	0.63
2N2	0.68
2W1	0.38
2W2	0.36
2W3	0.55
2W4	1.28
2W5	0.70
1NE	0.74
1SE	1.46
1SW	2.41

REV	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

DATE OF ISSUE 09/29/16
DRAWN BY EJJ
DESIGNED BY JGW
CHECKED BY ASL
APPROVED BY ASL

PREPARED BY:
CORNERSTONE ENVIRONMENTAL GROUP, LLC

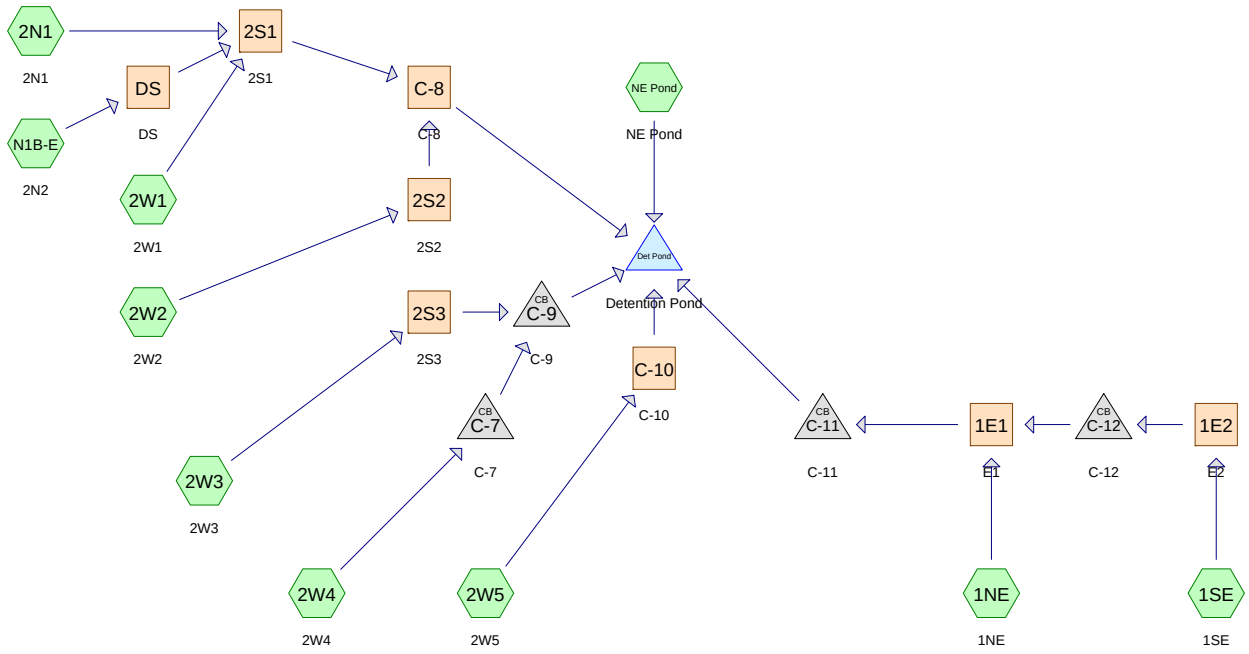
BRIDGETON LANDFILL, LLC.
BRIDGETON LANDFILL
BRIDGETON, MISSOURI

NORTH QUARRY - EVOH COVER DESIGN
CAP PHASE 1A AND 1B DRAINAGE AREA MAP

FIGURE NO. **2**
PROJECT NO. 160512

1" 1/2" 0" 1"

File: K:\PROJECTS\BRIDGETON (MO)\160512 - NORTH QUARRY EVOH COVER DESIGN_Plan Set_RESPONSE TO COMMENTS SEPT 2016\APRIL 2016 NQ Fig 2-drainage area.dwg Layout: FIG1-DRAINAGE AREA User: edward.jarman Sep 30, 2016 - 8:17am



Subcat Reach Pond Link

Routing Diagram for Stormwater Calculations for EVOH Cap Phases 1A & 1B

Prepared by Cornerstone, Printed 9/30/2016

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.510	98	(NE Pond)
6.780	100	(1NE, 1SE, 2N1, 2W1, 2W2, 2W3, 2W4, 2W5, N1B-E)

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
7.290	Other	1NE, 1SE, 2N1, 2W1, 2W2, 2W3, 2W4, 2W5, N1B-E, NE Pond

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	7.290	7.290		1NE, 1SE, 2N1, 2W1, 2W2, 2W3, 2W4, 2W5, N1B-E, NE Pond

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	C-10	485.23	484.94	30.0	0.0097	0.012	18.0	0.0	0.0
2	C-8	484.40	483.40	30.0	0.0333	0.012	18.0	0.0	0.0
3	C-11	483.00	482.70	30.0	0.0100	0.012	24.0	0.0	0.0
4	C-12	483.60	483.45	20.0	0.0075	0.012	24.0	0.0	0.0
5	C-7	491.00	489.00	20.0	0.1000	0.012	24.0	0.0	0.0
6	C-9	485.90	484.90	30.0	0.0333	0.012	18.0	0.0	0.0
7	Det Pond	479.91	476.48	442.4	0.0078	0.012	18.0	0.0	0.0

Time span=0.00-120.00 hrs, dt=0.01 hrs, 12001 points x 9
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1NE: 1NE Runoff Area=0.740 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=265' Slope=0.0490 '/' Tc=1.8 min CN=100 Runoff=7.23 cfs 0.370 af

Subcatchment 1SE: 1SE Runoff Area=1.460 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=345' Tc=3.1 min CN=100 Runoff=13.72 cfs 0.730 af

Subcatchment 2N1: 2N1 Runoff Area=0.630 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=620' Tc=2.2 min CN=100 Runoff=6.08 cfs 0.315 af

Subcatchment 2W1: 2W1 Runoff Area=0.380 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=140' Slope=0.1500 '/' Tc=0.7 min CN=100 Runoff=3.83 cfs 0.190 af

Subcatchment 2W2: 2W2 Runoff Area=0.360 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=180' Slope=0.1300 '/' Tc=0.9 min CN=100 Runoff=3.61 cfs 0.180 af

Subcatchment 2W3: 2W3 Runoff Area=0.550 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=285' Slope=0.1000 '/' Tc=1.4 min CN=100 Runoff=5.43 cfs 0.275 af

Subcatchment 2W4: 2W4 Runoff Area=1.280 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=300' Slope=0.1100 '/' Tc=1.4 min CN=100 Runoff=12.64 cfs 0.640 af

Subcatchment 2W5: 2W5 Runoff Area=0.700 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=300' Slope=0.1100 '/' Tc=1.4 min CN=100 Runoff=6.91 cfs 0.350 af

Subcatchment N1B-E: 2N2 Runoff Area=0.680 ac 100.00% Impervious Runoff Depth=6.00"
Flow Length=580' Tc=2.4 min CN=100 Runoff=6.53 cfs 0.340 af

Subcatchment NE Pond: NE Pond Runoff Area=0.510 ac 100.00% Impervious Runoff Depth=5.76"
Tc=1.0 min CN=98 Runoff=5.08 cfs 0.245 af

Reach 1E1: E1 Avg. Flow Depth=1.21' Max Vel=7.65 fps Inflow=20.36 cfs 1.100 af
n=0.012 L=60.0' S=0.0075 '/' Capacity=150.53 cfs Outflow=20.36 cfs 1.100 af

Reach 1E2: E2 Avg. Flow Depth=0.99' Max Vel=6.92 fps Inflow=13.72 cfs 0.730 af
n=0.012 L=310.0' S=0.0075 '/' Capacity=99.14 cfs Outflow=13.57 cfs 0.730 af

Reach 2S1: 2S1 Avg. Flow Depth=0.66' Max Vel=7.19 fps Inflow=15.83 cfs 0.845 af
n=0.012 L=200.0' S=0.0100 '/' Capacity=158.01 cfs Outflow=15.78 cfs 0.845 af

Reach 2S2: 2S2 Avg. Flow Depth=0.30' Max Vel=4.66 fps Inflow=3.61 cfs 0.180 af
n=0.012 L=100.0' S=0.0100 '/' Capacity=158.01 cfs Outflow=3.57 cfs 0.180 af

Reach 2S3: 2S3 Avg. Flow Depth=0.37' Max Vel=5.29 fps Inflow=5.43 cfs 0.275 af
n=0.012 L=65.0' S=0.0100 '/' Capacity=158.01 cfs Outflow=5.42 cfs 0.275 af

Reach C-10: C-10 Avg. Flow Depth=0.85' Max Vel=6.66 fps Inflow=6.91 cfs 0.350 af
18.0" Round Pipe n=0.012 L=30.0' S=0.0097 '/' Capacity=11.19 cfs Outflow=6.91 cfs 0.350 af

Reach C-8: C-8 Avg. Flow Depth=1.14' Max Vel=13.35 fps Inflow=19.24 cfs 1.025 af
18.0" Round Pipe n=0.012 L=30.0' S=0.0333 '/' Capacity=20.78 cfs Outflow=19.24 cfs 1.025 af

Reach DS: DS Avg. Flow Depth=0.14' Max Vel=4.55 fps Inflow=6.53 cfs 0.340 af
n=0.012 L=300.0' S=0.0200 '/' Capacity=378.55 cfs Outflow=6.42 cfs 0.340 af

Pond C-11: C-11 Peak Elev=486.91' Inflow=20.36 cfs 1.100 af
24.0" Round Culvert n=0.012 L=30.0' S=0.0100 '/' Outflow=20.36 cfs 1.100 af

Pond C-12: C-12 Peak Elev=485.94' Inflow=13.57 cfs 0.730 af
24.0" Round Culvert n=0.012 L=20.0' S=0.0075 '/' Outflow=13.57 cfs 0.730 af

Pond C-7: C-7 Peak Elev=493.12' Inflow=12.64 cfs 0.640 af
24.0" Round Culvert n=0.012 L=20.0' S=0.1000 '/' Outflow=12.64 cfs 0.640 af

Pond C-9: C-9 Peak Elev=487.10' Inflow=18.06 cfs 0.915 af
Outflow=18.06 cfs 0.915 af

Pond Det Pond: Detention Pond Peak Elev=483.82' Storage=1.399 af Inflow=68.98 cfs 3.635 af
18.0" Round Culvert n=0.012 L=442.4' S=0.0078 '/' Outflow=11.82 cfs 3.598 af

