BURNS McDONNELL

Spurlock Station Landfill Run-On and Run-Off Control System Plan

EAST KENTUCKY POWER COOPERATIVE

East Kentucky Power Cooperative

Coal Combustion Residual Rule Compliance

Revision 0
October 13, 2016

Spurlock Station Landfill Run-On and Run-Off Control System Plan

Prepared for

East Kentucky Power Cooperative
Coal Combustion Residual Rule Compliance
Winchester, Kentucky

Revision 0
October 13, 2016

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

East Kentucky Power Cooperative
Spurlock Station Landfill
Run-On and Run-Off
Control System Plan

Report Index

Certification

I hereby certify, as a Professional Engineer in the Commonwealth of Kentucky, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the East Kentucky Power Cooperative or others without specific verification or adaptation by the Engineer.

10/13/16 9:20 AM

Kira E. Wylam

Kira Wylam, P.E. (KY #30195)

Date: 10/13/2016

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EKPC	East Kentucky Power Cooperative
EPA	Environmental Protection Agency
HSG	Hydrologic Soil Group
KAR	Kentucky Administrative Record
KDEP	Kentucky Department of Environmental Protection
KPDES	Kentucky Pollution Discharge Elimination System
MW	Megawatt
NRCS	National Resources Conservation Services
NWS	National Weather Service
RCRA	Resource Conservation and Recovery Act
RUSLE	Revised Universal Soil Loss Equation
SCS	Soil Conservation Service
TR-55	Technical Release 55
TSS	Total Suspended Solids
U.S.C.	United States Code
WSS	Web Soil Survey

1.0 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency (EPA) issued the final version of the federal Coal Combustion Residual Rule (CCR Rule) to regulate the disposal of coal combustion residual (CCR) materials generated at coal-fired units. The rule will be administered as part of the Resource Conservation and Recovery Act (RCRA, 42 United States Code [U.S.C.] §6901 et seq.), using the Subtitle D approach.

East Kentucky Power Cooperative (EKPC) is subject to the CCR Rule and as such must develop a Run-On and Run-Off Control System Plan per 40 Code of Federal Regulations (CFR) §257.81. This document serves as EKPC's Run-On and Run-Off Control System Plan for the existing CCR Landfill (as defined in §257.53) at Spurlock Station.

The Run-On and Run-Off Control System Plan will contain the following per §257.81(c):

- Documentation of how the run-on and run-off control systems have been designed and constructed to meet the following requirements:
  - A run-on control system to prevent flow onto the active portion of the CCR unit during peak discharge from a 24-hour, 25-year storm; and
  - A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
    - Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.
- Supporting engineering calculations for the plan.
- Certification by a qualified professional engineer.

The following run-on and run-off control system terms are defined per the CCR Rule:

- Active Portion – That part of the CCR unit that has received or is receiving CCR or non-CCR waste and that has not completed closure in accordance with §257.102.
- Run-off – Any rainwater, leachate, or other liquid that drains over land from any part of a CCR landfill or lateral expansion of a CCR landfill.
- Run-on – Any rainwater, leachate, or other liquid that drains over land onto any part of a CCR landfill or lateral expansion of a CCR landfill.

2.0 REVIEW OF EXISTING INFORMATION

Spurlock Station (Spurlock) is owned and operated by EKPC. Spurlock is a 1,346 net megawatt (MW) coal-fired power plant located in Mason County, approximately five miles northwest of Maysville, Kentucky. The Spurlock CCR Landfill (Landfill) is a special waste landfill permitted by the Kentucky Department of Environmental Protection (KDEP) Permit No. 081-00005. The following subsections provide information associated with the Landfill including design drawings and engineering calculations included in the permit application and construction documentation. An aerial view of the Landfill can be found in Appendix A. Design drawings pertinent to the Run-on and Run-off Control System Plan can be found in Appendix B.

2.1 Site Characteristics and Hydrology

The Landfill site soils belong to hydrologic soil group (HSG) Types C and D comprised of dump, silt loams, and silt clay loam soils. The hydrologic soil classification was obtained from the National Resources and Conservation Service (NRCS) Web Soil Survey (WSS) data. The NRCS WSS data included in Appendix C is based on the Version 11 Survey Data dated September 15, 2015.

The 25-year and 100-year, 24-hour design storm rainfall depths for the site are 4.8 inches and 5.8 inches, respectively, as presented in "Rainfall Frequency Values for Kentucky: Engineering Memorandum No. 2," revised June 1, 1979.

2.2 Engineering Calculations

Run-on and run-off controls for the Landfill were designed by others as part of the permit application to the Commonwealth of Kentucky. The permit calculations were performed using the 25-year, 24-hour rainfall event and/or the 100-year, 24-hour rainfall event. Since the CCR Rule only requires the use of the 25-year, 24-hour rainfall event, calculations based on the 100-year, 24-hour rainfall event are considered conservative and exceed the requirements of the CCR Rule. The pertinent permit calculations related to this run-on and run-off control system plan can be found in Appendix D. The design calculations are discussed in further detail in this Section.

2.2.1 Methodology

The design calculations found in the permit were performed using the SEDCAD 4 computer program. SEDCAD is a generally accepted and comprehensive program that includes hydrology, hydraulics, and design and evaluation of surface water and erosion and sediment control measures. SEDCAD uses Soil Conservation Service (SCS) Curve Number methodology for peak flow and run-off calculation and the

Muskingum method for routing. The Revised Universal Soil Loss Equation (RUSLE) is used within SEDCAD to calculate sediment load. The methods of determination of the peak flow rates and run-off volumes are based on the SCS run-off curve number method for Type II rainfall distribution as outlined in Technical Release 55 (TR-55) "Urban Hydrology for Small Watersheds" from the National Resources Conservation Services (NRCS), formerly the SCS.

2.2.2 Permit Calculations

Below is a summary of the pertinent calculations from the Landfill permit relative to this Run-on and Run-off Control System Plan.

2.2.2.1 Channels

The permit calculations found in Appendix D for the terrace ditch, diversion berm, and down drain were performed using the 100-year, 24-hour rainfall event. The calculations in Appendix D for the diversion ditches were performed using the 25-year, 24-hour rainfall event. Design drawings indicating the design dimensions can be found in Appendix B. A summary of the results from the permit calculations for the channels can be found in Table 2-1.

Table 2-1: Permit Calculation Channel Results

Channel Type	Discharge	Flow Depth	Channel Depth	CCR Compliance Met
Terrace Ditch	6.23 ft^3/sec	0.65 ft	0.75 ft	✓
Diversion Berm	11.95 ft^3/sec	1.76 ft	2.0 ft	✓
Downdrain	79.61 ft^3/sec	0.99 ft	1.5 ft	✓
Diversion Ditch (Class I)	22.15 ft^3/sec	1.99 ft	3.0 ft	✓
Diversion Ditch (Class II)	102.84 ft^3/sec	2.56 ft	3.0 ft	✓
Diversion Ditch (Class III)	332.70 ft^3/sec	2.84 ft	3.5 ft	✓

2.2.2.2 Sediment Ponds

There are two on-site sediment ponds at the Landfill; sediment pond 1 and sediment pond 2. The CCR Rule does not provide any guidance on design of sediment ponds. It only requires that runoff be collected and controlled for the water volume resulting from a 25-year, 24-hour storm event. Therefore, the design requirements for sediment ponds revert back to the existing state requirements. The sediment ponds were designed to meet the requirements of 401 Kentucky Administrative Record (KAR) 48:070(2)(4) which includes minimum storage volume and principal spillway discharge to pass the 25-year, 24-hour rainfall event without emergency spillway discharge. The sediment ponds have been permitted under Kentucky

Pollution Discharge Elimination System (KPDES) Permit No. KY0022250 to discharge through Outfalls 001 and 008. The calculations in Appendix D for the design of the sediment ponds were developed using the 25-year, 24-hour rainfall event. A summary of results from the permit calculations for the sediment ponds can be found in Table 2-2.

Table 2-2: Permit Calculation Sediment Pond Results

Sediment Pond	Emergency Spillway Elevation	Top of Dam Elevation	100-year, 24-hour Rainfall Event Water Elevation[a]	CCR Compliance Met
Pond 1	621.0 ft	624.0 ft	620.98 ft	✓
Pond 2	812.0 ft	814.0 ft	811.39 ft	✓

(a) Meets and exceeds CCR requirement for 25-year, 24-hour rainfall event

3.0 RUN-ON AND RUN-OFF CONTROL SYSTEM SUMMARY

The CCR Rule requires run-on and run-off control systems to prevent flow onto the active portion of the CCR unit and to collect and control discharge from the active portion of the CCR unit as noted in Section 1.0. Section 2.0 summarizes the design of the various run-on and run-off control system features based on the maximum surface water flows at the time the Landfill is fully constructed and capped. Throughout the active life of the Landfill, the run-on and run-off control system will be constructed using the various channels indicated in Section 2.0 to control run-on and run-off onto and from the active portion of the CCR unit. The run-on and run-off control system is comprised of terrace channels, down drain channels, perimeter channels, and sediment ponds. The run-on and run-off control plan drawings which show the locations of each type of channel and the sediment ponds are included in Appendix B.

3.1 Run-Off Channels

Run-off channels collect stormwater that has fallen on the Landfill surface and divert the stormwater from the active portion of the Landfill to the sediment ponds. The plan drawings depict typical channel sections for three types of run-off channels as described below.

3.1.1 Terrace Channels

Terrace channels intercept stormwater run-off at intermediate points along the slope face of the Landfill and direct the stormwater to the down drain channels. The use of the terrace channel reduces the distance run-off travels over the slope face, resulting in decreased velocity and reduced sediment load. There are two types of terrace channels indicated in the permit calculations and design drawings: one created by constructing a terrace on the face of the Landfill (terrace ditch) and the other by constructing a diversion berm on the face of the Landfill (diversion berm).

3.1.2 Down Drain Channels

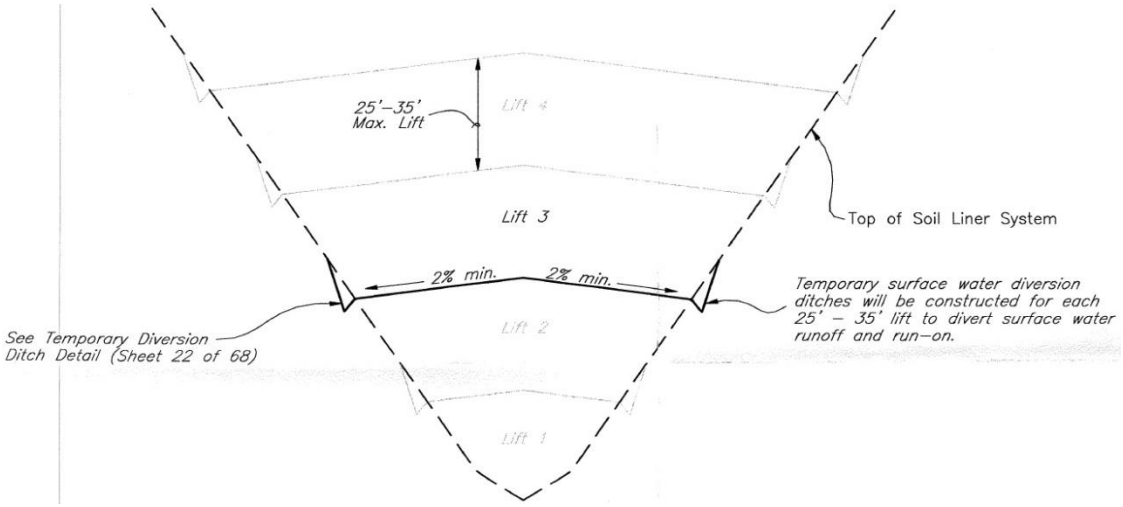
Down drain channels collect the run-off from the terrace channels and direct the stormwater down the slope of the Landfill in a controlled channel to the perimeter channels.

3.1.3 Perimeter Channels

Perimeter channels collect run-off from the down drain channels and direct the stormwater to the sediment ponds. There are three classes of perimeter channels (diversion ditches) denoted in the permit calculations and design drawings: Class I, Class II, and Class III. Class I channels are grass-lined, Class II channels are lined with 5 inch to 9 inch aggregate, and Class III channels are lined with ¼ to 1 ½ cubic foot rip rap.

As the Landfill is brought to final grade through filling operations, temporary perimeter channels will each be built with 25- to 35-foot vertical lift of ash to control run-off from the active portion of the CCR unit and divert it to the sediment ponds during filling operations. The temporary perimeter channel typical section is a v-ditch with 2:1 side slopes. Figure 3-1, below, illustrates the location of the temporary perimeter channels as they relate to the placement of CCR material.

Figure 3-1: Temporary Perimeter Channel Locations



3.2 Run-On Channels

Run-on channels intercept surface water drainage and prevent it from running on to the active portion of the Landfill. For on-site drainage, the terrace channels and temporary perimeter channels double as both the run-on and run-off control channels. For off-site drainage, the perimeter channels double as both the run-on and run-off control channels.

3.3 Sediment Ponds

Sediment ponds are a run-off control feature used to reduce the amount of total suspended solids (TSS) leaving the site.