Summary for Subcatchment 1NE: 1NE

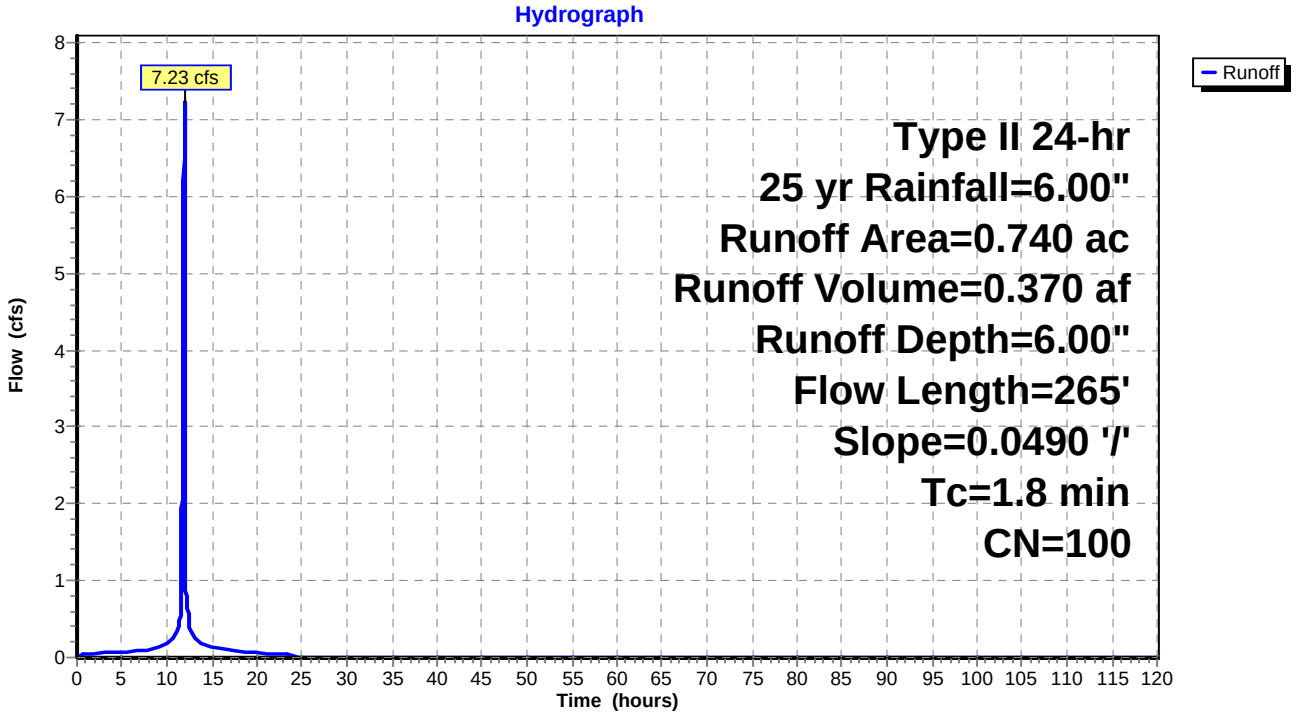
Runoff = 7.23 cfs @ 11.92 hrs, Volume= 0.370 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.740	100	
	0.740		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	265	0.0490	2.50		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.50"

Subcatchment 1NE: 1NE



Summary for Subcatchment 1SE: 1SE

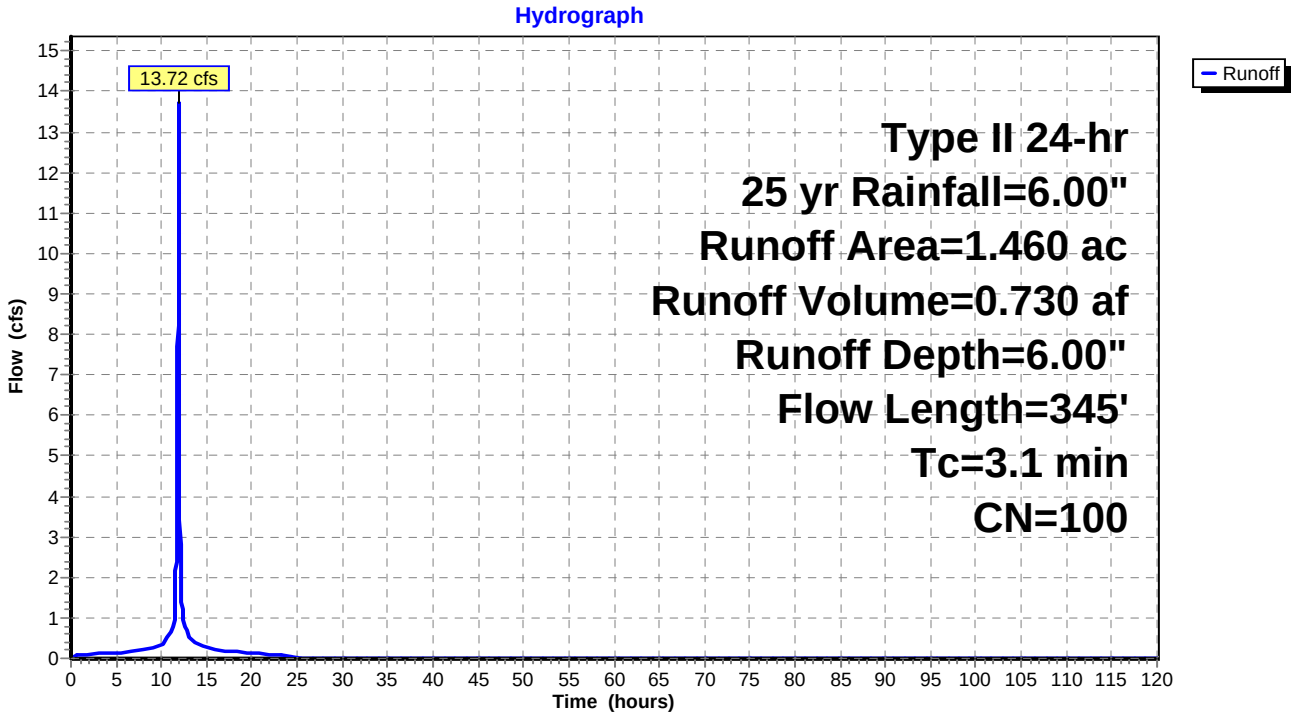
Runoff = 13.72 cfs @ 11.93 hrs, Volume= 0.730 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	1.460	100	
	1.460		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.2	35	0.1140	2.34		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.50"
2.9	310	0.0075	1.76		**Shallow Concentrated Flow, Lined Channel** Paved Kv= 20.3 fps
3.1	345	Total			

Subcatchment 1SE: 1SE



Summary for Subcatchment 2N1: 2N1

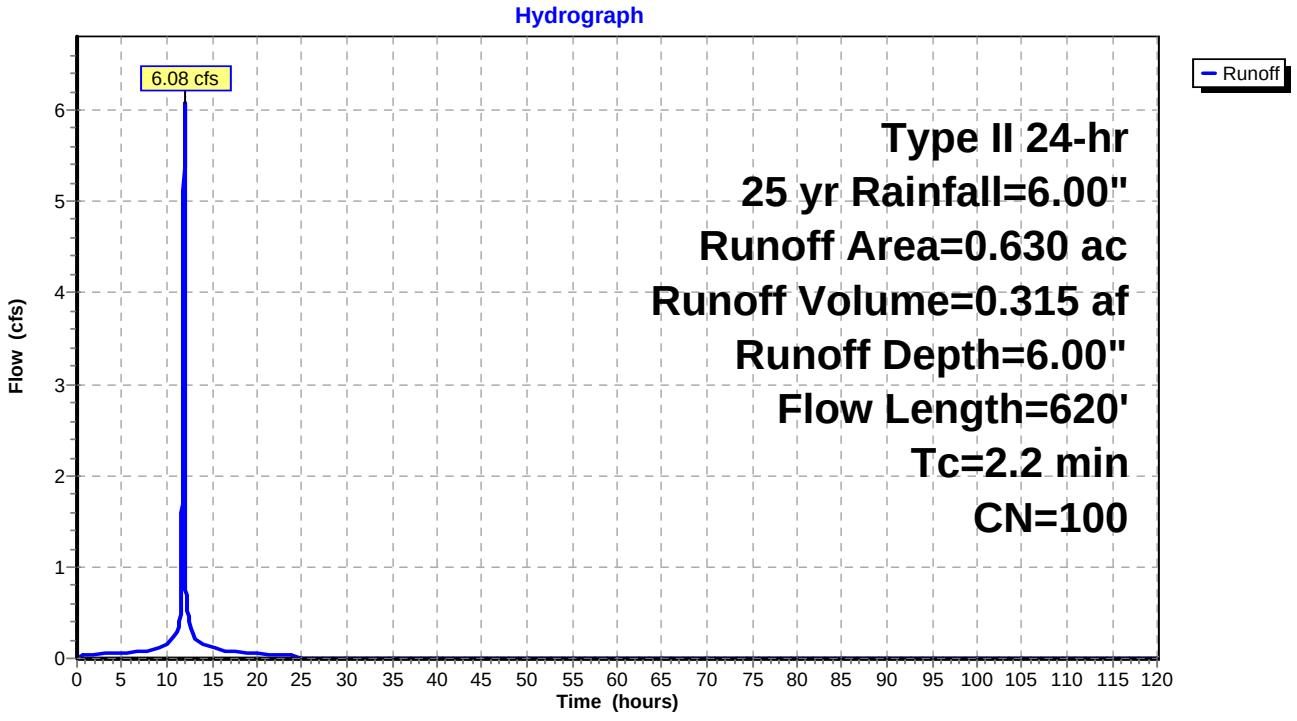
Runoff = 6.08 cfs @ 11.92 hrs, Volume= 0.315 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.630	100	
	0.630		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	60	0.2300	3.45		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
1.9	560	0.0600	4.97		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.2	620	Total			

Subcatchment 2N1: 2N1



Summary for Subcatchment 2W1: 2W1

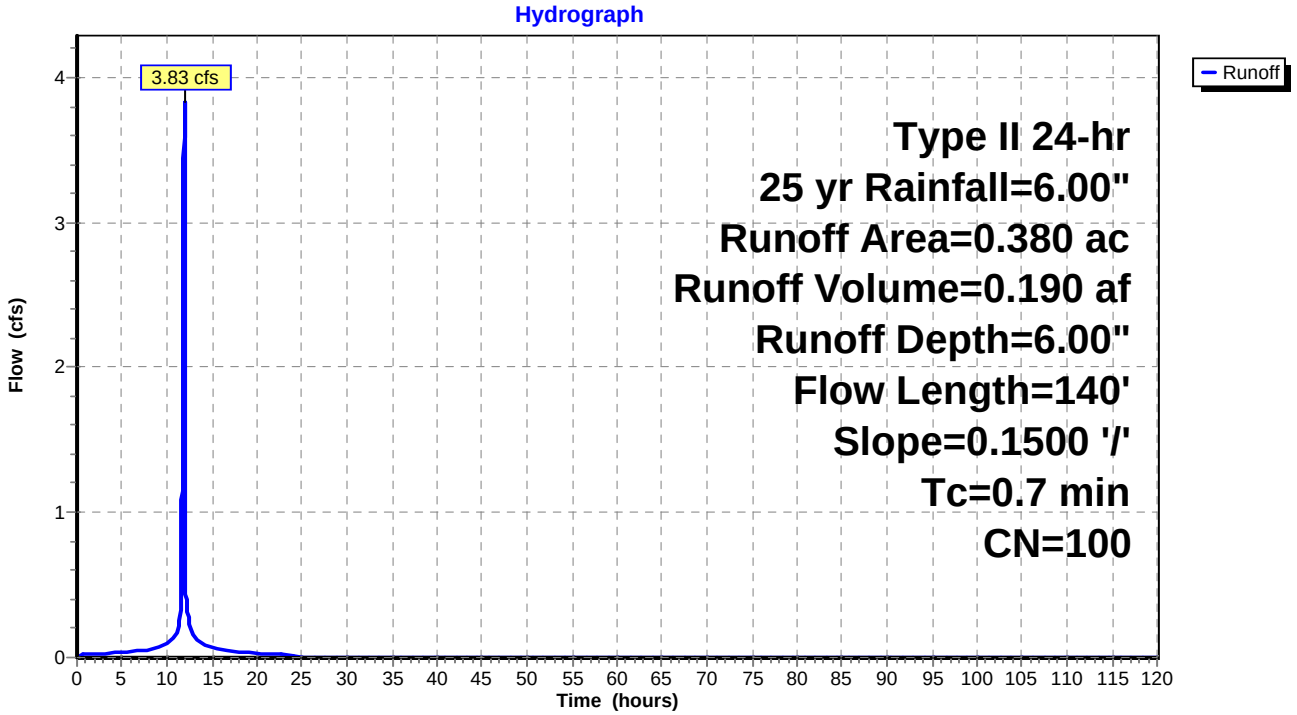
Runoff = 3.83 cfs @ 11.91 hrs, Volume= 0.190 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.380	100	
	0.380		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	140	0.1500	3.44		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"

Subcatchment 2W1: 2W1



Summary for Subcatchment 2W2: 2W2

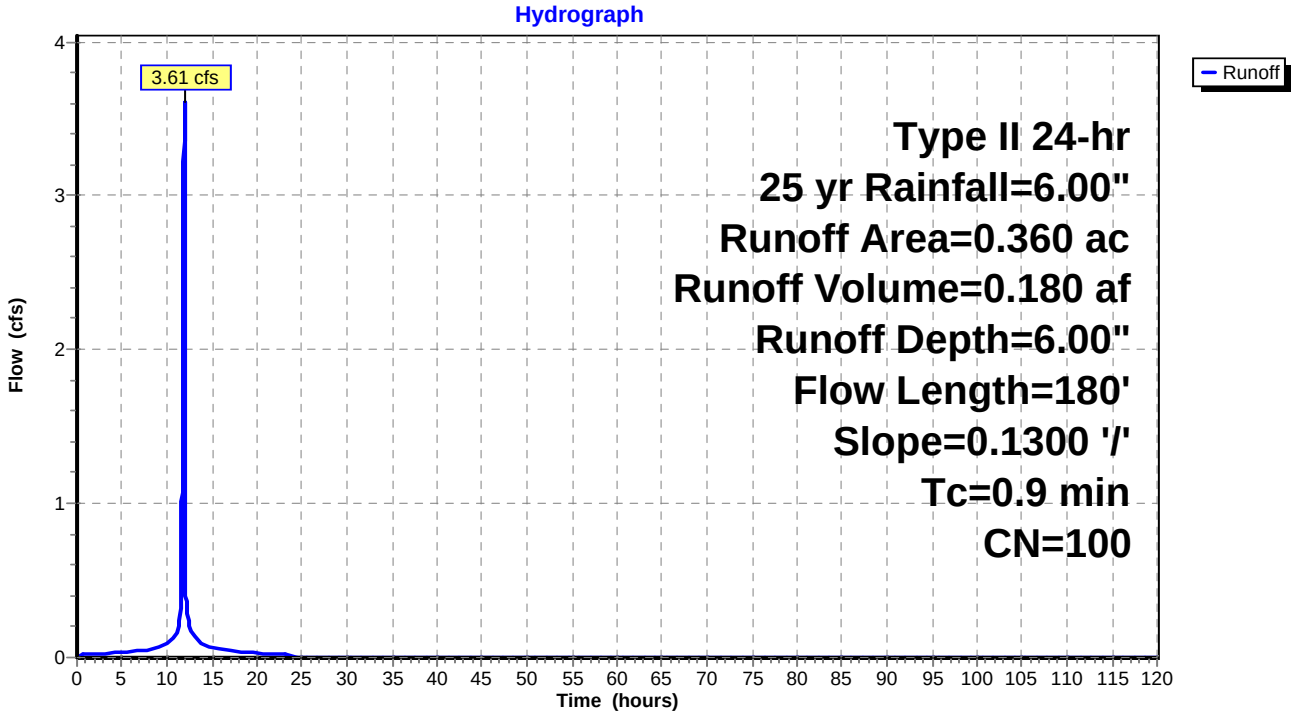
Runoff = 3.61 cfs @ 11.91 hrs, Volume= 0.180 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.360	100	
	0.360		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	180	0.1300	3.42		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"

Subcatchment 2W2: 2W2



Summary for Subcatchment 2W3: 2W3

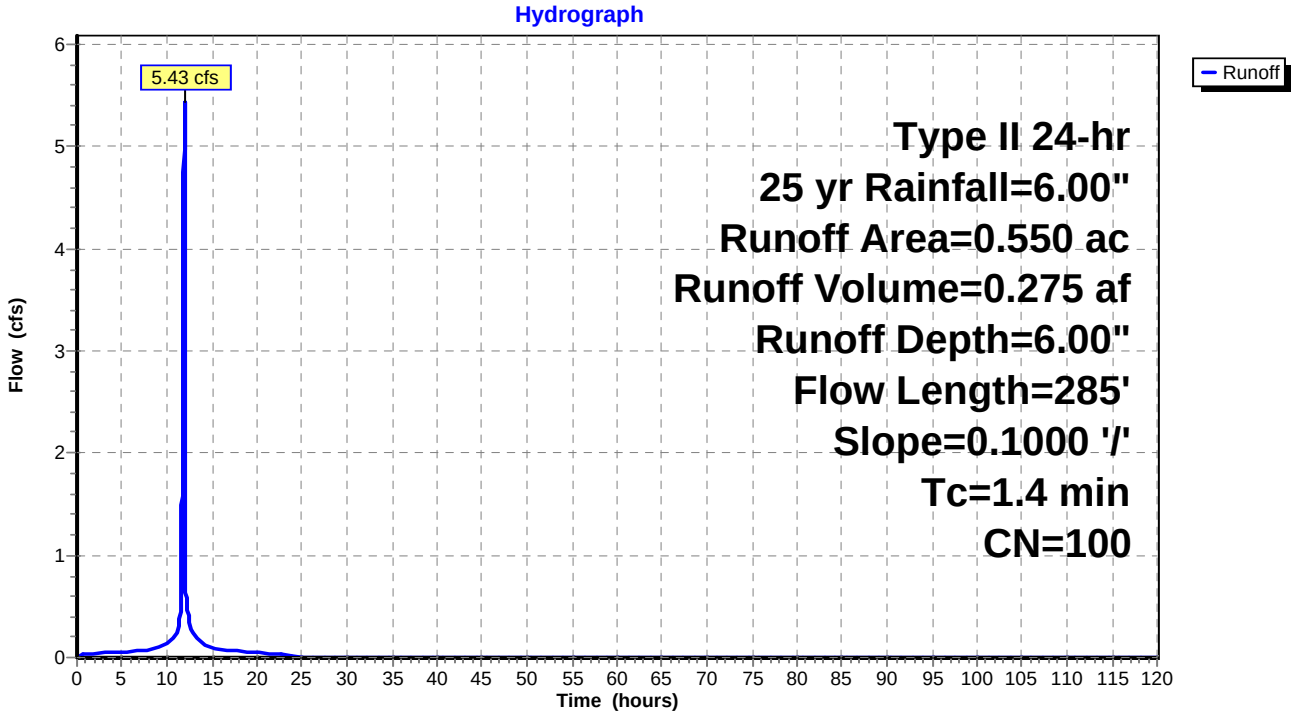
Runoff = 5.43 cfs @ 11.92 hrs, Volume= 0.275 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.550	100	
	0.550		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	285	0.1000	3.38		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"

Subcatchment 2W3: 2W3



Summary for Subcatchment 2W4: 2W4

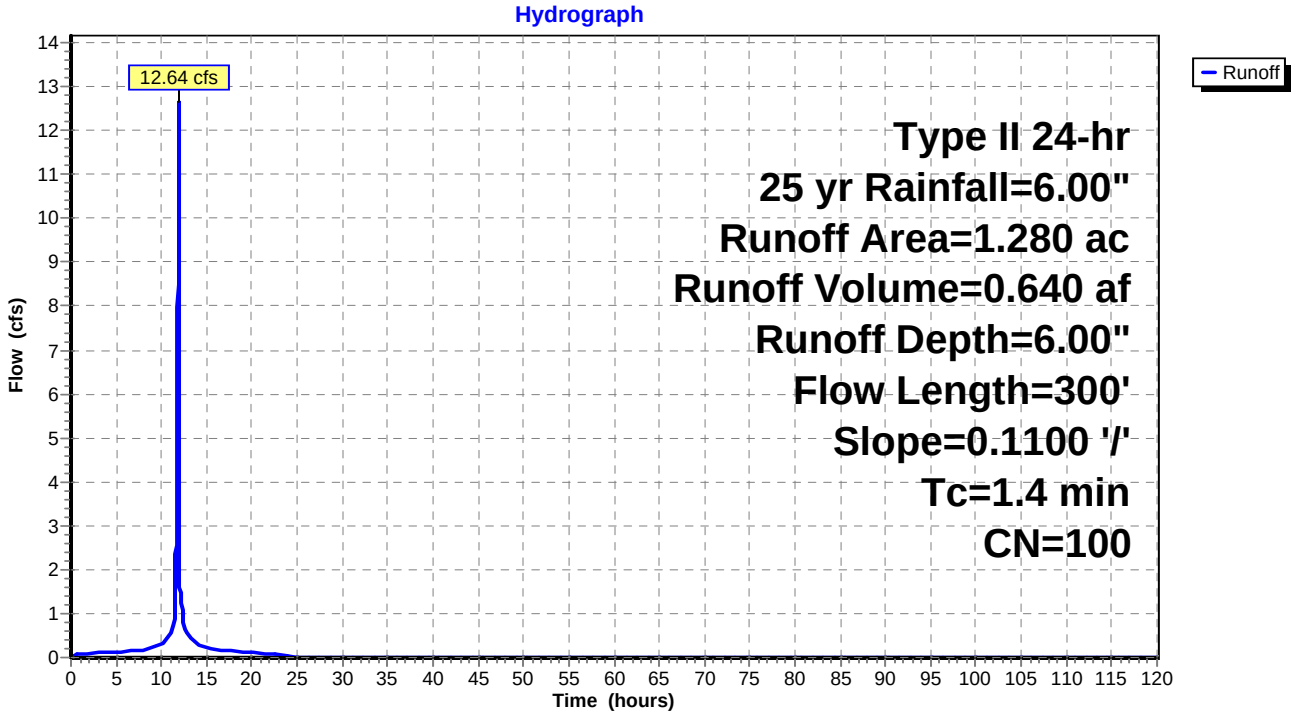
Runoff = 12.64 cfs @ 11.92 hrs, Volume= 0.640 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	1.280	100	
	1.280		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	300	0.1100	3.54		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"