3.4 Run-On and Run-Off Compliance Summary

Based on a review of the existing permit calculations provided here-in, the channels in the Run-On and Run-Off Control System Plan were adequately designed to meet the CCR Rule requirement to convey run-on and run-off resulting from the 25-year, 24-hour rainfall event.

Based on a review of the permit calculations provided here-in, the sediment ponds in the Run-On and Run-Off Control System Plan were adequately designed to meet the CCR Rule requirement to collect and

control as least the water volume resulting from the 25-year, 24-hour rainfall event. In addition, as indicated in Section 2.0, sediment ponds 1 and 2 have been permitted to discharge through Outfalls 001 and 008, thus meeting the requirements of 40 CFR §257.3-3.

4.0 PERIODIC ASSESSMENT AND AMMENDMENT

The initial run-on and run-off control system plan will be placed in the CCR Operating Record by October 17, 2016. The plan may be amended at any time, and is required to be amended whenever there is a change in conditions which would substantially affect the written plan in effect. A periodic run-on and run-off control system plan will be prepared every five years. Preparing the periodic plans may be achieved by reviewing the current plan in effect and amending the plan as required. In all cases, the date for completing the previous plan is the basis for establishing the deadline to complete the subsequent periodic plan. Each periodic plan will be certified by a qualified professional engineer in the Commonwealth of Kentucky. All amendments and revisions will be placed on the CCR public website within 30 days following placement in the facility's CCR Operating Record. A record of revisions made to this document is included in Section 5.0.

5.0 REVISIONS AND UPDATES

Revision Number	Date	Revisions Made	By Whom
0	10/13/2016	Issued for Initial Compliance	Burns & McDonnell

APPENDIX A - LANDFILL AERIALS

NOTES:

1. MAP DATA: GOOGLE

N

0 1200' 2400'

SCALE IN FEET

BURNS McDONNELL

date 8/5/2016

designed A. MYERS

EAST KENTUCKY POWER COOPERATIVE

SPURLOCK STATION

SITE PLAN

project -

contract -

drawing **SK - CIVIL - 001** rev no. **0**

NOTES:

1. MAP DATA: GOOGLE

N

0 600' 1200'

SCALE IN FEET

BURNS McDONNELL

date 8/5/2016

designed A. MYERS

EAST KENTUCKY POWER COOPERATIVE

SPURLOCK STATION LANDFILL

SITE PLAN

project -

contract -

drawing **SK - CIVIL - 002** rev no. **0**

8/8/2016 \\bmcd\dfs\Clients\ENR\EKPC\86144_EKPCFLEETCCR\Design_Common\Site Plans\SK-Spurlock-Landfill-2.dgn

APPENDIX B - LANDFILL PERMIT DESIGN DRAWINGS

EAST KENTUCKY POWER COOPERATIVE, INC.
SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
MODIFICATION TO PERMIT NO. 081-00005

LEGEND

- Existing Contours
- Proposed Final Grade Contour — 960
- Approximate Property Boundary
- Approximate Limits of Proposed Permit Boundary — P
- Approximate Limits of Proposed Property and Permit Boundary — PP
- Approximate Limits of Proposed Waste
- 100' Buffer Zone
- Proposed Access Road
- Existing Access Road
- Existing Groundwater Monitoring Point — ● IW-8
- Proposed Groundwater Monitoring Point — ○ MW-2A
- Proposed Surface Water Monitoring Point — ▲ SW-1
- Diversion Ditches:
  - Class I
  - Class II
  - Class III
  - Berm
  - Terrace
  - Downdrain

NORTH

▲ SW-1

Site Entrance

Proposed Access Road

Karst Feature
(To be excavated and sealed off prior to waste placement. See Details, Sheet 22 of 68.)

▲ SW-3

PROPOSED POND 2

EXISTING ACCESS ROAD

EXISTING HAUL ROAD

● IW-8 (MW-1)

STA. 47+00
N 255597.8986
E 1616486.9374

Baughby Creek Road

KY 576

Proposed Waste Limits

EXISTING ACCESS ROAD

STA. 3+50
N 252837.8946
E 1619928.8669

○ MW-2A

SW-2

○ MW-3A

PROPOSED POND 1

EXISTING ACCESS ROAD

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

GENERAL FINAL GRADING PLAN

Topography from Aerial Survey on March 13, 2001 by Photo Science, Inc., Lexington, Kentucky.

STATE OF KENTUCKY
RANDALL W. HASSELL
LICENSED PROFESSIONAL ENGINEER

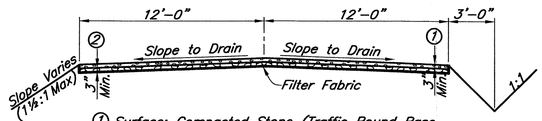
DRAWN BY:	WJL JT
CHECKED BY:	STO
DATE:	February 2002
SCALE:	1" = 200'

REVISIONS	
6-28-02	Karst Buffer

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2000015

SHEET NO.
17 of 68



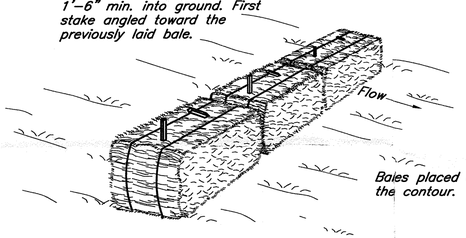
① Surface: Compacted Stone (Traffic Bound Base as specified by the Ky.D.O.T.)

② Base: Compacted No. 2 Stone

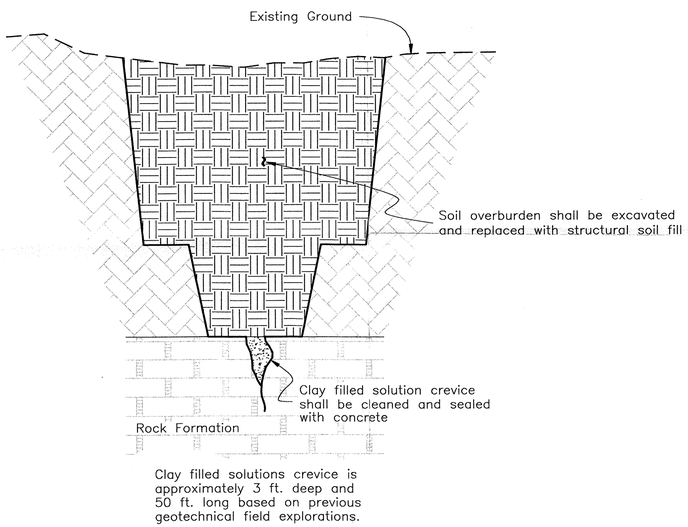
1. Rerocking of the Access Roads will be accomplished on a periodic basis, as needed, to maintain them "all weather" usable. Dust control will be provided by watering on an as needed basis. The Access Roads are to be maintained to within 200 feet of Working Areas.
2. Access Roads to all Monitoring locations and Sediment Control Structures will be the same as above with the exception of width.
3. Access Roads will be maintained around all constructed Waste Areas.

ACCESS ROAD TYPICAL SECTION
N.T.S.

Tempory Bale Silt Checks shall be:
(1) placed where needed to provide erosion control until revegetation is established.
(2) inspected periodically, depending upon the past weather conditions.
(3) replaced when check is approximately 50% full.

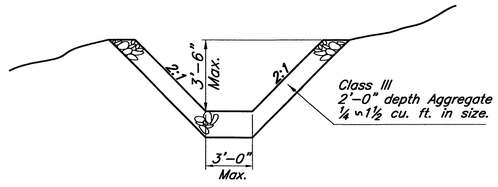


TEMPORARY BALE SILT CHECK
N.T.S.

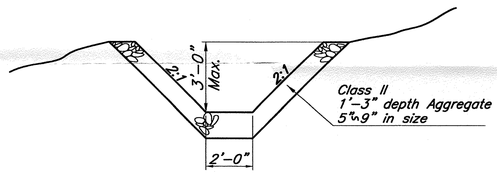


Clay filled solutions crevice is approximately 3 ft. deep and 50 ft. long based on previous geotechnical field explorations.

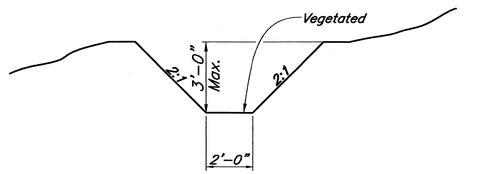
KARST FEATURE REMEDIATION DETAIL
N.T.S.



CLASS III

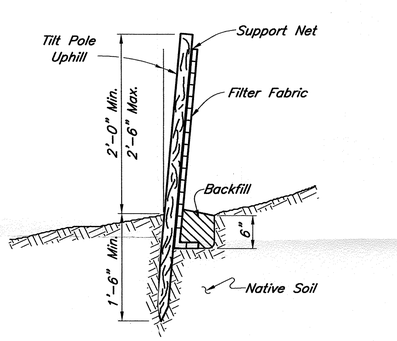


CLASS II



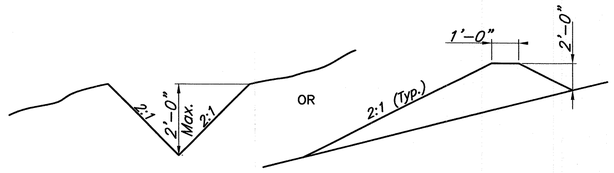
CLASS I

DIVERSION DITCHES
N.T.S.

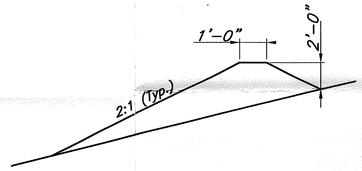


NOTE: Fence to be constructed at the toe of the disturbed area.

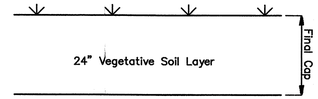
SILT FENCE
N.T.S.



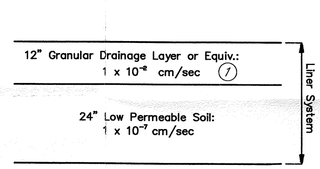
TEMPORARY DIVERSION DITCHES
N.T.S.



DIVERSION BERM
N.T.S.

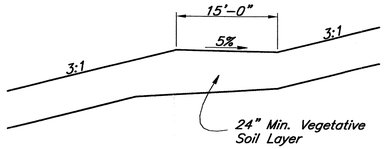


FINAL CAP DESIGN
N.T.S.



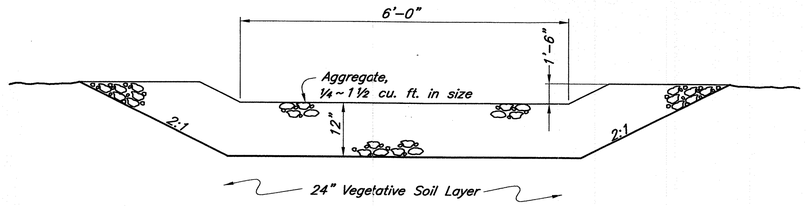
① The drainage layer will be installed only in the valley bottoms, drainage lines and pathways.

LINER DESIGN
N.T.S.



Minimum Drainage Slope of 1.5%

HORIZONTAL TERRACE
N.T.S.



DOWNDRAIN
N.T.S.