Subcatchment 2W4: 2W4



Summary for Subcatchment 2W5: 2W5

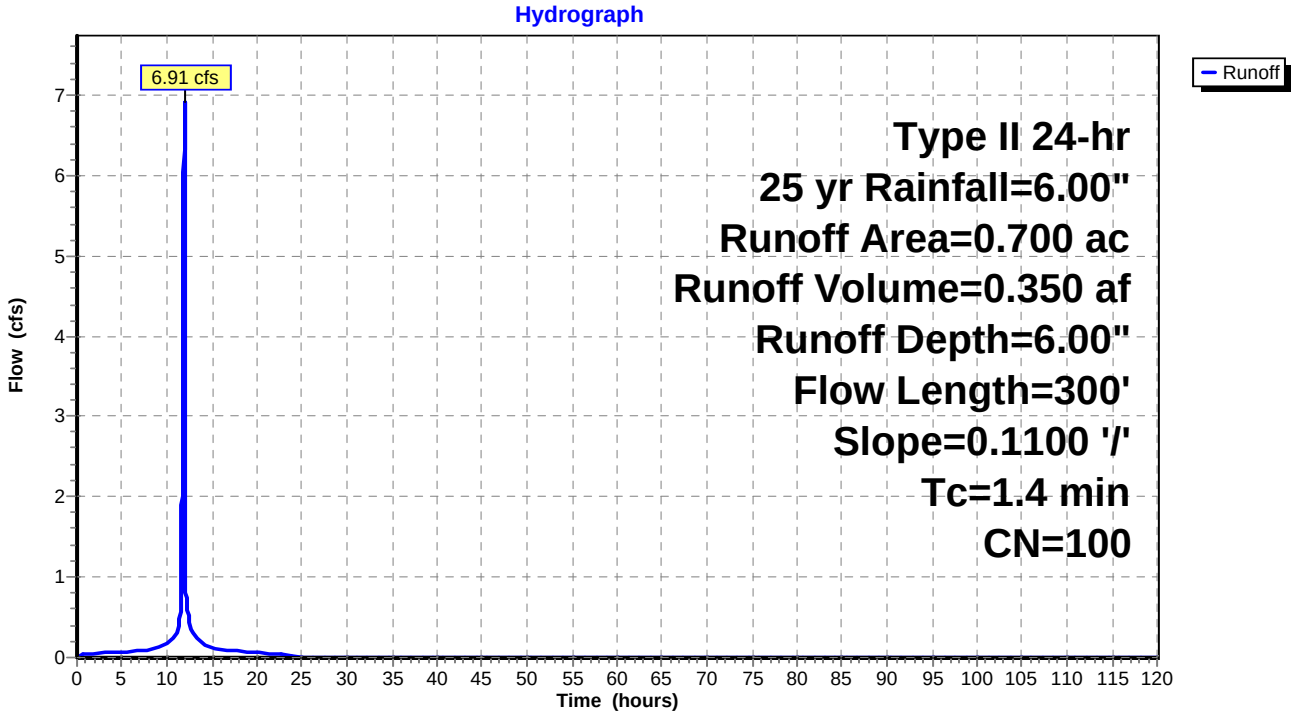
Runoff = 6.91 cfs @ 11.92 hrs, Volume= 0.350 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.700	100	
	0.700		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	300	0.1100	3.54		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"

Subcatchment 2W5: 2W5



Summary for Subcatchment N1B-E: 2N2

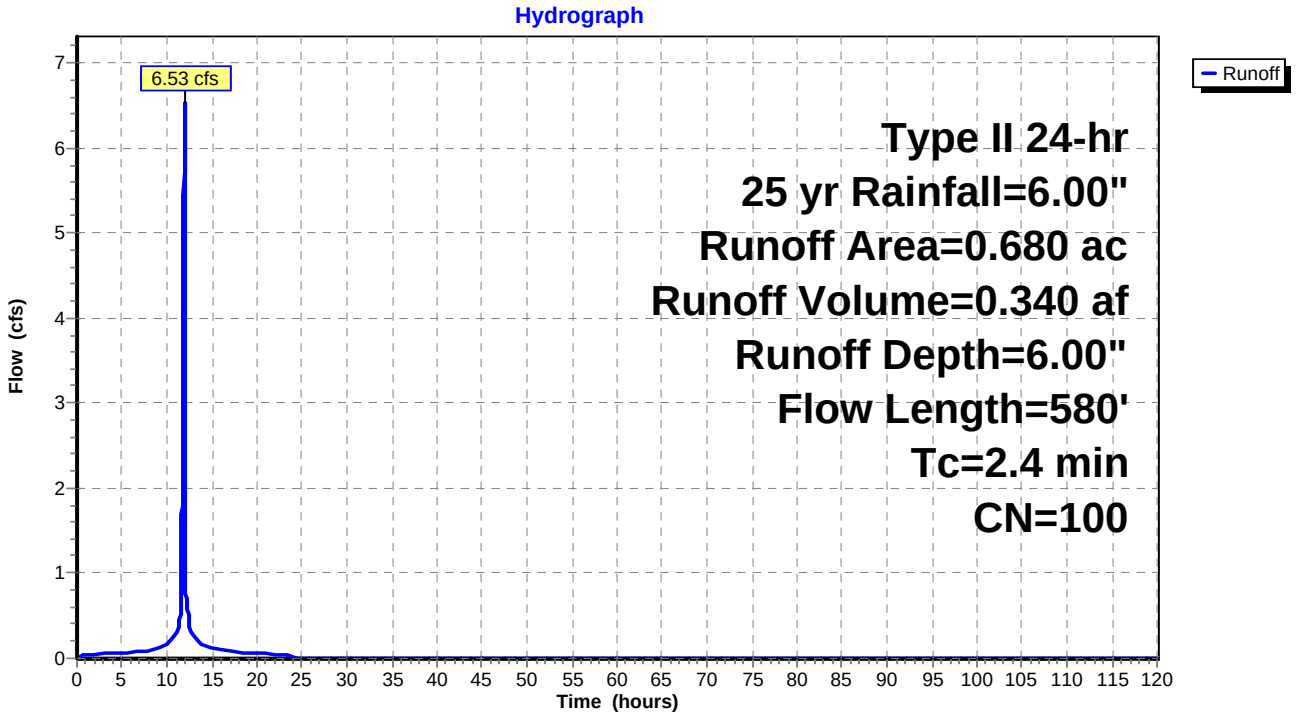
Runoff = 6.53 cfs @ 11.93 hrs, Volume= 0.340 af, Depth= 6.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.680	100	
	0.680		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	80	0.0700	2.27		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.50"
1.8	500	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.4	580	Total			

Subcatchment N1B-E: 2N2



Summary for Subcatchment NE Pond: NE Pond

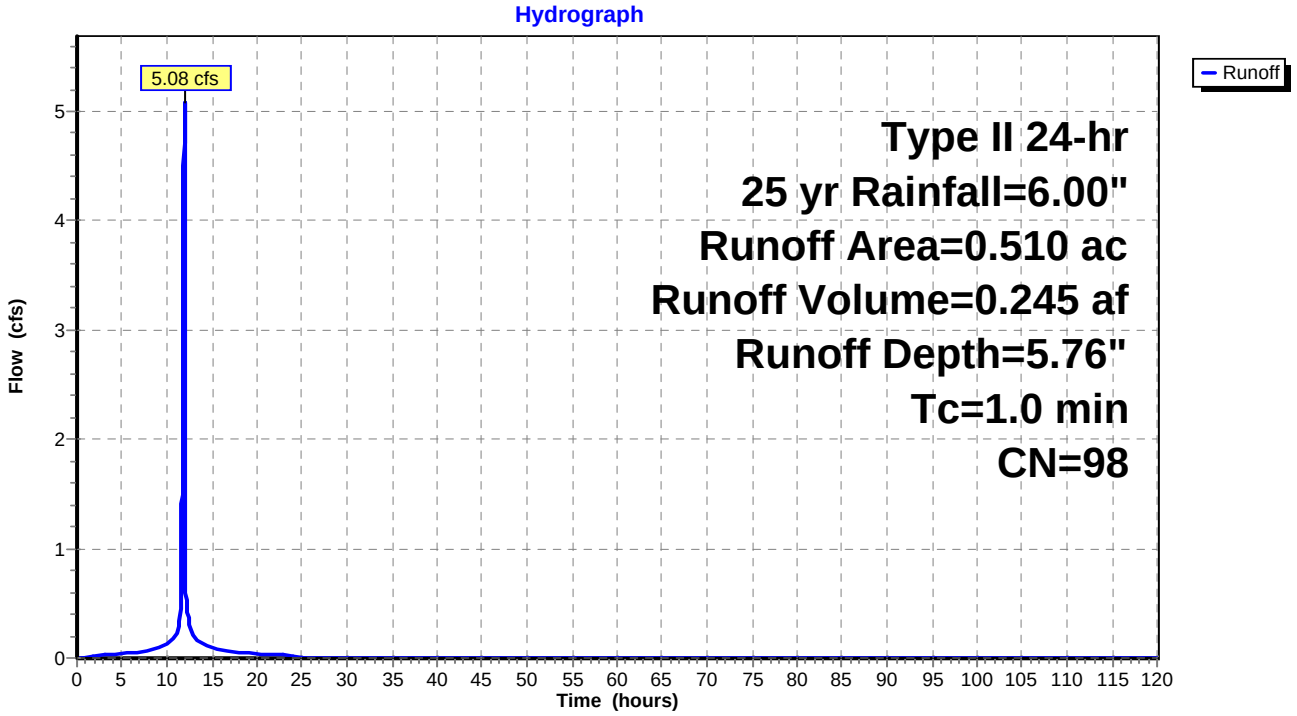
Runoff = 5.08 cfs @ 11.91 hrs, Volume= 0.245 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs
Type II 24-hr 25 yr Rainfall=6.00"

	Area (ac)	CN	Description
*	0.510	98	
	0.510		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0					**Direct Entry,**

Subcatchment NE Pond: NE Pond



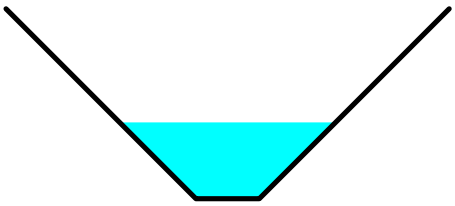
Summary for Reach 1E1: E1

Inflow Area = 2.200 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 20.36 cfs @ 11.93 hrs, Volume= 1.100 af
Outflow = 20.36 cfs @ 11.93 hrs, Volume= 1.100 af, Atten= 0%, Lag= 0.1 min

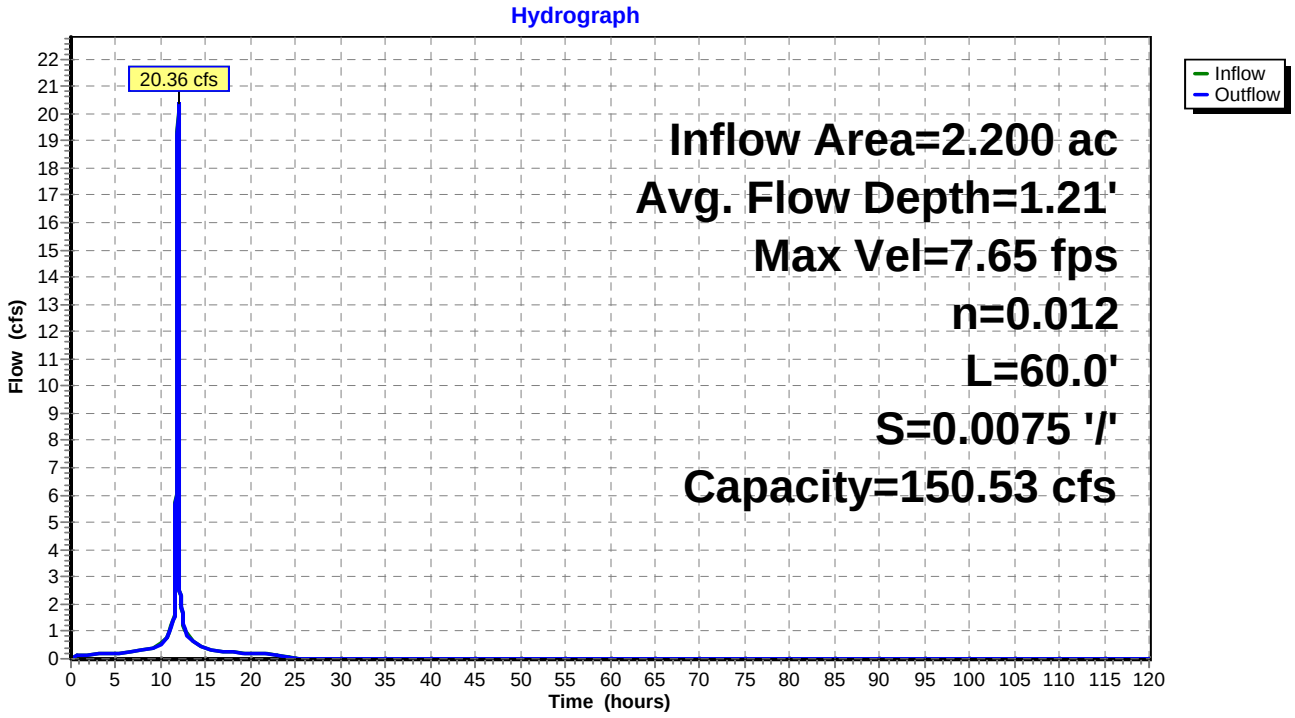
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 7.65 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.32 fps, Avg. Travel Time= 0.4 min

Peak Storage= 160 cf @ 11.93 hrs
Average Depth at Peak Storage= 1.21'
Bank-Full Depth= 3.00' Flow Area= 12.0 sf, Capacity= 150.53 cfs

1.00' x 3.00' deep channel, n= 0.012
Side Slope Z-value= 1.0 '/' Top Width= 7.00'
Length= 60.0' Slope= 0.0075 '/'
Inlet Invert= 483.45', Outlet Invert= 483.00'



Reach 1E1: E1



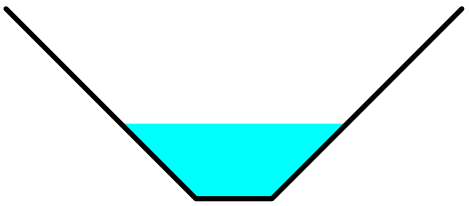
Summary for Reach 1E2: E2

Inflow Area = 1.460 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 13.72 cfs @ 11.93 hrs, Volume= 0.730 af
Outflow = 13.57 cfs @ 11.94 hrs, Volume= 0.730 af, Atten= 1%, Lag= 0.5 min

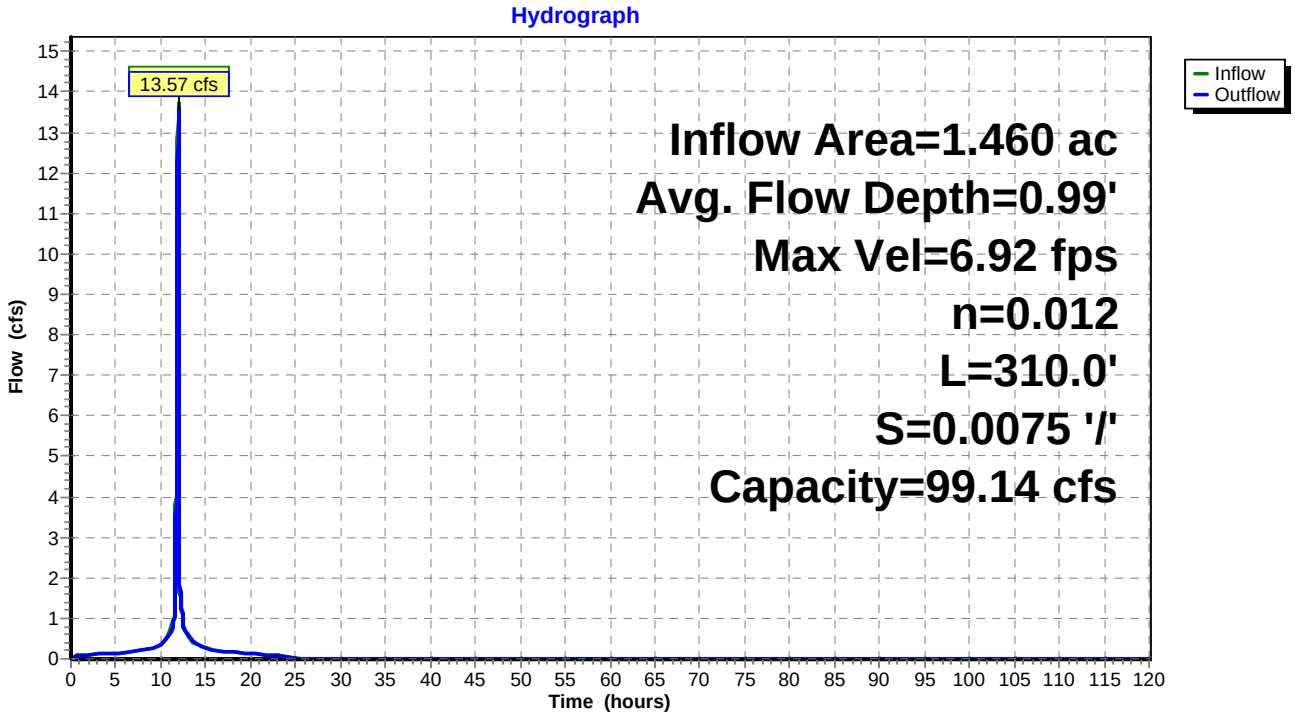
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 6.92 fps, Min. Travel Time= 0.7 min
Avg. Velocity = 2.02 fps, Avg. Travel Time= 2.6 min

Peak Storage= 608 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.99'
Bank-Full Depth= 2.50' Flow Area= 8.8 sf, Capacity= 99.14 cfs

1.00' x 2.50' deep channel, n= 0.012
Side Slope Z-value= 1.0 '/' Top Width= 6.00'
Length= 310.0' Slope= 0.0075 '/'
Inlet Invert= 485.93', Outlet Invert= 483.60'



Reach 1E2: E2



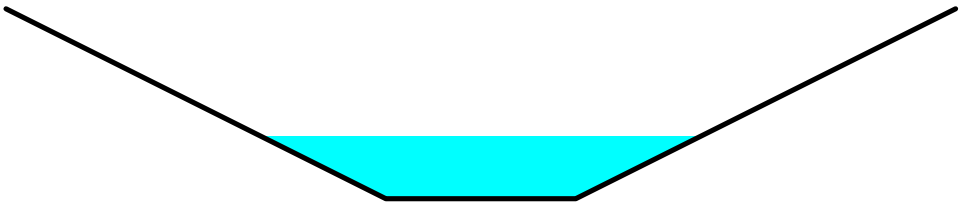
Summary for Reach 2S1: 2S1

Inflow Area = 1.690 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 15.83 cfs @ 11.92 hrs, Volume= 0.845 af
Outflow = 15.78 cfs @ 11.93 hrs, Volume= 0.845 af, Atten= 0%, Lag= 0.3 min

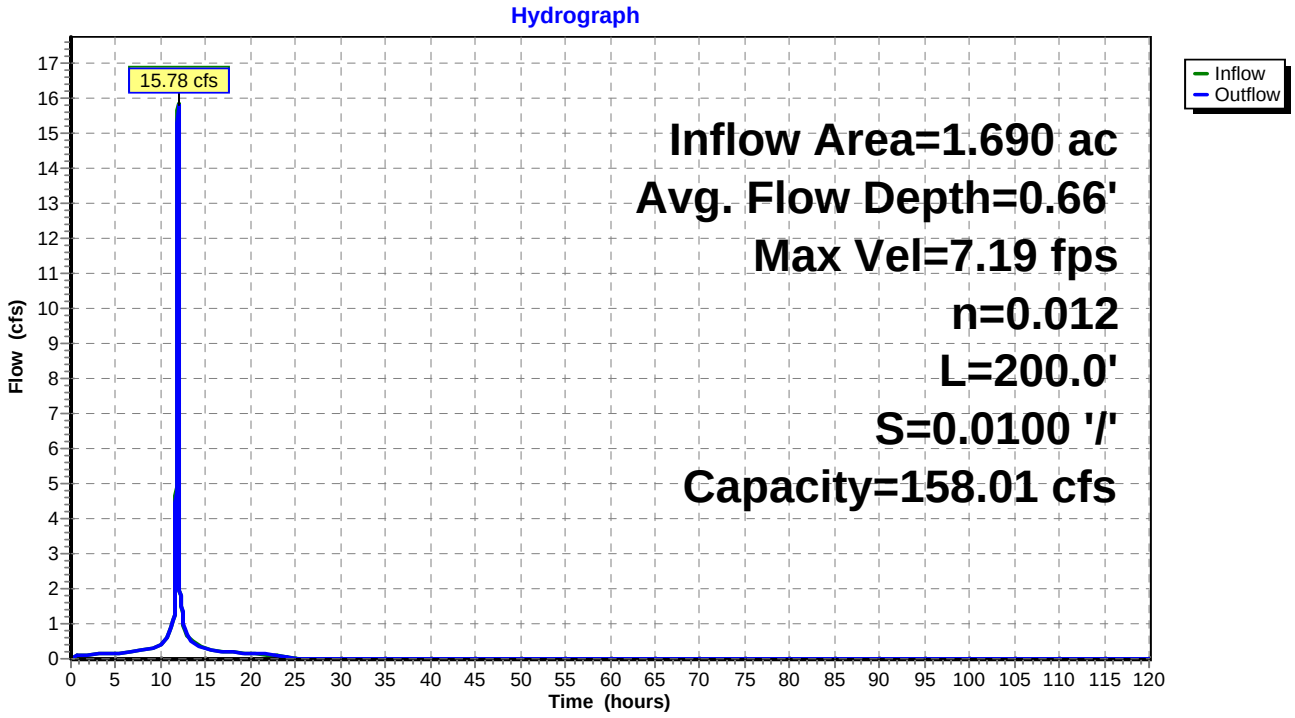
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 7.19 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.86 fps, Avg. Travel Time= 1.8 min

Peak Storage= 439 cf @ 11.93 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 158.01 cfs

2.00' x 2.00' deep channel, n= 0.012 EVOH
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 200.0' Slope= 0.0100 '/'
Inlet Invert= 486.40', Outlet Invert= 484.40'