EAST KENTUCKY POWER COOPERATIVE, INC.
SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
MODIFICATION TO PERMIT NO. 081-00005

DRAWN BY: CMW	
CHECKED BY: STD	
DATE: February 2002	
SCALE: As Noted	
REVISIONS	
12-20-02	ADDED DETAILS
2-5-03	KARST DETAIL

KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2000015

SHEET NO.
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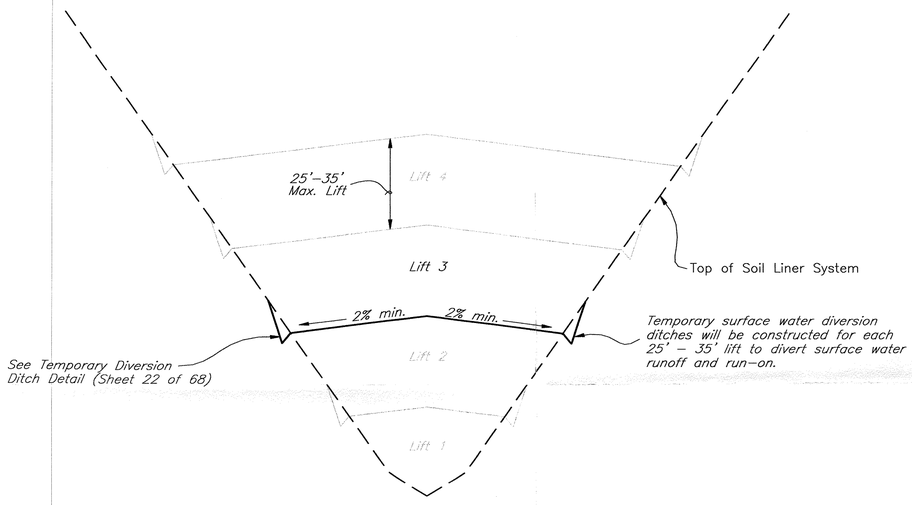
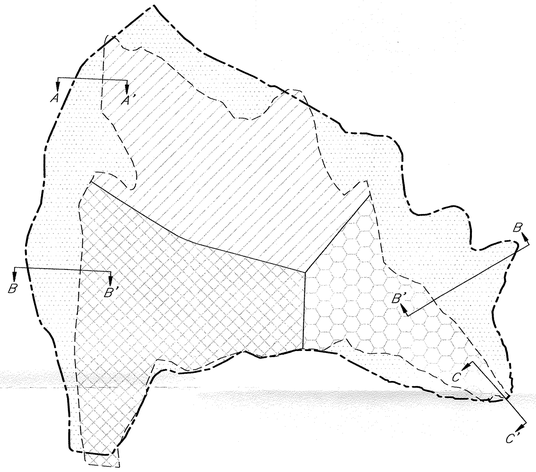
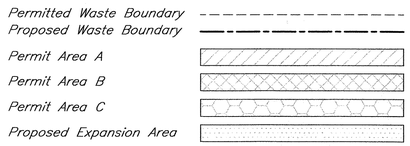
MISCELLANEOUS DETAILS



CROSS–SECTION OF TYPICAL CELL CONSTRUCTION SEQUENCE

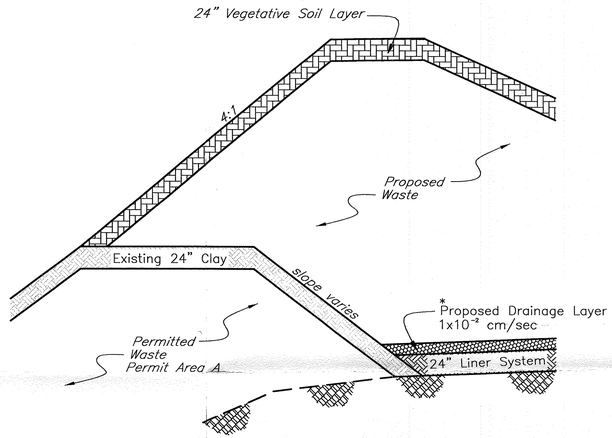
N.T.S.





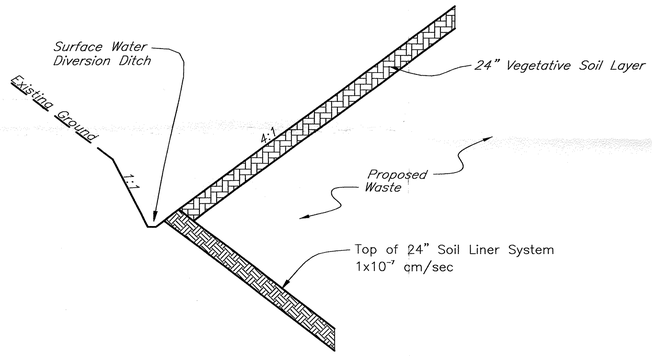
LINER TRANSITION AREAS

N.T.S.



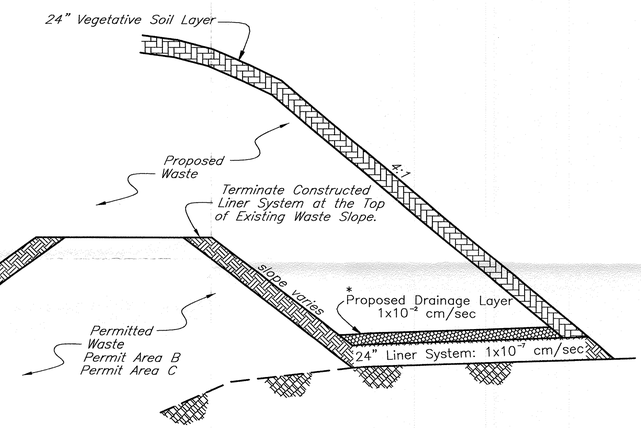
LINER TRANSITION SECTION A – A'

N.T.S.



TYPICAL SURFACE WATER DIVERSION DITCH

N.T.S.



LINER TRANSITION SECTION B – B'

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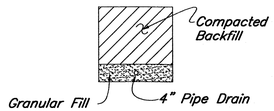
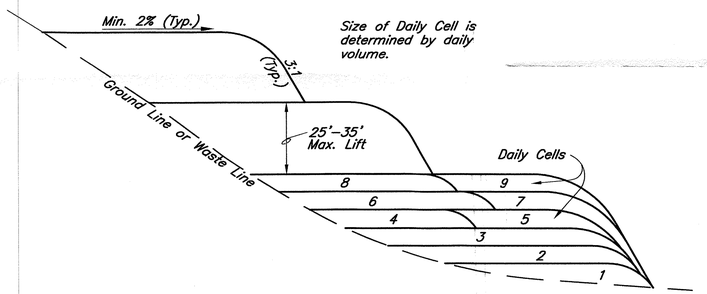
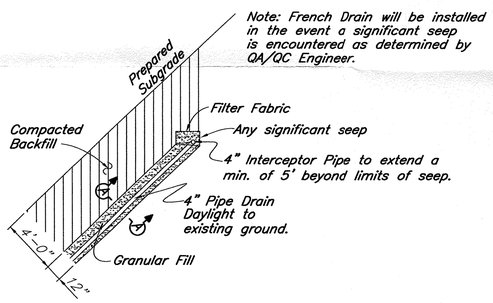


SECTION A–A



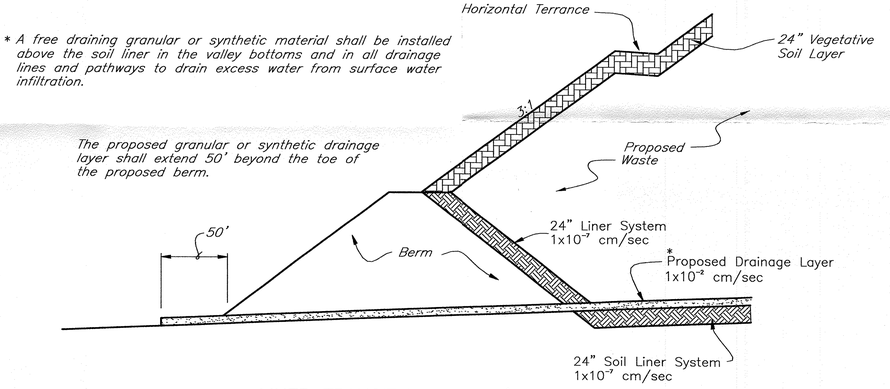
PROFILE OF TYPICAL CELL CONSTRUCTION SEQUENCE

N.T.S.



FRENCH DRAIN (IF NEEDED)

N.T.S.



LINER TRANSITION C – C'

N.T.S.

EAST KENTUCKY POWER COOPERATIVE, INC.
SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
MODIFICATION TO PERMIT NO. 081-00005

DRAWN BY: CTW
CHECKED BY: STO
DATE: February 2002
SCALE: As Noted

REVISIONS	
12-20-02	ADDED DETAILS

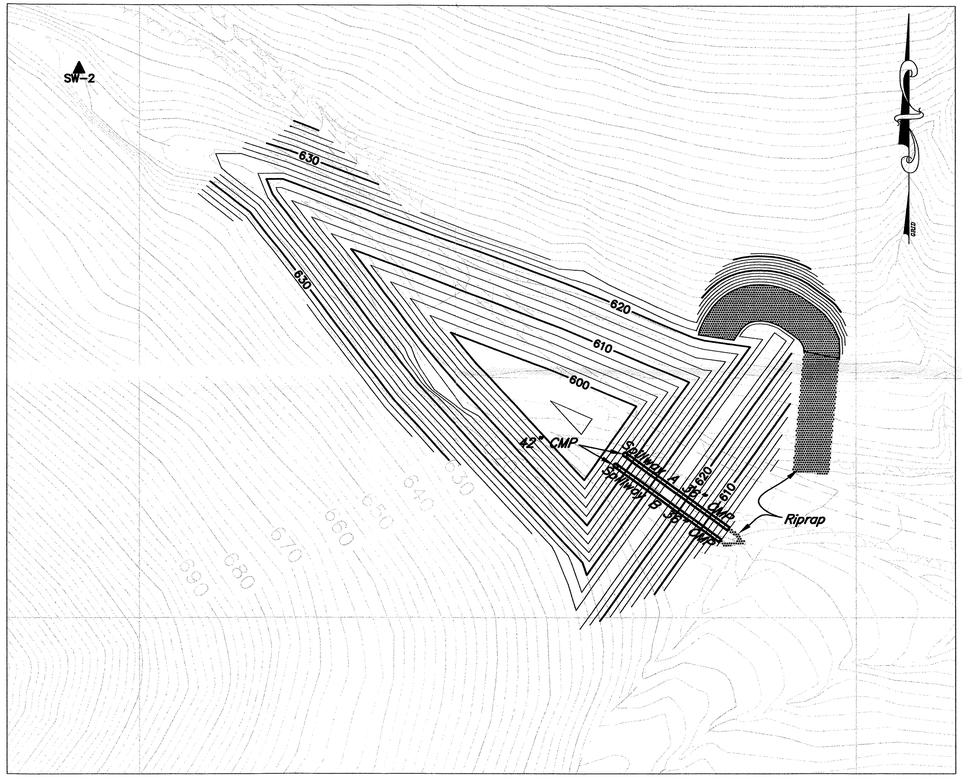
KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2000015

SHEET NO.
23 of 68

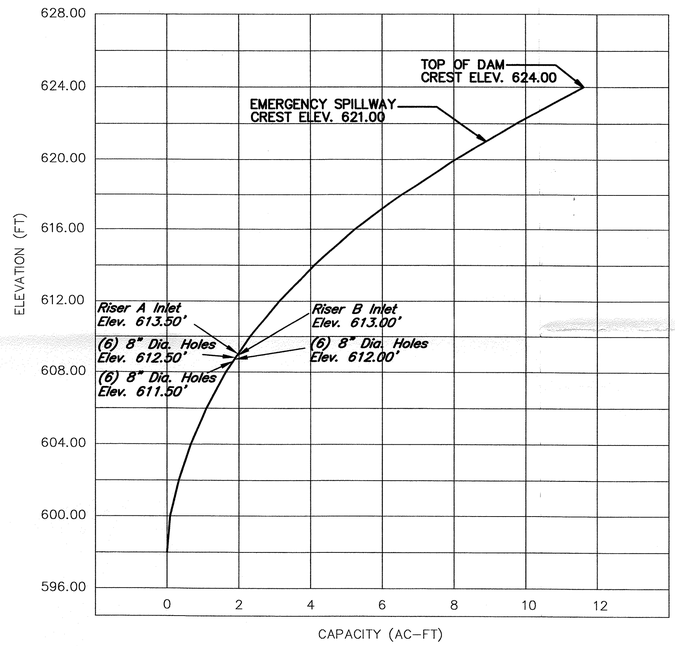
MISCELLANEOUS DETAILS

N:\P\2000015\PLANS\Detail Sheets.dwg, 02/14/2003 03:40:06 PM, CTW



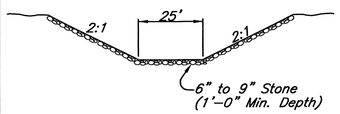
POND 1

SCALE: 1" = 50'

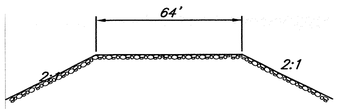


CAPACITY ELEVATION CURVE

SCALE AS NOTED



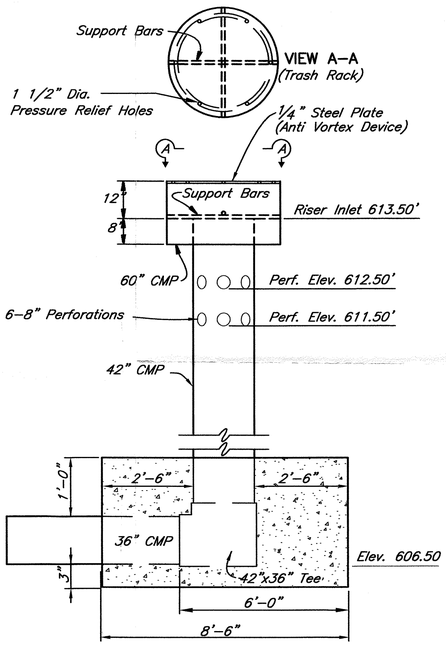
TYPICAL SECTION



CONTROL SECTION

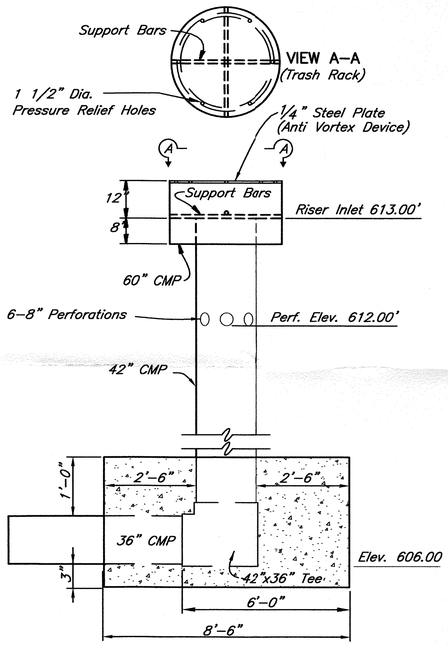
EMERGENCY SPILLWAY

N.T.S



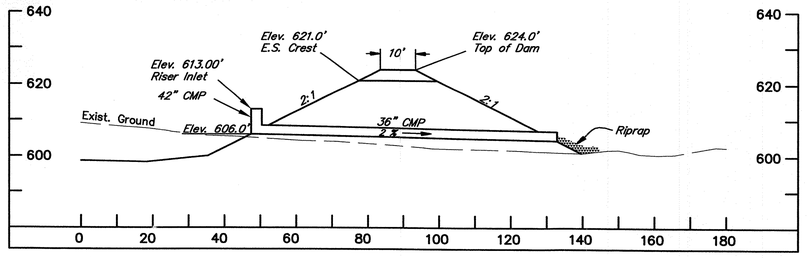
RISER A

N.T.S



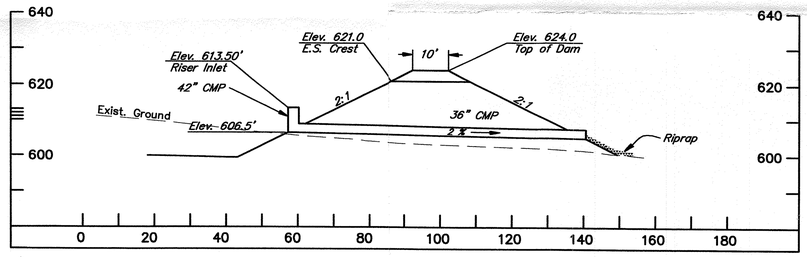
RISER B

N.T.S



SECTION AT SPILLWAY B

SCALE AS NOTED



SECTION AT SPILLWAY A

SCALE AS NOTED

EAST KENTUCKY POWER COOPERATIVE, INC.
SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
MODIFICATION TO PERMIT NO. 081-00005

COMMONWEALTH OF KENTUCKY
BRIAN K. RANDALL RUSSELL
LICENSED PROFESSIONAL ENGINEER

DRAWN BY: CTW, WJL
CHECKED BY: STO
CHECKED BY: RWR
DATE: February, 2002
SCALE: As Noted
REVISIONS

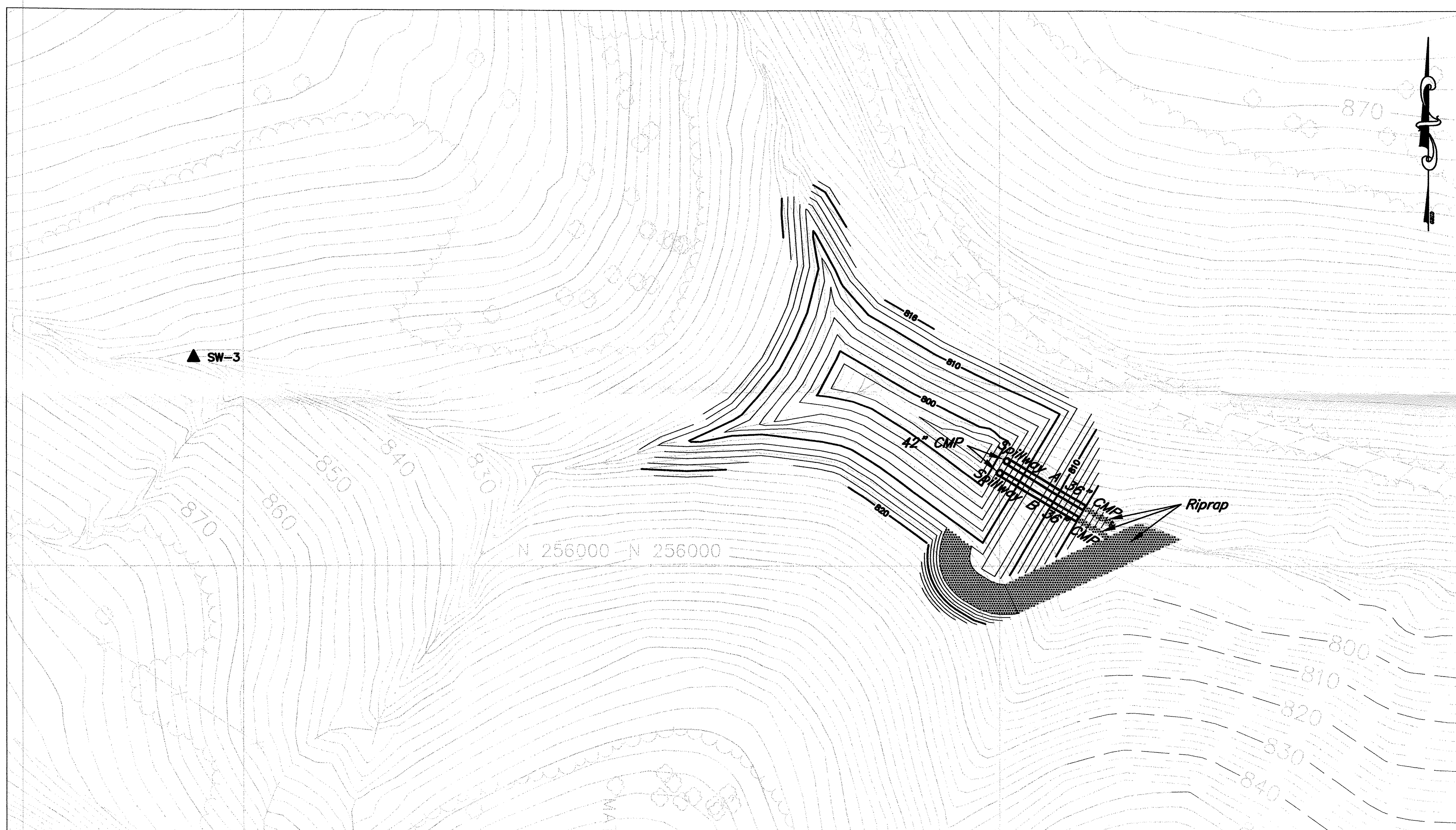
KENVIRONS, INC.
FRANKFORT, KENTUCKY

PROJECT NO.
2000015

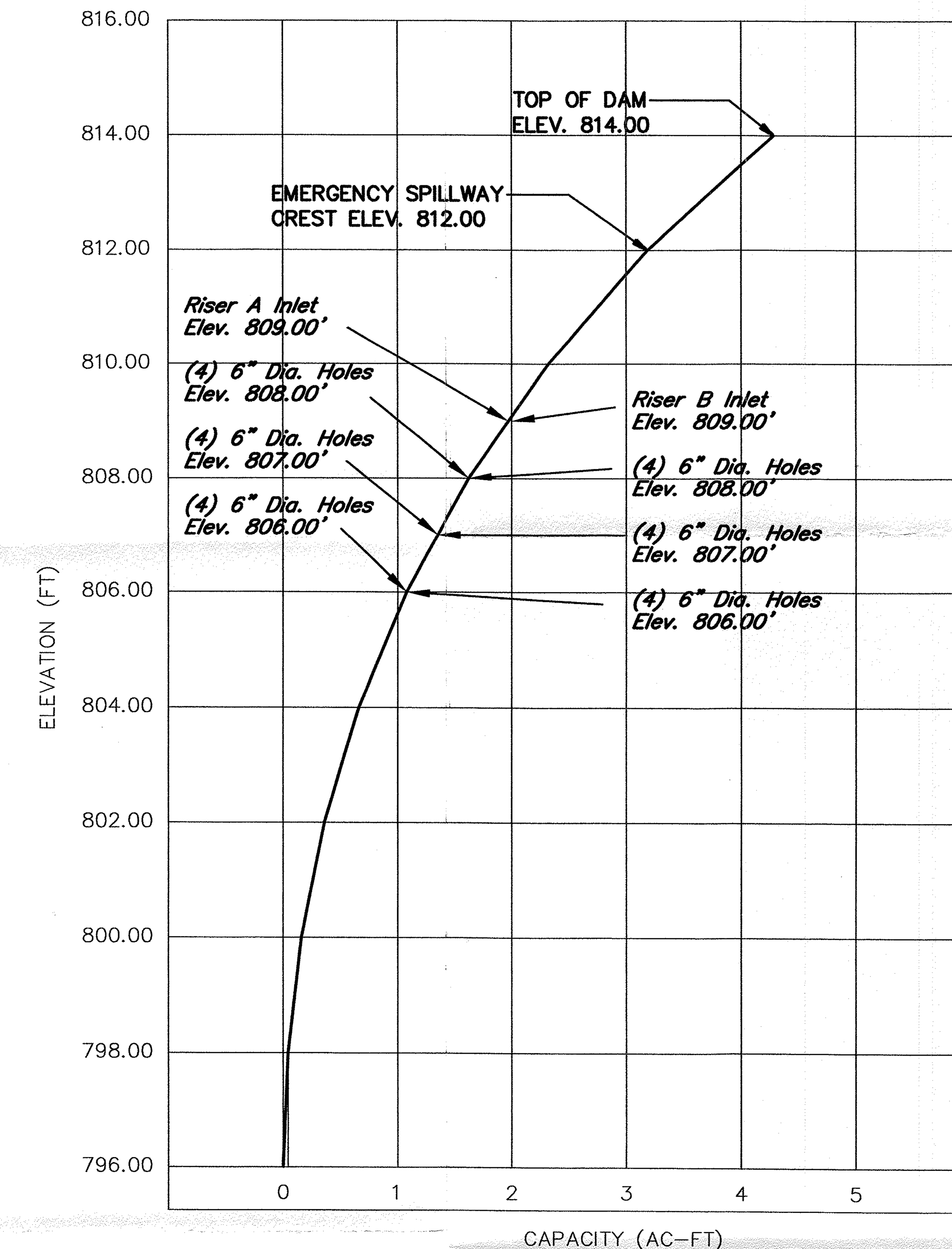
SHEET NO.
24 of 68

POND 1 DETAILS

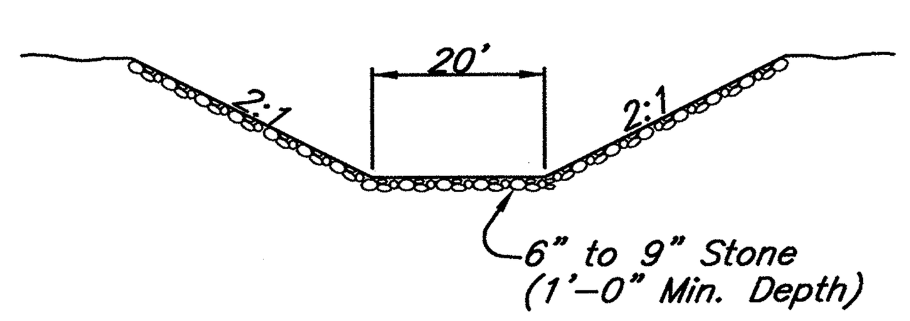
MAR 2 2002
DIVISION OF WASTE MANAGEMENT
SOLID WASTE BRANCH



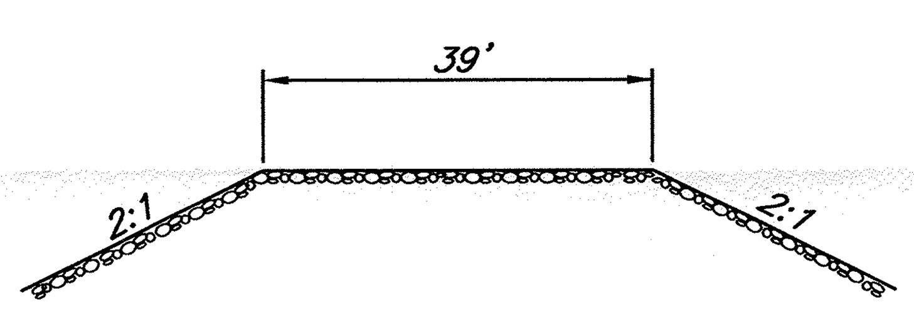
POND 2
SCALE: 1" = 50'