Reach 2S1: 2S1



Summary for Reach 2S2: 2S2

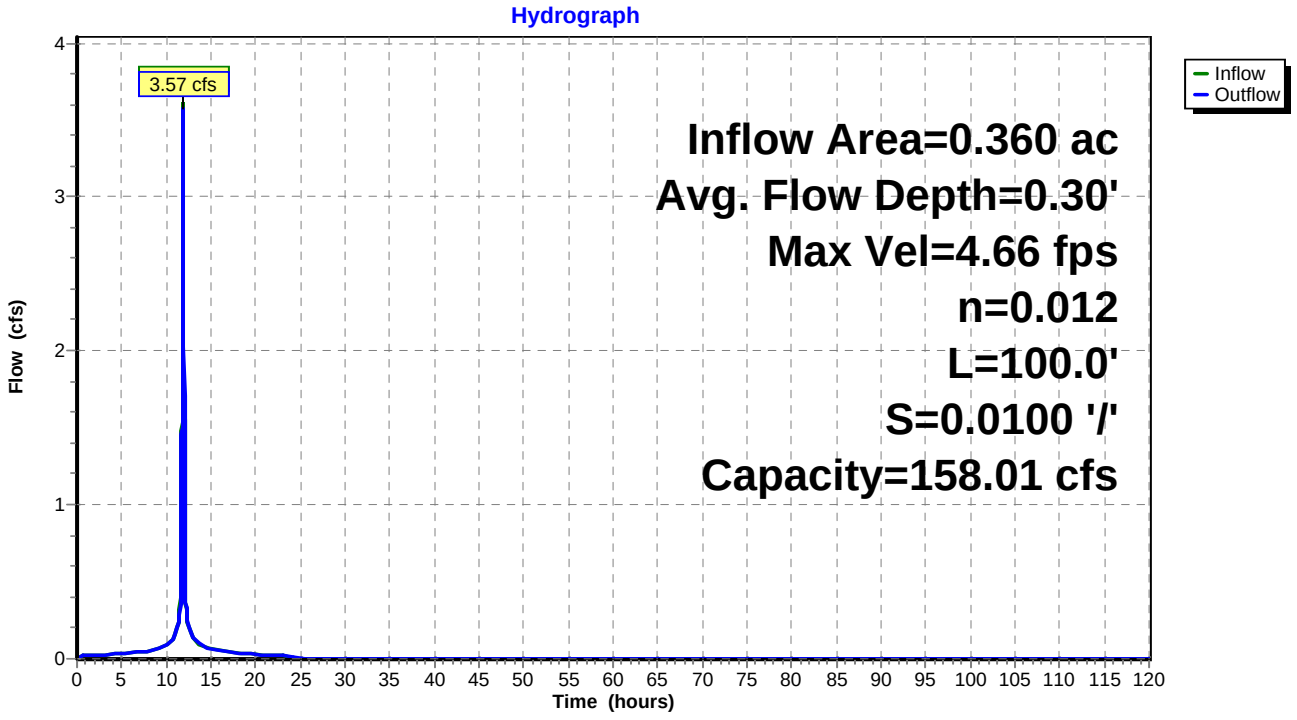
Inflow Area = 0.360 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 3.61 cfs @ 11.91 hrs, Volume= 0.180 af
Outflow = 3.57 cfs @ 11.91 hrs, Volume= 0.180 af, Atten= 1%, Lag= 0.2 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 4.66 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 1.5 min

Peak Storage= 77 cf @ 11.91 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 158.01 cfs

2.00' x 2.00' deep channel, n= 0.012 EVOH
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 100.0' Slope= 0.0100 '/'
Inlet Invert= 485.40', Outlet Invert= 484.40'

Reach 2S2: 2S2



Summary for Reach 2S3: 2S3

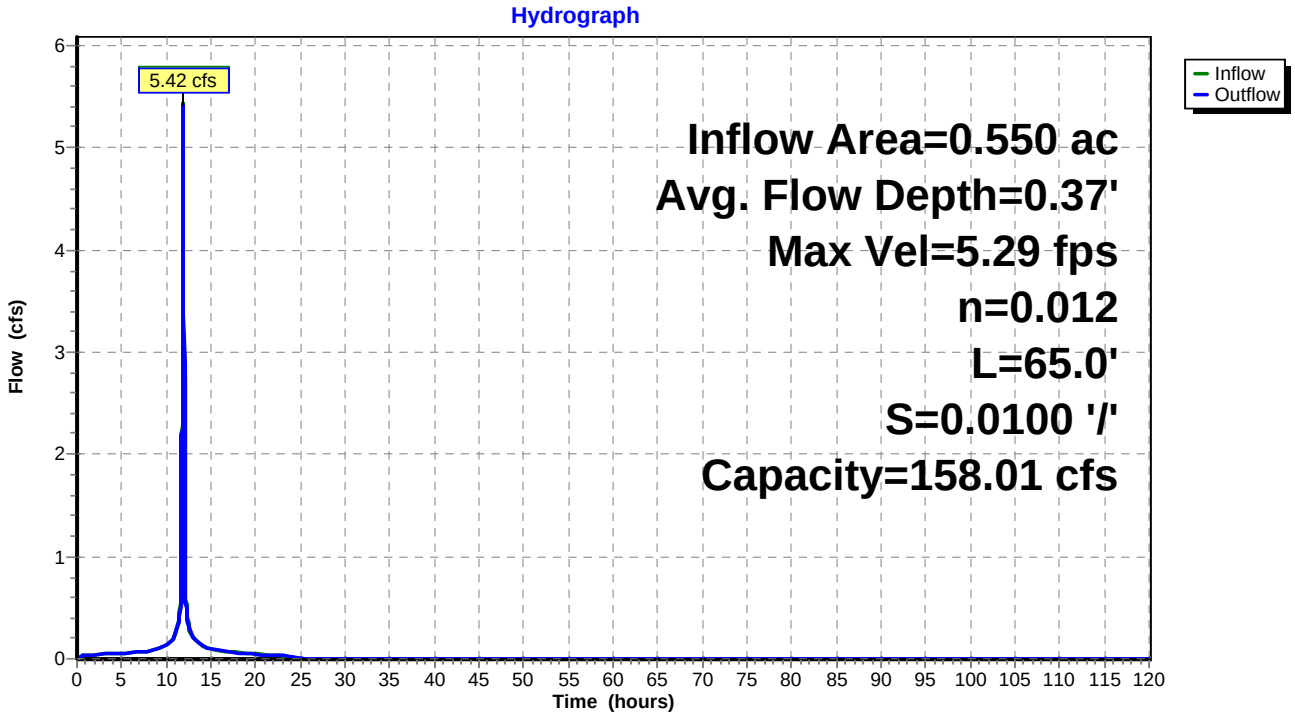
Inflow Area = 0.550 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 5.43 cfs @ 11.92 hrs, Volume= 0.275 af
Outflow = 5.42 cfs @ 11.92 hrs, Volume= 0.275 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 5.29 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 0.9 min

Peak Storage= 67 cf @ 11.92 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 2.00' Flow Area= 12.0 sf, Capacity= 158.01 cfs

2.00' x 2.00' deep channel, n= 0.012 EVOH
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 65.0' Slope= 0.0100 '/'
Inlet Invert= 485.05', Outlet Invert= 484.40'

Reach 2S3: 2S3



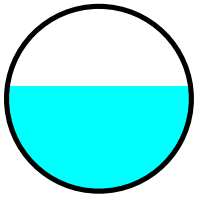
Summary for Reach C-10: C-10

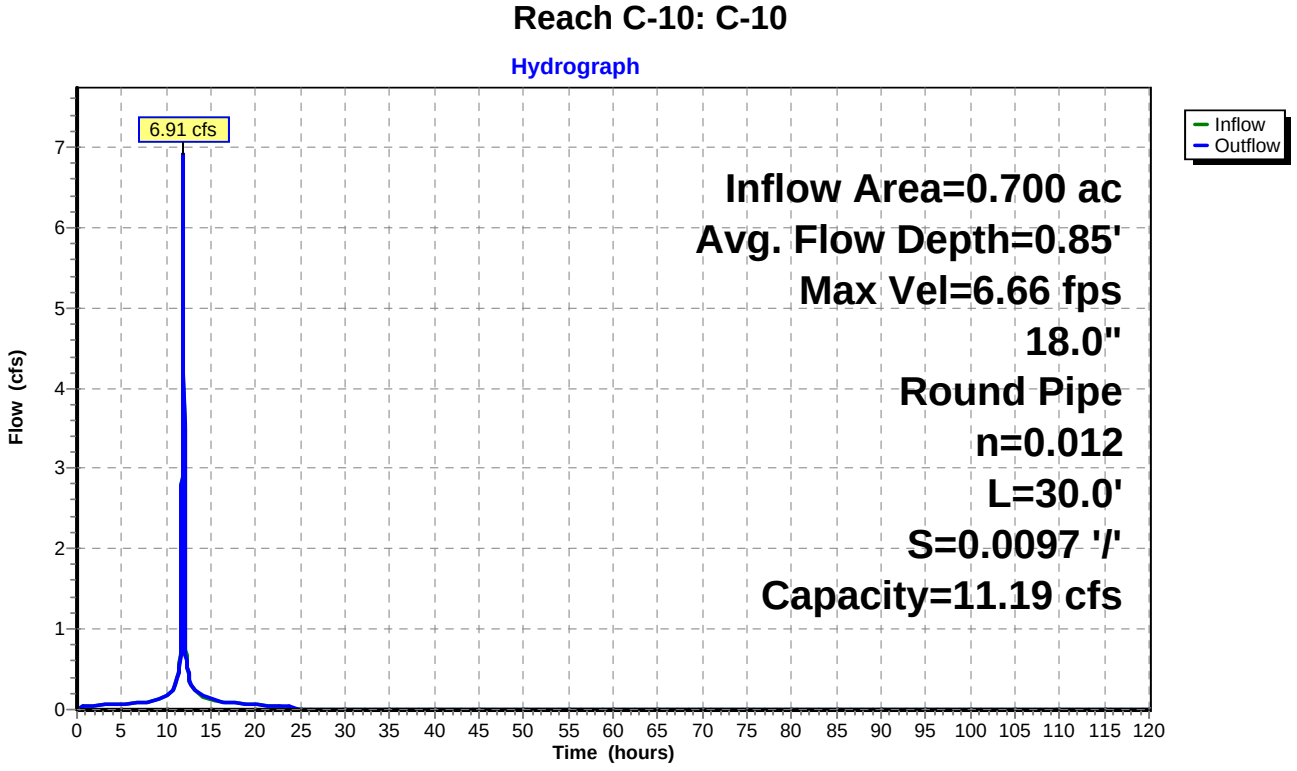
Inflow Area = 0.700 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 6.91 cfs @ 11.92 hrs, Volume= 0.350 af
Outflow = 6.91 cfs @ 11.92 hrs, Volume= 0.350 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 6.66 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.99 fps, Avg. Travel Time= 0.3 min

Peak Storage= 31 cf @ 11.92 hrs
Average Depth at Peak Storage= 0.85'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 11.19 cfs

18.0" Round Pipe
n= 0.012
Length= 30.0' Slope= 0.0097 '/'
Inlet Invert= 485.23', Outlet Invert= 484.94'





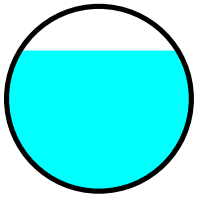
Summary for Reach C-8: C-8

Inflow Area = 2.050 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 19.24 cfs @ 11.92 hrs, Volume= 1.025 af
Outflow = 19.24 cfs @ 11.92 hrs, Volume= 1.025 af, Atten= 0%, Lag= 0.0 min