CAPACITY ELEVATION CURVE
SCALE AS NOTED

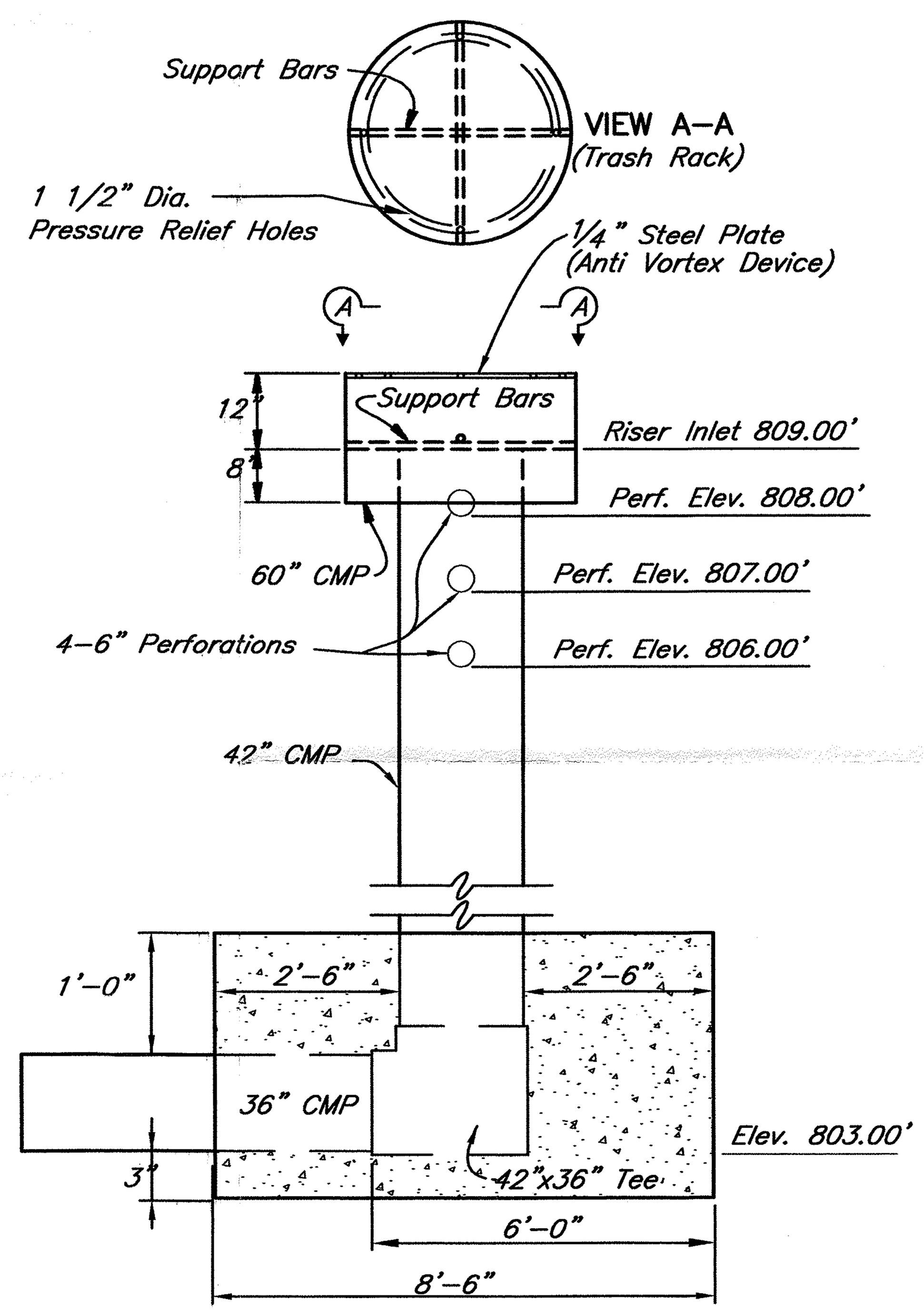


TYPICAL SECTION

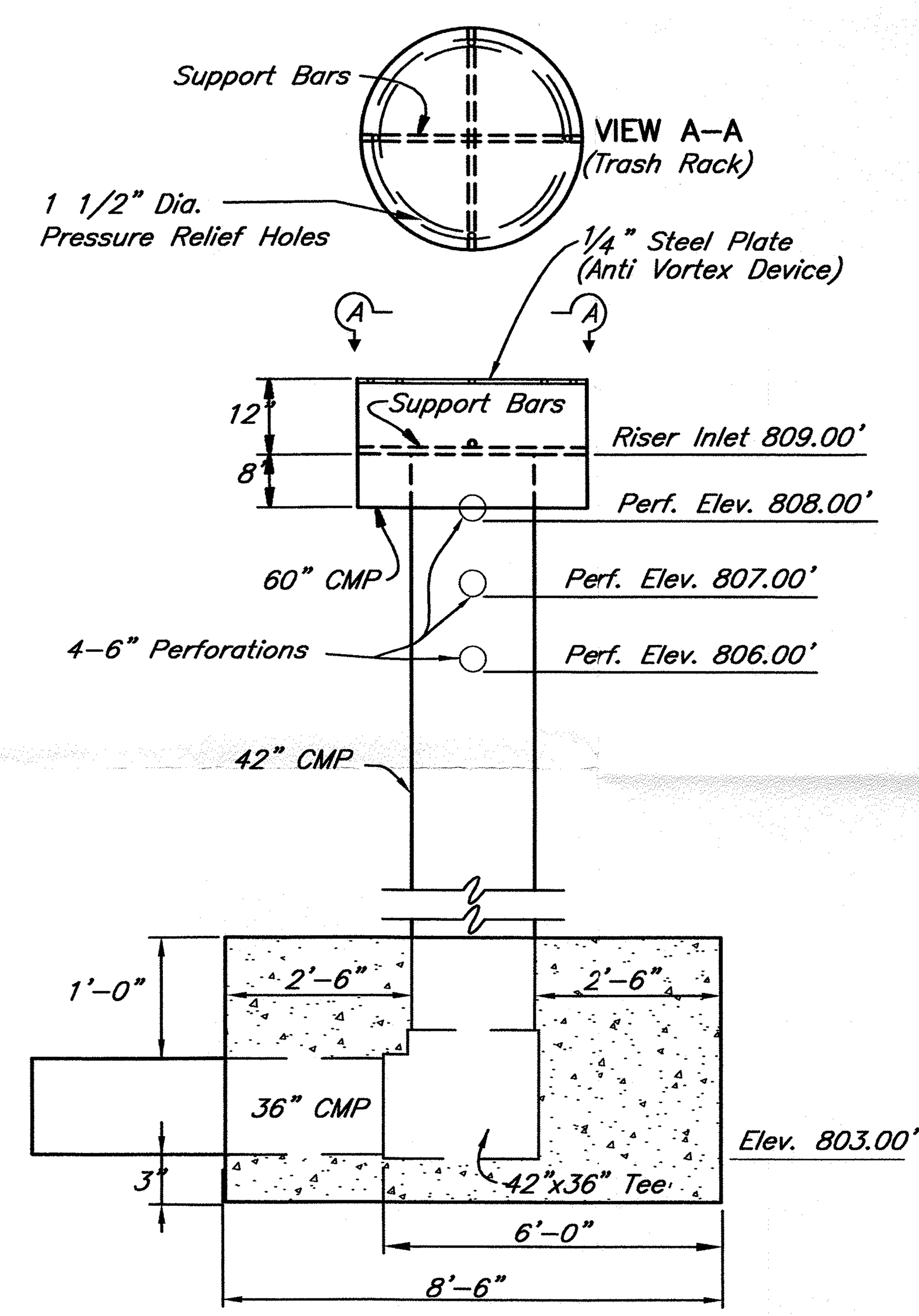


CONTROL SECTION

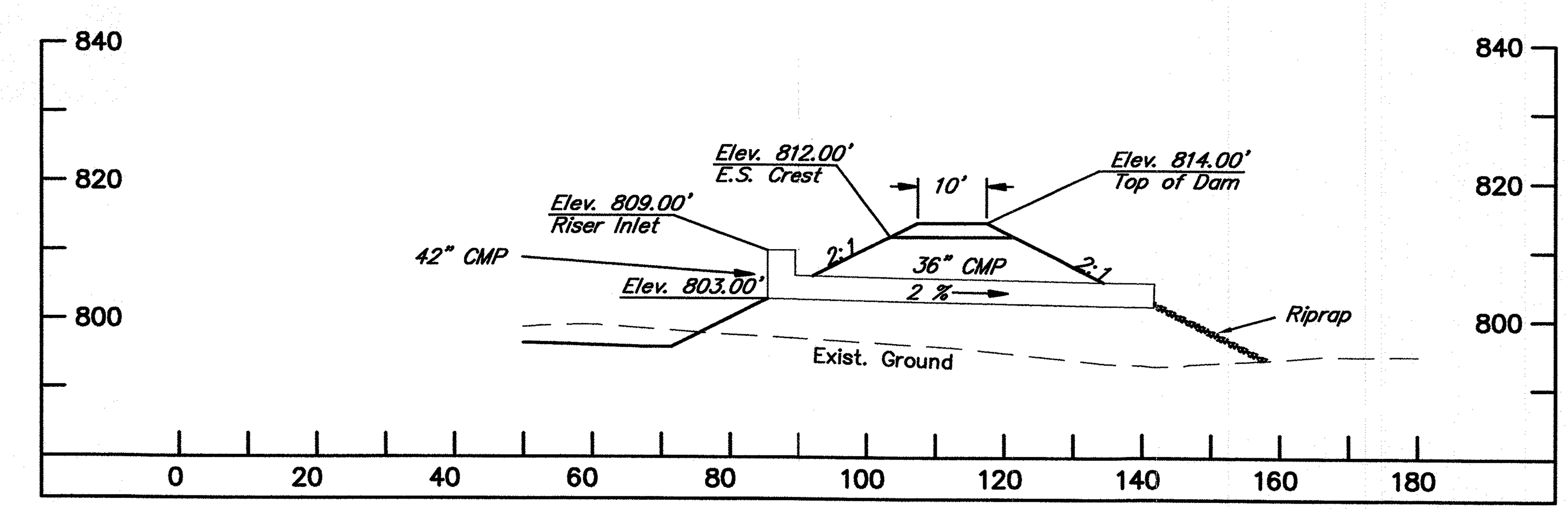
EMERGENCY SPILLWAY
N.T.S



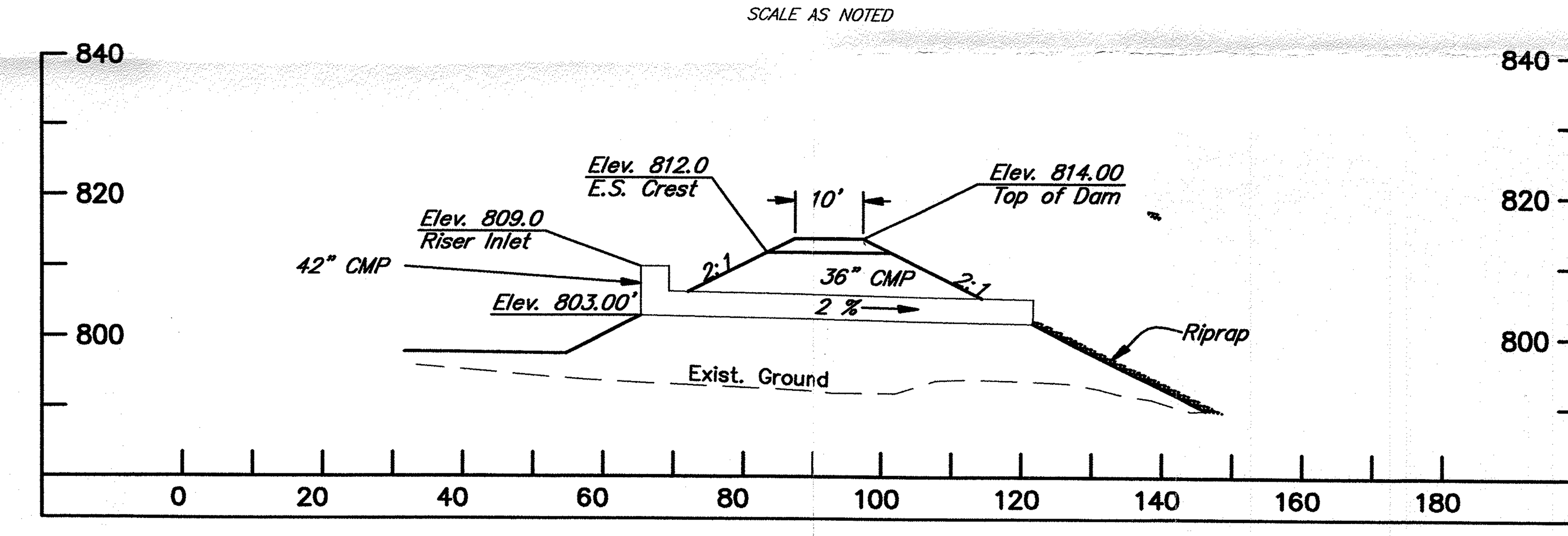
RISER A
N.T.S



RISER B
N.T.S



SECTION AT SPILLWAY B
SCALE AS NOTED



SECTION AT SPILLWAY A
SCALE AS NOTED

EAST KENTUCKY POWER COOPERATIVE, INC.
SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
MODIFICATION TO PERMIT NO. 081-00005