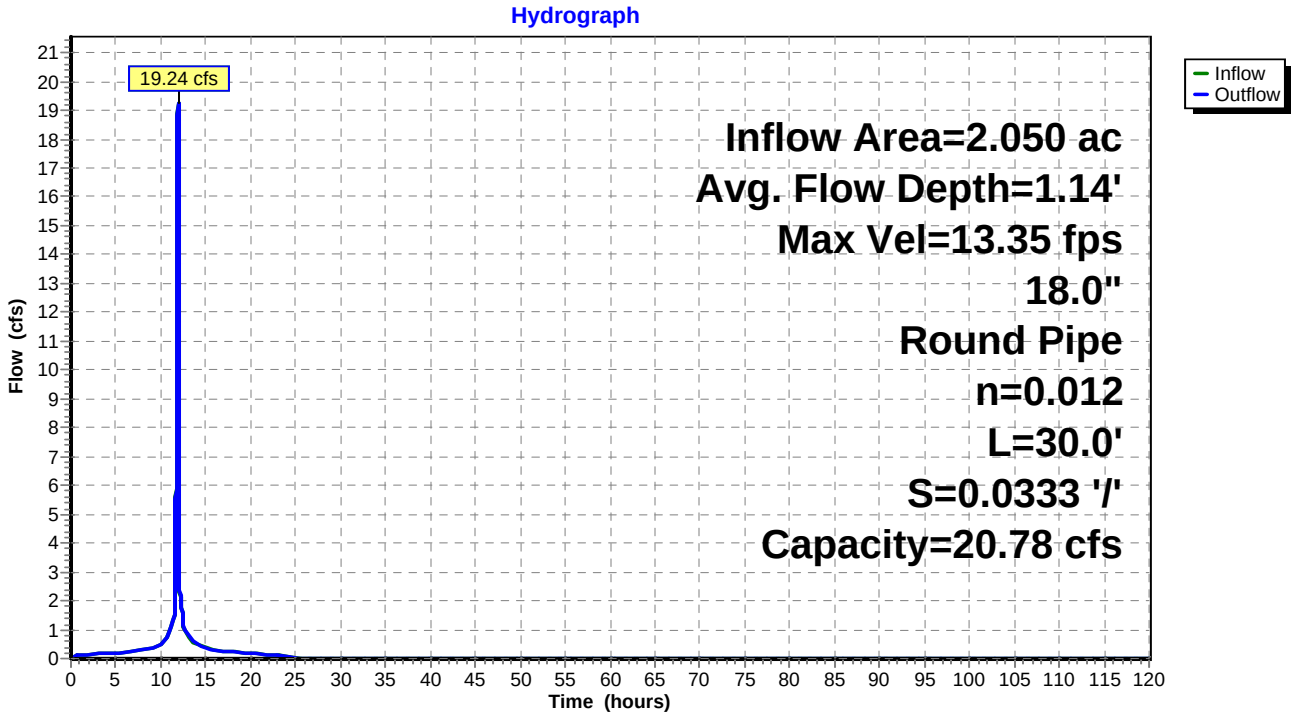
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 13.35 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 4.17 fps, Avg. Travel Time= 0.1 min

Peak Storage= 43 cf @ 11.92 hrs
Average Depth at Peak Storage= 1.14'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 20.78 cfs

18.0" Round Pipe
n= 0.012
Length= 30.0' Slope= 0.0333 '/'
Inlet Invert= 484.40', Outlet Invert= 483.40'



Reach C-8: C-8



Summary for Reach DS: DS

Inflow Area = 0.680 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 6.53 cfs @ 11.93 hrs, Volume= 0.340 af
Outflow = 6.42 cfs @ 11.94 hrs, Volume= 0.340 af, Atten= 2%, Lag= 0.6 min

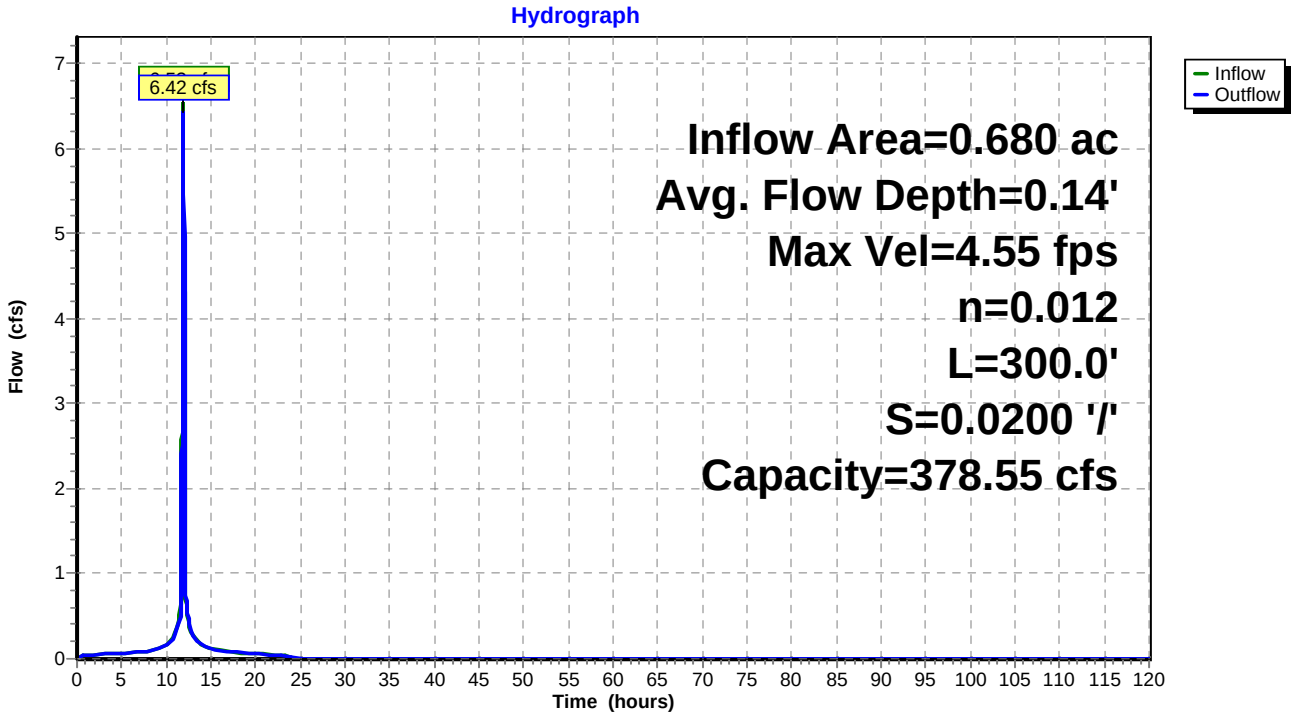
Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Max. Velocity= 4.55 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 4.3 min

Peak Storage= 422 cf @ 11.94 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.50' Flow Area= 19.5 sf, Capacity= 378.55 cfs

10.00' x 1.50' deep channel, n= 0.012
Side Slope Z-value= 2.0 '/' Top Width= 16.00'
Length= 300.0' Slope= 0.0200 '/'
Inlet Invert= 0.00', Outlet Invert= -6.00'

‡

Reach DS: DS



Summary for Pond C-11: C-11

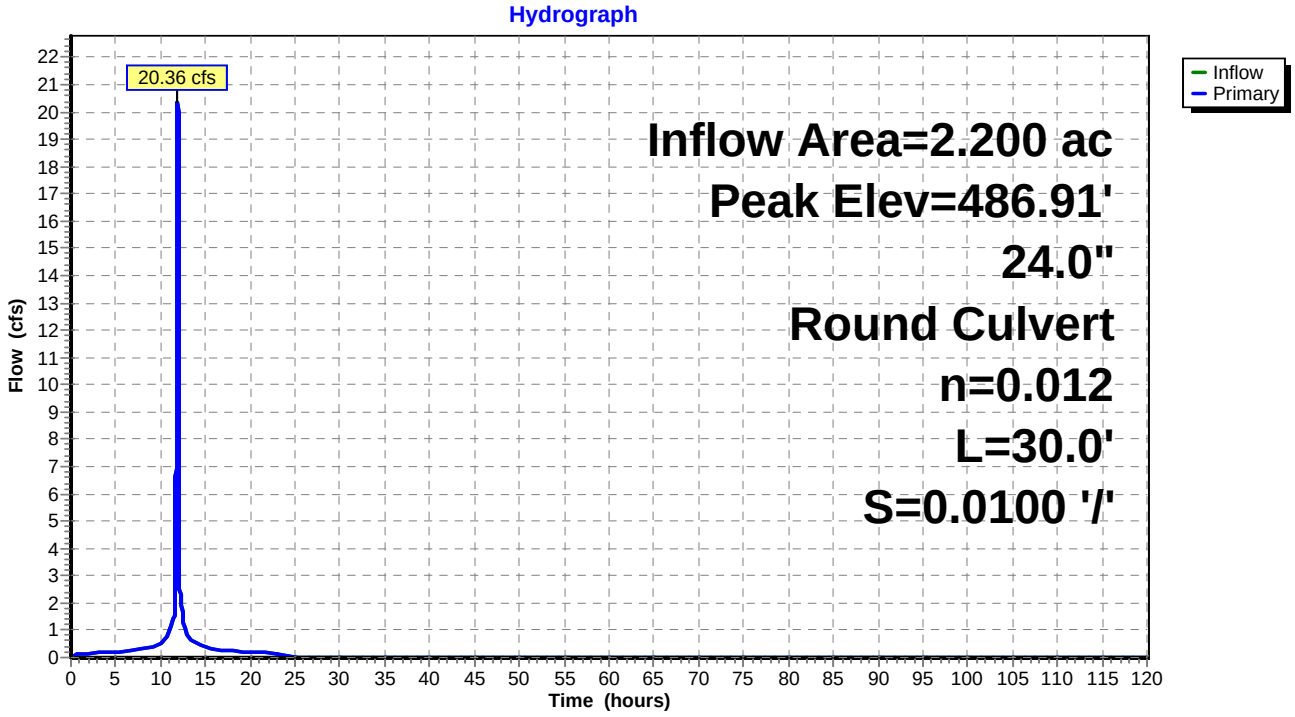
Inflow Area = 2.200 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 20.36 cfs @ 11.93 hrs, Volume= 1.100 af
Outflow = 20.36 cfs @ 11.93 hrs, Volume= 1.100 af, Atten= 0%, Lag= 0.0 min
Primary = 20.36 cfs @ 11.93 hrs, Volume= 1.100 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 486.91' @ 11.93 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	483.00'	**24.0" Round Culvert** L= 30.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 483.00' / 482.70' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Primary OutFlow Max=20.31 cfs @ 11.93 hrs HW=486.89' TW=483.13' (Dynamic Tailwater)
1=Culvert (Inlet Controls 20.31 cfs @ 6.46 fps)