DRAWN BY: CTW, WJL
CHECKED BY: SWO
CHECKED BY: RWR
DATE: 8-30-2001
SCALE: As Noted
REVISIONS

KENVIRONS, INC.
FRANKFORT, KENTUCKY

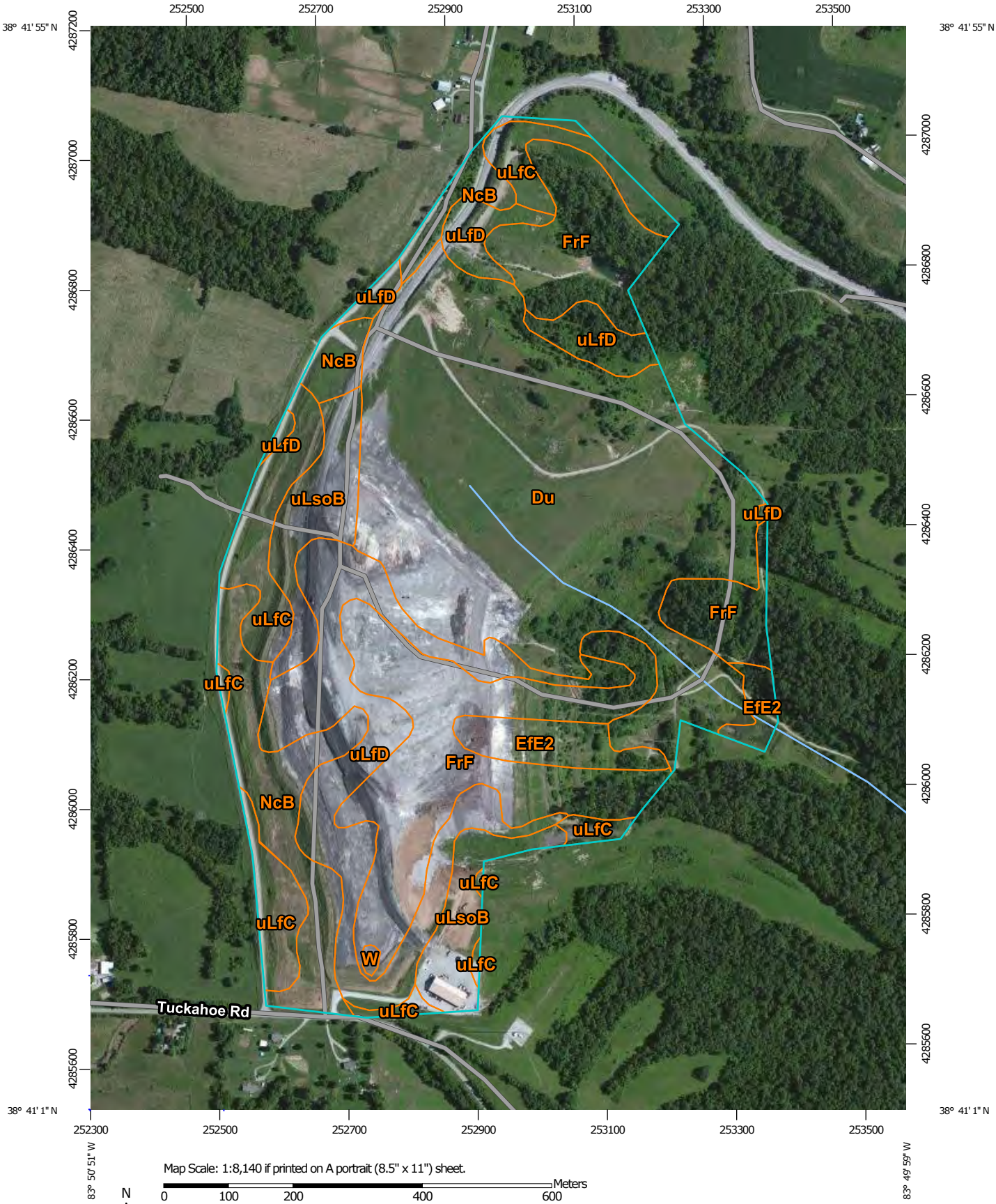
PROJECT NO.
2000015

POND 2 DETAILS

SHEET NO.
25 of 68

APPENDIX C - NRCS WEB SOIL SURVEY INFORMATION

Soil Map—Mason County, Kentucky
(Spurlock Landfill)



Map Scale: 1:8,140 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 100 200 400 600

Feet
0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Mason County, Kentucky
Survey Area Data: Version 11, Sep 15, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 30, 2010—Oct 15, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Mason County, Kentucky (KY161)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Du	Dumps	70.8	36.6%
EfE2	Eden flaggy silty clay loam, 20 to 40 percent slopes, eroded	6.2	3.2%
FrF	Fairmount-Rock outcrop complex, 30 to 60 percent slopes	41.2	21.3%
NcB	Nicholson silt loam, 2 to 6 percent slopes	17.2	8.9%
uLfC	Lowell-Faywood silt loams, 6 to 12 percent slopes	15.9	8.2%
uLfD	Lowell-Faywood silt loams, 12 to 20 percent slopes	29.7	15.4%
uLsoB	Lowell-Sandview silt loams, 2 to 6 percent slopes	12.3	6.4%
W	Water	0.2	0.1%
Totals for Area of Interest		**193.6**	**100.0%**

Hydrologic Soil Group and Surface Runoff

This table gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

Surface runoff refers to the loss of water from an area by flow over the land surface. Surface runoff classes are based on slope, climate, and vegetative cover. The concept indicates relative runoff for very specific conditions. It is assumed that the surface of the soil is bare and that the retention of surface water resulting from irregularities in the ground surface is minimal. The classes are negligible, very low, low, medium, high, and very high.

Report—Hydrologic Soil Group and Surface Runoff

Absence of an entry indicates that the data were not estimated. The dash indicates no documented presence.

Hydrologic Soil Group and Surface Runoff–Mason County, Kentucky			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
Du—Dumps			
Dumps	100	—	—

Hydrologic Soil Group and Surface Runoff–Mason County, Kentucky			
Map symbol and soil name	**Pct. of map unit**	**Surface Runoff**	**Hydrologic Soil Group**
EfE2—Eden flaggy silty clay loam, 20 to 40 percent slopes, eroded			
Eden	80	High	D
FrF—Fairmount-Rock outcrop complex, 30 to 60 percent slopes			
Fairmount	60	Very high	D
Rock outcrop	25	—	—
NcB—Nicholson silt loam, 2 to 6 percent slopes			
Nicholson	90	Medium	C
uLfC—Lowell-Faywood silt loams, 6 to 12 percent slopes			
Lowell	70	Medium	C
Faywood	20	Medium	D
uLfD—Lowell-Faywood silt loams, 12 to 20 percent slopes			
Lowell	70	High	C
Faywood	25	High	D
uLsoB—Lowell-Sandview silt loams, 2 to 6 percent slopes			
Lowell	75	Low	C
Sandview	20	Low	C
W—Water			
Water	100	—	—

Data Source Information

Soil Survey Area: Mason County, Kentucky
Survey Area Data: Version 11, Sep 15, 2015

APPENDIX D - LANDFILL PERMIT SURFACE WATER CONTROL CALCULATIONS

SPURLOCK STATION LANDFILL
Terrace Ditch Design

100 Yr/24 Hr Rain Event

CTW

Kenvirons, Inc.
452 Versailles Road
Frankfort KY 40601

Phone: (502) 695-4357

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	5.800 inches

Particle Size Distribution:

Size (mm)	FMSM Soil Sample Average
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	Terrace

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	1.700	1.700	6.23	0.52	55.4	134,675	48.92	27.08

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure Detail:

Structure #1 (Vegetated Channel)

Terrace

Triangular Vegetated Channel Inputs:

Material: Tall fescue

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
3.0:1	20.0:1	2.0	D, D		10.00		5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class D w/o Freeboard	Capacity Class D w/ Freeboard
Design Discharge:	6.23 cfs		6.23 cfs	
Depth:	0.65 ft	0.71 ft	0.65 ft	0.71 ft
Top Width:	14.86 ft	16.34 ft	14.86 ft	16.34 ft
Velocity:	1.30 fps		1.30 fps	
X-Section Area:	4.80 sq ft		4.80 sq ft	
Hydraulic Radius:	0.322		0.322	
Froude Number:	0.40		0.40	
Roughness Coefficient:	0.0761		0.0761	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	1.700	0.102	0.000	0.000	81.000	M	6.23	0.524
	Σ	**1.700**						**6.23**	**0.524**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.350	100.00	33.33	0.2900	0.5000	1	55.4	134,675	48.92	27.08
	Σ							**55.4**	**134,675**	**48.92**	**27.08**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	33.33	33.33	100.00	4.610	0.006
		6. Grassed waterway	2.00	14.74	737.00	2.120	0.096
#1	**1**	**Time of Concentration:**					**0.102**

SPURLOCK STATION LANDFILL

Diversion Berm Design

100 Yr / 24 Hr Rain Event

Charles Wilson

Kenvirons, Inc.
452 Versailles Road
Frankfort KY 40601

Phone: (502) 695-4357

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	5.800 inches

Particle Size Distribution:

Size (mm)	FMSM Soil Sample Average
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	Diversion Berm

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	3.260	3.260	11.95	1.01	25.8	34,094	12.38	6.79

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure Detail:

Structure #1 (Vegetated Channel)

Diversion Berm

Triangular Vegetated Channel Inputs:

Material: Tall fescue

Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.0:1	4.0:1	2.0	D, B				5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	11.95 cfs		11.95 cfs	
Depth:	1.18 ft		1.76 ft	
Top Width:	7.11 ft		10.58 ft	
Velocity:	2.84 fps		1.28 fps	
X-Section Area:	4.21 sq ft		9.32 sq ft	
Hydraulic Radius:	0.562		0.836	
Froude Number:	0.65		0.24	
Roughness Coefficient:	0.0506		0.1458	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	3.260	0.108	0.000	0.000	81.000	M	11.95	1.006
	Σ	**3.260**						**11.95**	**1.006**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.350	200.00	25.00	0.2900	0.1000	1	25.8	34,094	12.38	6.79
	Σ							**25.8**	**34,094**	**12.38**	**6.79**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	25.00	50.00	200.00	4.000	0.013
		6. Grassed waterway	2.00	14.52	726.00	2.120	0.095
#1	**1**	**Time of Concentration:**					**0.108**

SPURLOCK STATION LANDFILL

Down Drain Design

100 Yr/24 Hr Rain Event

Charles Wilson

Kenvirons, Inc.
452 Versailles Road
Frankfort KY 40601

Phone: (502) 695-4357

General Information

Storm Information:

Storm Type:	NRCS Type II
Design Storm:	100 yr - 24 hr
Rainfall Depth:	5.800 inches

Particle Size Distribution:

Size (mm)	FMSM Soil Sample Average
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	End	0.000	0.000	Down Drain

Structure Summary:

	Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#1	22.200	22.200	79.61	6.85	200.5	38,913	13.98	7.65

Particle Size Distribution(s) at Each Structure

Structure #1:

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	98.506%
2.0000	89.019%
0.4250	83.467%
0.0750	79.430%
0.0200	66.108%
0.0050	42.793%
0.0020	35.224%
0.0010	30.278%

Structure Detail:

Structure #1 (Riprap Channel)

Down Drain

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
6.00	2.0:1	2.0:1	25.0	0.50		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	79.61 cfs	
Depth:	0.99 ft	1.49 ft
Top Width:	9.94 ft	11.94 ft
Velocity:	10.13 fps	
X-Section Area:	7.86 sq ft	
Hydraulic Radius:	0.755	
Froude Number:	2.01	
Manning's n:	0.0610	
Dmin:	5.00 in	
D50:	9.00 in	
Dmax:	12.00 in	

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#1	1	22.200	0.104	0.104	0.420	81.000	M	81.39	6.849
	Σ	**22.200**						**79.61**	**6.849**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#1	1	0.320	200.00	25.00	0.2900	0.1000	1	202.3	39,269	14.26	7.80
	Σ							**200.5**	**38,913**	**13.98**	**7.65**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	25.00	25.75	103.00	4.000	0.007
		6. Grassed waterway	2.00	12.80	640.00	2.120	0.083
		8. Large gullies, diversions, and low flowing streams	25.00	200.00	800.00	15.000	0.014
#1	**1**	**Time of Concentration:**					**0.104**

Subwatershed Muskingum Routing Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	25.00	25.75	103.00	4.000	0.007
		6. Grassed waterway	2.00	12.80	640.00	2.120	0.083
		8. Large gullies, diversions, and low flowing streams	25.00	200.00	800.00	15.000	0.014
#1	**1**	**Muskingum K:**					**0.104**

SPURLOCK STATION LANDFILL

Pond 1 and Pond 2 Design

25 Yr / 24 Hr Rain Event

CTW

Kenvirons, Inc.
452 Versailles Road
Frankfort KY 40601

Phone: (502) 695-4357

General Information

Storm Information:

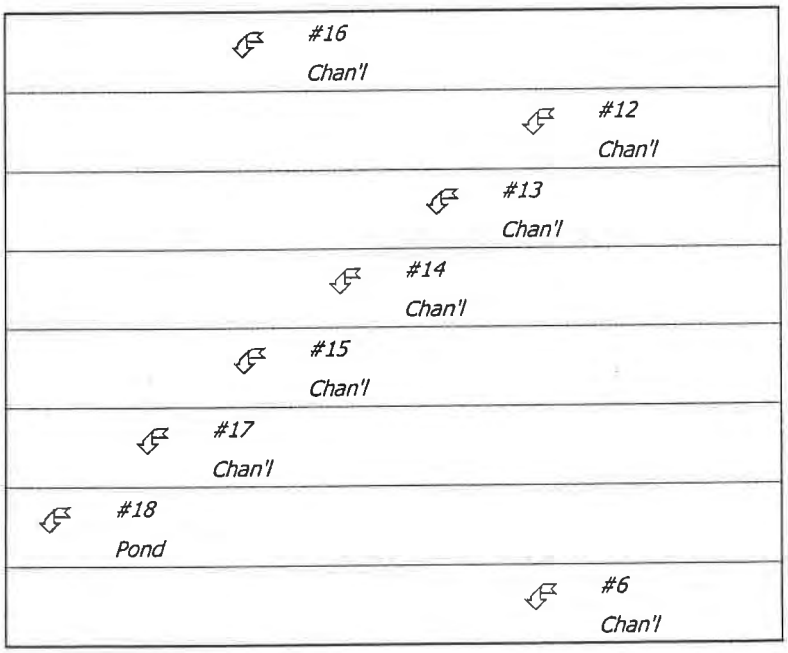
Storm Type:	NRCS Type II
Design Storm:	25 yr - 24 hr
Rainfall Depth:	4.800 inches

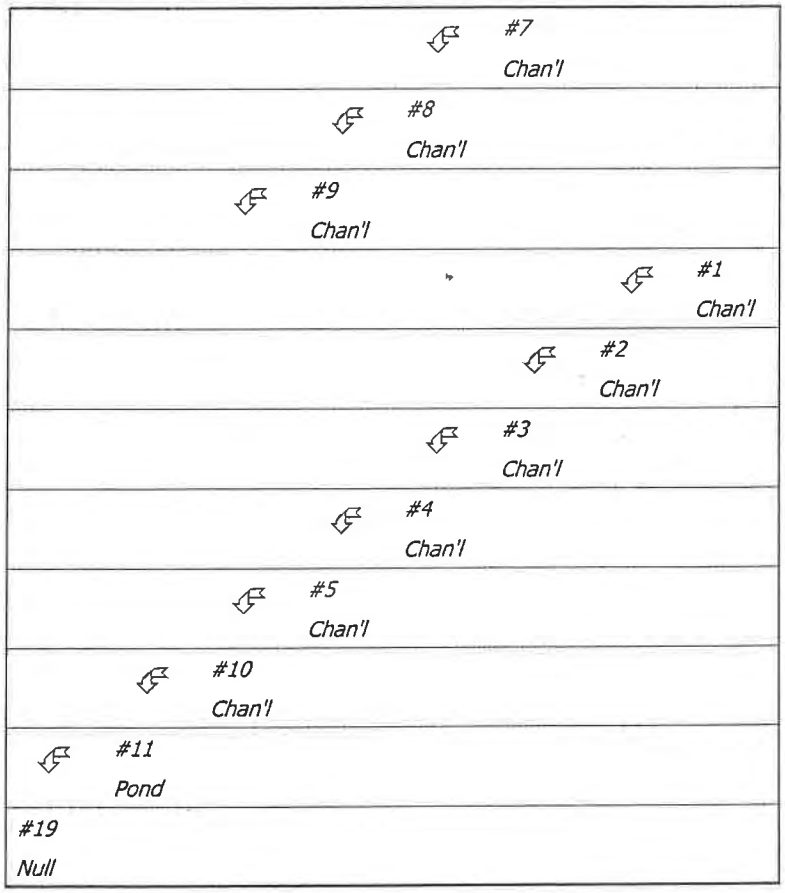
Particle Size Distribution:

Size (mm)	FMSM Soil Sample Average
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure Networking:

Type	Stru #	(flows into)	Stru #	Musk. K (hrs)	Musk. X	Description
Channel	#1	==>	#2	0.025	0.371	Diversion Ditch (Pond1)
Channel	#2	==>	#3	0.051	0.341	Diversion Ditch (Pond 1)
Channel	#3	==>	#4	0.078	0.325	Diversion Ditch (Pond 1)
Channel	#4	==>	#5	0.029	0.441	Diversion Ditch (Pond 1)
Channel	#5	==>	#10	0.005	0.402	Diversion Ditch (Pond 1)
Channel	#6	==>	#7	0.085	0.357	Diversion Ditch (Pond 1)
Channel	#7	==>	#8	0.064	0.324	Diversion Ditch (Pond 1)
Channel	#8	==>	#9	0.042	0.434	Diversion Ditch (Pond 1)
Channel	#9	==>	#10	0.005	0.402	Diversion Ditch (Pond 1)
Channel	#10	==>	#11	0.000	0.399	Diversion Ditch (Pond 1)
Pond	#11	==>	#19	0.000	0.000	Pond 1
Channel	#12	==>	#13	0.129	0.319	Diversion Ditch (Pond 2)
Channel	#13	==>	#14	0.100	0.323	Diversion Ditch (Pond 2)
Channel	#14	==>	#15	0.006	0.338	Diversion Ditch (Pond 2)
Channel	#15	==>	#17	0.056	0.408	Diversion Ditch (Pond 2)
Channel	#16	==>	#17	0.056	0.408	Diversion Ditch (Pond 2)
Channel	#17	==>	#18	0.000	0.406	Diversion Ditch (Pond 2)
Pond	#18	==>	#19	0.000	0.000	Pond 2
Null	#19	==>	End	0.000	0.000	





Structure Routing Details:

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	8. Large gullies, diversions, and low flowing streams	2.67	12.00	449.00	4.90	0.025
#1	**Muskingum K:**					**0.025**
#2	8. Large gullies, diversions, and low flowing streams	1.48	10.00	676.00	3.64	0.051
#2	**Muskingum K:**					**0.051**
#3	8. Large gullies, diversions, and low flowing streams	1.12	10.00	892.06	3.17	0.078
#3	**Muskingum K:**					**0.078**
#4	8. Large gullies, diversions, and low flowing streams	17.94	244.00	1,360.01	12.70	0.029
#4	**Muskingum K:**					**0.029**
#5	8. Large gullies, diversions, and low flowing streams	5.44	8.00	147.00	6.99	0.005
#5	**Muskingum K:**					**0.005**
#6	8. Large gullies, diversions, and low flowing streams	2.00	26.00	1,300.00	4.24	0.085

Stru #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#6	**Muskingum K:**					**0.085**
#7	8. Large gullies, diversions, and low flowing streams	1.10	8.00	730.06	3.14	0.064
#7	**Muskingum K:**					**0.064**
#8	8. Large gullies, diversions, and low flowing streams	13.82	236.00	1,708.00	11.15	0.042
#8	**Muskingum K:**					**0.042**
#9	8. Large gullies, diversions, and low flowing streams	5.44	8.00	147.00	6.99	0.005
#9	**Muskingum K:**					**0.005**
#10	8. Large gullies, diversions, and low flowing streams	5.00	0.54	10.80	6.70	0.000
#10	**Muskingum K:**					**0.000**
#12	8. Large gullies, diversions, and low flowing streams	1.00	14.00	1,395.11	3.00	0.129
#12	**Muskingum K:**					**0.129**
#13	8. Large gullies, diversions, and low flowing streams	1.07	12.00	1,120.02	3.10	0.100
#13	**Muskingum K:**					**0.100**
#14	8. Large gullies, diversions, and low flowing streams	1.39	1.10	79.00	3.54	0.006
#14	**Muskingum K:**					**0.006**
#15	8. Large gullies, diversions, and low flowing streams	6.38	99.00	1,552.01	7.57	0.056
#15	**Muskingum K:**					**0.056**
#16	8. Large gullies, diversions, and low flowing streams	6.38	99.00	1,552.01	7.57	0.056
#16	**Muskingum K:**					**0.056**
#17	8. Large gullies, diversions, and low flowing streams	6.00	0.58	9.66	7.35	0.000
#17	**Muskingum K:**					**0.000**

Structure Summary:

		Immediate Contributing Area (ac)	Total Contributing Area (ac)	Peak Discharge (cfs)	Total Runoff Volume (ac-ft)	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc. (ml/l)	24VW (ml/l)
#16		11.100	11.100	22.15	2.60	13.1	8,484	2.29	1.23
#12		0.540	0.540	1.54	0.13	0.4	4,188	1.52	0.83
#13		13.500	14.040	27.04	3.29	14.7	7,420	1.92	1.05
#14		25.200	39.240	71.63	9.19	60.0	11,545	2.98	1.54
#15		11.300	50.540	99.35	11.83	76.3	10,917	3.07	1.57
#17		9.800	71.440	140.48	16.72	91.0	9,511	2.67	1.30
#18	In	10.500	81.940	170.48	19.18	92.3	9,045	2.55	1.13
	Out			143.12	19.18	61.7	5,351	0.50	0.25
#6		3.800	3.800	10.86	0.89	3.7	5,708	2.07	1.12
#7		27.000	30.800	63.78	7.21	39.7	9,327	2.54	1.33
#8		18.270	49.070	98.45	11.49	63.3	9,328	2.53	1.33
#9		21.100	70.170	151.35	16.43	93.4	8,907	2.68	1.43
#1		4.400	4.400	12.57	1.03	4.5	5,947	2.16	1.17
#2		4.490	8.890	25.40	2.08	9.5	6,224	2.26	1.22
#3		14.700	23.590	52.75	5.52	28.6	14,183	4.27	1.29
#4		25.700	49.290	102.84	11.54	63.1	11,919	3.39	1.35
#5		24.600	73.890	168.22	17.30	103.0	9,114	2.87	1.53
#10		4.600	148.660	332.70	34.80	197.6	8,721	2.69	1.44
#11	In	6.280	154.940	350.64	36.27	199.1	8,345	2.58	1.39
	Out			210.68	36.27	125.4	5,297	0.48	0.26
#19		0.000	236.880	352.59	55.46	187.1	5,159	0.47	0.00

Particle Size Distribution(s) at Each Structure

Structure #16 (Diversion Ditch (Pond 2)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	100.000%
2.0000	100.000%
0.4250	100.000%
0.0750	96.213%
0.0200	80.076%
0.0050	51.835%
0.0020	42.666%
0.0010	36.676%

Structure #12 (Diversion Ditch (Pond 2)):

Size (mm)	In/Out
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure #13 (Diversion Ditch (Pond 2)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	100.000%

Size (mm)	In/Out
2.0000	99.687%
0.4250	99.541%
0.0750	98.386%
0.0200	81.885%
0.0050	53.006%
0.0020	43.630%
0.0010	37.504%

Structure #14 (Diversion Ditch (Pond 2)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	100.000%
2.0000	100.000%
0.4250	99.889%
0.0750	98.390%
0.0200	81.888%
0.0050	53.008%
0.0020	43.632%
0.0010	37.506%

Structure #15 (Diversion Ditch (Pond 2)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	99.487%
2.0000	97.479%
0.4250	96.217%
0.0750	94.183%
0.0200	78.386%
0.0050	50.742%
0.0020	41.766%
0.0010	35.902%

Structure #17 (Diversion Ditch (Pond 2)):

Size (mm)	In/Out
19.0000	100.000%

Size (mm)	In/Out
9.5000	100.000%
4.7500	99.532%
2.0000	97.682%
0.4250	96.527%
0.0750	94.208%
0.0200	78.407%
0.0050	50.755%
0.0020	41.777%
0.0010	35.911%

Structure #18 (Pond 2):

Size (mm)	In	Out
19.0000	100.000%	100.000%
9.5000	100.000%	100.000%
4.7500	99.504%	100.000%
2.0000	97.545%	100.000%
0.4250	96.326%	100.000%
0.0750	93.983%	100.000%
0.0200	78.219%	100.000%
0.0050	50.634%	75.732%
0.0020	41.677%	62.336%
0.0010	35.826%	53.584%

Structure #6 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure #7 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	99.774%
2.0000	98.888%
0.4250	98.370%
0.0750	95.836%
0.0200	79.762%
0.0050	51.632%
0.0020	42.499%
0.0010	36.532%

Structure #8 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	99.861%
2.0000	99.305%
0.4250	98.979%
0.0750	95.979%
0.0200	79.881%
0.0050	51.709%
0.0020	42.562%
0.0010	36.587%

Structure #9 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	99.133%
2.0000	95.723%
0.4250	93.728%
0.0750	90.405%
0.0200	75.242%
0.0050	48.706%
0.0020	40.091%
0.0010	34.462%

Structure #1 (Diversion Ditch (Pond1)):

Size (mm)	In/Out
19.0000	99.900%
9.5000	99.900%
4.7500	97.600%
2.0000	88.200%
0.4250	82.700%
0.0750	78.700%
0.0200	65.500%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure #2 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	97.601%
2.0000	88.201%
0.4250	82.701%
0.0750	78.701%
0.0200	65.501%
0.0050	42.400%
0.0020	34.900%
0.0010	30.000%

Structure #3 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	99.200%
2.0000	96.057%
0.4250	94.219%
0.0750	90.361%
0.0200	75.205%
0.0050	48.682%
0.0020	40.071%
0.0010	34.445%

Structure #4 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	99.640%
2.0000	98.217%
0.4250	97.385%
0.0750	93.566%
0.0200	77.872%
0.0050	50.409%
0.0020	41.492%
0.0010	35.667%