Pond C-11: C-11



Summary for Pond C-12: C-12

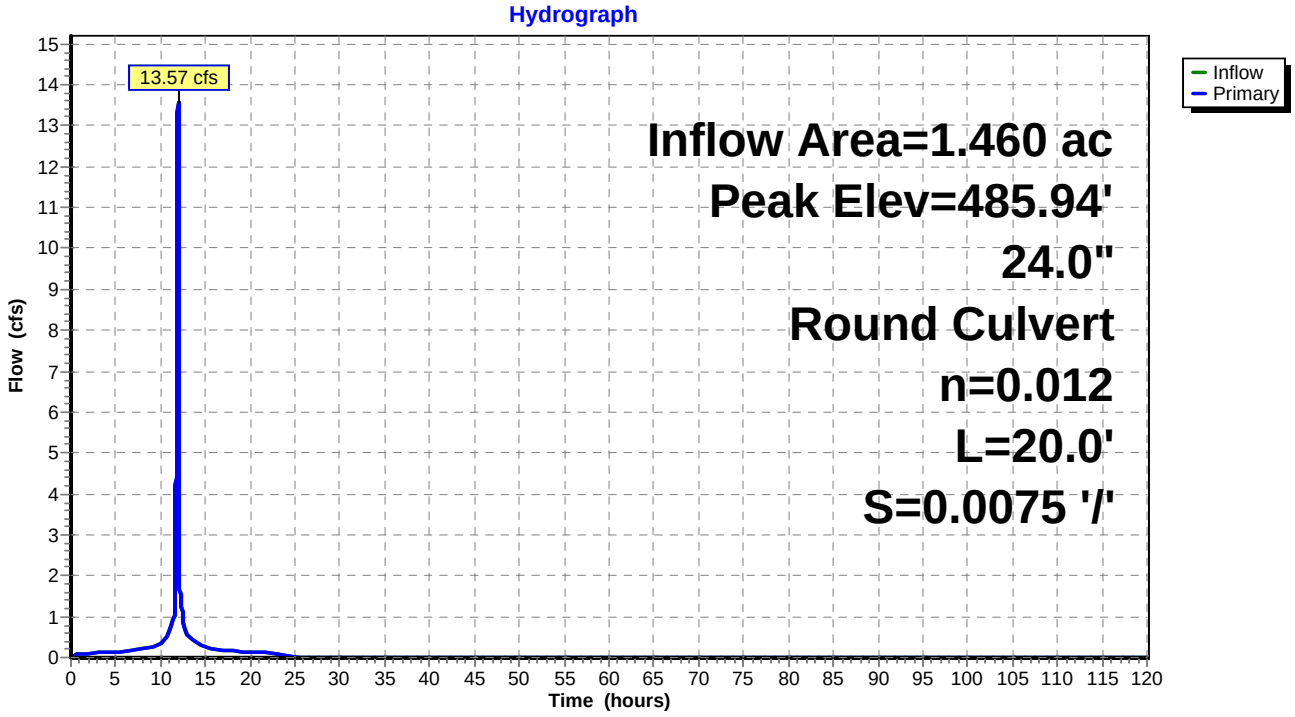
Inflow Area = 1.460 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 13.57 cfs @ 11.94 hrs, Volume= 0.730 af
Outflow = 13.57 cfs @ 11.94 hrs, Volume= 0.730 af, Atten= 0%, Lag= 0.0 min
Primary = 13.57 cfs @ 11.94 hrs, Volume= 0.730 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 485.94' @ 11.94 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	483.60'	**24.0" Round Culvert** L= 20.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 483.60' / 483.45' S= 0.0075 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Primary OutFlow Max=13.54 cfs @ 11.94 hrs HW=485.93' TW=484.65' (Dynamic Tailwater)
1=Culvert (Inlet Controls 13.54 cfs @ 4.31 fps)

Pond C-12: C-12



Summary for Pond C-7: C-7

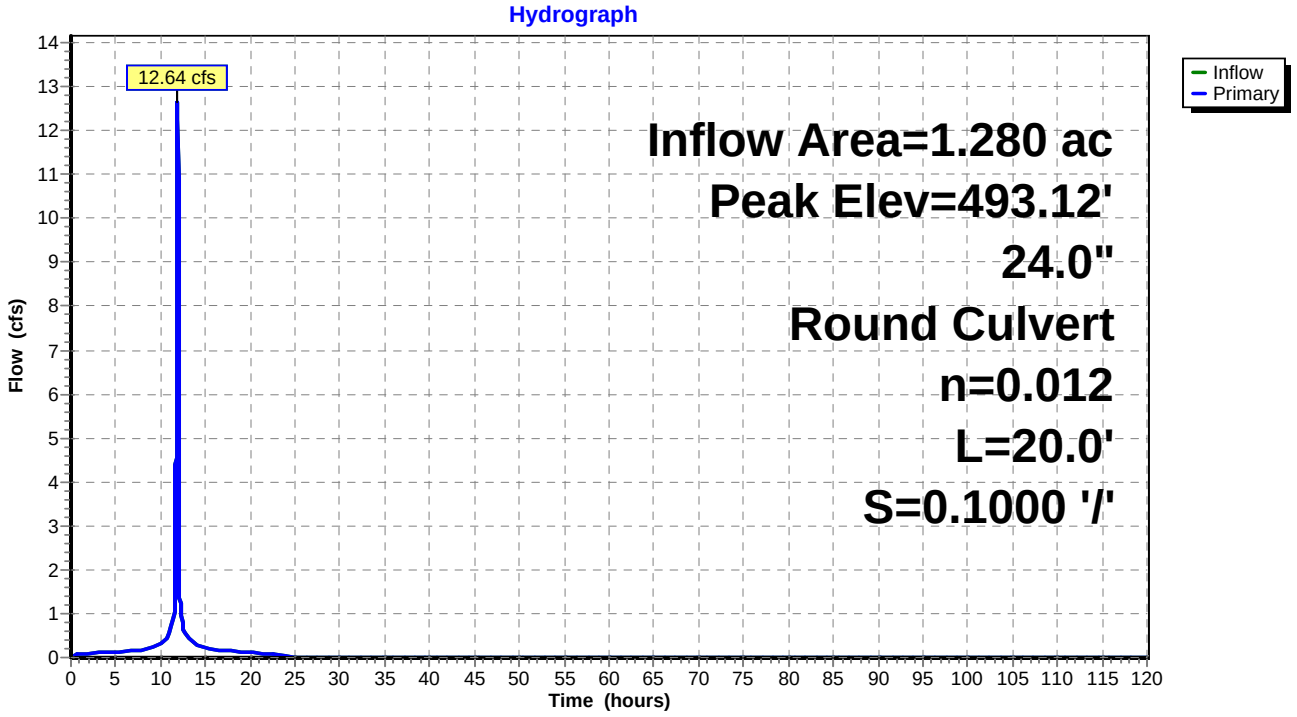
Inflow Area = 1.280 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 12.64 cfs @ 11.92 hrs, Volume= 0.640 af
Outflow = 12.64 cfs @ 11.92 hrs, Volume= 0.640 af, Atten= 0%, Lag= 0.0 min
Primary = 12.64 cfs @ 11.92 hrs, Volume= 0.640 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 493.12' @ 11.92 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	491.00'	**24.0" Round Culvert** L= 20.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 491.00' / 489.00' S= 0.1000 '/' Cc= 0.900 n= 0.012, Flow Area= 3.14 sf

Primary OutFlow Max=12.56 cfs @ 11.92 hrs HW=493.11' TW=487.10' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 12.56 cfs @ 4.00 fps)

Pond C-7: C-7



Summary for Pond C-9: C-9

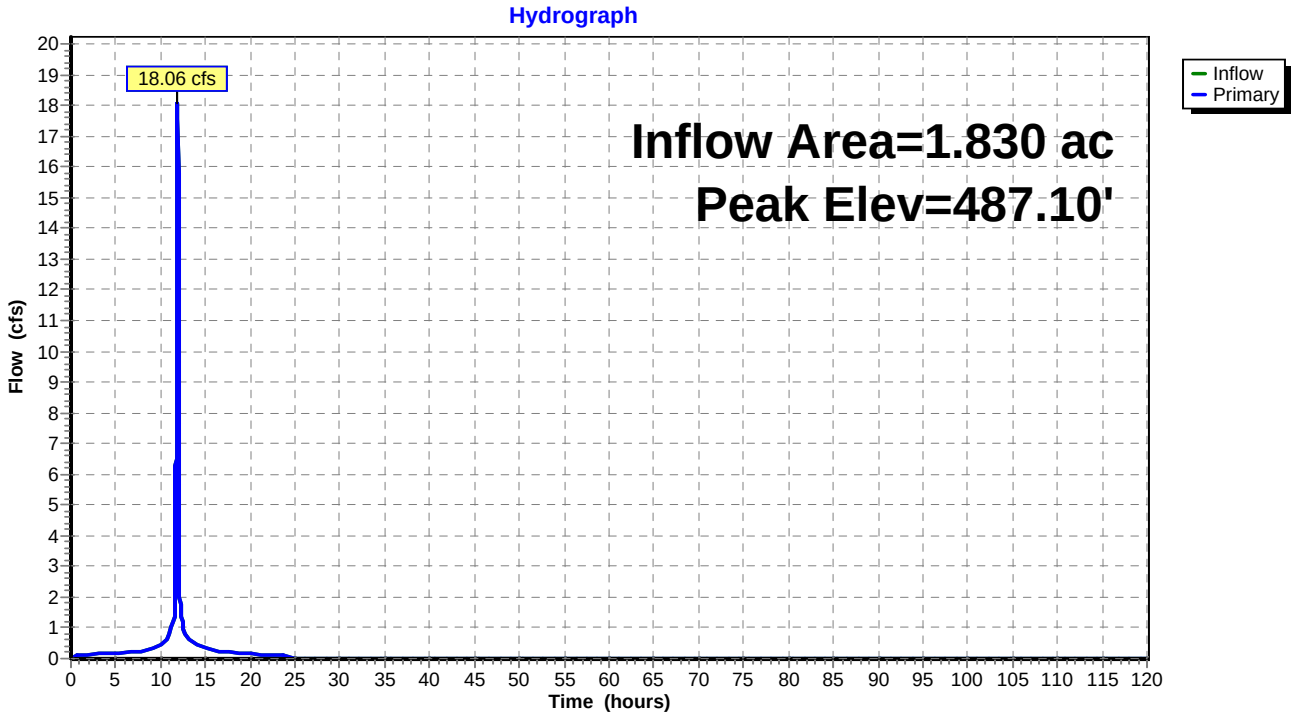
Inflow Area = 1.830 ac,100.00% Impervious, Inflow Depth = 6.00" for 25 yr event
Inflow = 18.06 cfs @ 11.92 hrs, Volume= 0.915 af
Outflow = 18.06 cfs @ 11.92 hrs, Volume= 0.915 af, Atten= 0%, Lag= 0.0 min
Primary = 18.06 cfs @ 11.92 hrs, Volume= 0.915 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 487.10' @ 11.92 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	485.90'	**18.0" Round Culvert** L= 30.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 485.90' / 484.90' S= 0.0333 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Primary	486.90'	**60.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=17.95 cfs @ 11.92 hrs HW=487.10' TW=482.92' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 4.47 cfs @ 2.95 fps)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 13.48 cfs @ 1.12 fps)

Pond C-9: C-9



Summary for Pond Det Pond: Detention Pond

Inflow Area = 7.290 ac,100.00% Impervious, Inflow Depth = 5.98" for 25 yr event
Inflow = 68.98 cfs @ 11.92 hrs, Volume= 3.635 af
Outflow = 11.82 cfs @ 12.05 hrs, Volume= 3.598 af, Atten= 83%, Lag= 8.0 min
Primary = 11.82 cfs @ 12.05 hrs, Volume= 3.598 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-120.00 hrs, dt= 0.01 hrs / 9
Peak Elev= 483.82' @ 12.05 hrs Surf.Area= 0.000 ac Storage= 1.399 af

Plug-Flow detention time= 153.0 min calculated for 3.598 af (99% of inflow)
Center-of-Mass det. time= 145.9 min (865.6 - 719.7)

Volume	Invert	Avail.Storage	Storage Description
#1	479.91'	2.391 af	**Custom Stage Data** Listed below

Elevation (feet)	Cum.Store (acre-feet)
479.91	0.000
480.00	0.117
482.00	0.732
484.00	1.467
486.00	2.391

Device	Routing	Invert	Outlet Devices
#1	Primary	479.91'	**18.0" Round Culvert** L= 442.4' Ke= 0.500 Inlet / Outlet Invert= 479.91' / 476.48' S= 0.0078 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf

Primary OutFlow Max=11.82 cfs @ 12.05 hrs HW=483.82' (Free Discharge)
1=Culvert (Barrel Controls 11.82 cfs @ 6.69 fps)

Pond Det Pond: Detention Pond