Structure #5 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	98.850%
2.0000	94.336%
0.4250	91.694%
0.0750	87.805%
0.0200	73.078%
0.0050	47.305%
0.0020	38.938%
0.0010	33.471%

Structure #10 (Diversion Ditch (Pond 1)):

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	98.977%
2.0000	94.954%
0.4250	92.600%
0.0750	88.978%
0.0200	74.054%
0.0050	47.937%
0.0020	39.458%
0.0010	33.918%

Structure #11 (Pond 1):

Size (mm)	In	Out
19.0000	100.000%	100.000%
9.5000	100.000%	100.000%
4.7500	98.967%	100.000%
2.0000	94.905%	100.000%
0.4250	92.528%	100.000%
0.0750	88.903%	100.000%
0.0200	73.992%	100.000%
0.0050	47.897%	76.064%
0.0020	39.425%	62.609%
0.0010	33.889%	53.819%

Structure #19:

Size (mm)	In/Out
19.0000	100.000%
9.5000	100.000%
4.7500	100.000%
2.0000	100.000%
0.4250	100.000%
0.0750	100.000%
0.0200	100.000%
0.0050	75.955%
0.0020	62.519%
0.0010	53.741%

Structure Detail:

Structure #16 (Vegetated Channel)

Diversion Ditch (Pond 2)

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	1.5	D, B		10.00		5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	22.15 cfs		22.15 cfs	
Depth:	1.32 ft	1.45 ft	1.99 ft	2.19 ft
Top Width:	7.28 ft	7.81 ft	9.97 ft	10.76 ft
Velocity:	3.62 fps		1.86 fps	
X-Section Area:	6.12 sq ft		11.92 sq ft	
Hydraulic Radius:	0.775		1.093	
Froude Number:	0.69		0.30	
Roughness Coefficient:	0.0426		0.1041	

Structure #12 (Vegetated Channel)

Diversion Ditch (Pond 2)

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	1.6	D, B		10.00		5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	1.54 cfs		1.54 cfs	
Depth:	0.46 ft	0.51 ft	0.94 ft	1.04 ft
Top Width:	3.84 ft	4.02 ft	5.78 ft	6.15 ft
Velocity:	1.15 fps		0.42 fps	
X-Section Area:	1.34 sq ft		3.67 sq ft	
Hydraulic Radius:	0.331		0.590	
Froude Number:	0.34		0.09	
Roughness Coefficient:	0.0783		0.3149	

Structure #13 (Riprap Channel)

Diversion Ditch (Pond 2)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	1.0		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	27.04 cfs	
Depth:	1.35 ft	1.49 ft
Top Width:	7.41 ft	7.95 ft
Velocity:	4.25 fps	
X-Section Area:	6.37 sq ft	
Hydraulic Radius:	0.791	
Froude Number:	0.81	
Manning's n:	0.0300	
Dmin:	1.00 in	
D50:	1.50 in	
Dmax:	3.00 in	

Structure #14 (Riprap Channel)

Diversion Ditch (Pond 2)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	1.1		10.00	

Riprap Channel Results:

PADER Method - Mild Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	71.63 cfs	
Depth:	2.19 ft	2.40 ft
Top Width:	10.75 ft	11.62 ft
Velocity:	5.14 fps	
X-Section Area:	13.93 sq ft	
Hydraulic Radius:	1.183	
Froude Number:	0.80	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #15 (Riprap Channel)

Diversion Ditch (Pond 2)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	1.4		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	99.35 cfs	
Depth:	2.39 ft	2.63 ft
Top Width:	11.58 ft	12.54 ft
Velocity:	6.11 fps	

	w/o Freeboard	w/ Freeboard
X-Section Area:	16.26 sq ft	
Hydraulic Radius:	1.279	
Froude Number:	0.91	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #17 (Riprap Channel)

Diversion Ditch (Pond 2)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	6.4		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	140.48 cfs	
Depth:	2.33 ft	2.56 ft
Top Width:	11.30 ft	12.23 ft
Velocity:	9.08 fps	
X-Section Area:	15.46 sq ft	
Hydraulic Radius:	1.247	
Froude Number:	1.37	
Manning's n:	0.0480	
Dmin:	5.00 in	
D50:	9.00 in	
Dmax:	12.00 in	

Structure #18 (Pond)

Pond 2

Pond Inputs:

Permanent Pool Elev:	806.00

Permanent Pool:	0.08 ac-ft
*Sediment Storage:	1.00 ac-ft
Dead Space:	20.00 %

**Sediment capacity was entered by user*

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
812.00	30.00	2.00:1	2.00:1	20.00

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev	Number of Holes per Elev
42.00	7.00	36.00	62.00	2.00	0.0240	809.00	4

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev	Number of Holes per Elev
42.00	7.00	36.00	62.00	2.00	0.0240	809.00	4

Pond Results:

Peak Elevation:	811.39
H'graph Detention Time:	0.26 hrs
Dewater Time:	0.59 days
Trap Efficiency:	33.14 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
805.66	0.228	0.000	0.000		Top of Sed. Storage
806.00	0.239	0.079	0.000		Low hole SPW #2 Low hole SPW #3
806.50	0.256	0.202	5.348	7.40	
807.00	0.273	0.335	7.563	2.70	
807.50	0.291	0.475	14.611	1.90	
808.00	0.309	0.625	18.260	0.55	

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
808.50	0.328	0.785	26.570	0.35	
809.00	0.348	0.954	31.360	0.20	Spillway #2 Spillway #3
809.50	0.368	1.133	35.372	0.30	
810.00	0.389	1.322	68.173	0.35	
810.50	0.411	1.522	113.474	0.15	
811.00	0.433	1.733	131.028	0.10	
811.39	0.451	1.906	143.123	0.10	Peak Stage
811.50	0.456	1.955	146.494		
812.00	0.479	2.188	160.476		Spillway #1
812.50	0.513	2.436	195.284		
813.00	0.549	2.702	229.202		
813.50	0.585	2.985	292.538		
814.00	0.623	3.287	361.265		

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Perf. Riser (cfs)	Perf. Riser (cfs)	Combined Total Discharge (cfs)
805.66	0.000	0.000	0.000	0.000
806.00	0.000	6.00>0.000	6.00>0.000	0.000
806.50	0.000	2.674	2.674	5.348
807.00	0.000	6.00>3.782	6.00>3.782	7.563
807.50	0.000	7.306	7.306	14.611
808.00	0.000	6.00>9.130	6.00>9.130	18.260
808.50	0.000	13.285	13.285	26.570
809.00	0.000	15.680	15.680	31.360
809.50	0.000	17.686	17.686	35.372
810.00	0.000	34.086	34.086	68.173
810.50	0.000	56.737	56.737	113.474
811.00	0.000	65.514	65.514	131.028
811.50	0.000	73.247	73.247	146.494
812.00	0.000	80.238	80.238	160.476
812.50	21.950	86.667	86.667	195.284
813.00	43.900	92.651	92.651	229.202
813.50	95.996	98.271	98.271	292.538
814.00	155.596	102.835	102.835	361.265

Structure #6 (Vegetated Channel)

Diversion Ditch (Pond 1)

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	2.9	D, B		10.00		5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	10.86 cfs		10.86 cfs	
Depth:	0.84 ft	0.93 ft	1.37 ft	1.50 ft
Top Width:	5.37 ft	5.71 ft	7.46 ft	8.01 ft
Velocity:	3.49 fps		1.68 fps	
X-Section Area:	3.11 sq ft		6.46 sq ft	
Hydraulic Radius:	0.539		0.797	
Froude Number:	0.81		0.32	
Roughness Coefficient:	0.0481		0.1296	

Structure #7 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	2.0		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	63.78 cfs	
Depth:	1.84 ft	2.02 ft
Top Width:	9.36 ft	10.09 ft
Velocity:	6.11 fps	
X-Section Area:	10.45 sq ft	

	w/o Freeboard	w/ Freeboard
Hydraulic Radius:	1.021	
Froude Number:	1.02	
Manning's n:	0.0350	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #8 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	1.1		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	98.45 cfs	
Depth:	2.51 ft	2.77 ft
Top Width:	12.06 ft	13.06 ft
Velocity:	5.57 fps	
X-Section Area:	17.67 sq ft	
Hydraulic Radius:	1.334	
Froude Number:	0.81	
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #9 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	13.8		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	151.35 cfs	
Depth:	2.10 ft	2.31 ft
Top Width:	10.40 ft	11.24 ft
Velocity:	11.63 fps	
X-Section Area:	13.01 sq ft	
Hydraulic Radius:	1.143	
Froude Number:	1.83	
Manning's n:	0.0520	
Dmin:	7.00 in	
D50:	12.00 in	
Dmax:	18.00 in	

Structure #1 (Vegetated Channel)

Diversion Ditch (Pond1)

Trapezoidal Vegetated Channel Inputs:

Material: Tall fescue

Bottom Width (ft)	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Retardance Classes	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)	Limiting Velocity (fps)
2.00	2.0:1	2.0:1	2.0	D, B		10.00		5.0

Vegetated Channel Results:

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Design Discharge:	12.57 cfs		12.57 cfs	
Depth:	0.99 ft	1.09 ft	1.58 ft	1.74 ft
Top Width:	5.96 ft	6.35 ft	8.32 ft	8.95 ft
Velocity:	3.19 fps		1.54 fps	
X-Section Area:	3.93 sq ft		8.15 sq ft	
Hydraulic Radius:	0.613		0.899	
Froude Number:	0.69		0.27	

	Stability Class D w/o Freeboard	Stability Class D w/ Freeboard	Capacity Class B w/o Freeboard	Capacity Class B w/ Freeboard
Roughness Coefficient:	0.0475		0.1273	

Structure #2 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	2.7		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	25.40 cfs	
Depth:	1.15 ft	1.26 ft
Top Width:	6.58 ft	7.04 ft
Velocity:	5.17 fps	
X-Section Area:	4.91 sq ft	
Hydraulic Radius:	0.690	
Froude Number:	1.05	
Manning's n:	0.0370	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #3 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	1.5	10.00		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	52.75 cfs	
Depth:	1.80 ft	1.98 ft
Top Width:	9.21 ft	9.93 ft
Velocity:	5.23 fps	
X-Section Area:	10.09 sq ft	
Hydraulic Radius:	1.004	
Froude Number:	0.88	
Manning's n:	0.0350	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #4 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	1.1	10.00		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	102.84 cfs	
Depth:	2.56 ft	2.82 ft
Top Width:	12.25 ft	13.28 ft
Velocity:	5.63 fps	
X-Section Area:	18.26 sq ft	
Hydraulic Radius:	1.356	
Froude Number:	0.81	

	w/o Freeboard	w/ Freeboard
Manning's n:	0.0340	
Dmin:	2.00 in	
D50:	3.00 in	
Dmax:	4.50 in	

Structure #5 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
2.00	2.0:1	2.0:1	17.9		10.00	

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	168.22 cfs	
Depth:	2.13 ft	2.34 ft
Top Width:	10.52 ft	11.37 ft
Velocity:	12.63 fps	
X-Section Area:	13.32 sq ft	
Hydraulic Radius:	1.156	
Froude Number:	1.98	
Manning's n:	0.0550	
Dmin:	7.00 in	
D50:	12.00 in	
Dmax:	18.00 in	

Structure #10 (Riprap Channel)

Diversion Ditch (Pond 1)

Trapezoidal Riprap Channel Inputs:

Material: Riprap

Bottom Width (ft)}	Left Sideslope Ratio	Right Sideslope Ratio	Slope (%)	Freeboard Depth (ft)	Freeboard % of Depth	Freeboard Mult. x (VxD)
3.00	3.0:1	3.0:1	5.4	10.00		

Riprap Channel Results:

PADER Method - Steep Slope Design

	w/o Freeboard	w/ Freeboard
Design Discharge:	332.70 cfs	
Depth:	2.84 ft	3.13 ft
Top Width:	20.07 ft	21.78 ft
Velocity:	10.14 fps	
X-Section Area:	32.82 sq ft	
Hydraulic Radius:	1.563	
Froude Number:	1.40	
Manning's n:	0.0460	
Dmin:	5.00 in	
D50:	9.00 in	
Dmax:	12.00 in	

Structure #11 (Pond)

Pond 1

Pond Inputs:

Permanent Pool Elev:	611.50
Permanent Pool:	0.08 ac-ft
*Sediment Storage:	1.90 ac-ft
Dead Space:	20.00 %

**Sediment capacity was entered by user*

Emergency Spillway

Spillway Elev	Crest Length (ft)	Left Sideslope	Right Sideslope	Bottom Width (ft)
621.00	30.00	2.00:1	2.00:1	25.00

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev	Number of Holes per Elev
42.00	7.00	36.00	94.00	2.00	0.0240	613.50	6

Perforated Riser

Riser Diameter (in)	Riser Height (ft)	Barrel Diameter (in)	Barrel Length (ft)	Barrel Slope (%)	Manning's n	Spillway Elev	Number of Holes per Elev
42.00	7.00	36.00	94.00	2.00	0.0240	613.00	6

Pond Results:

Peak Elevation:	620.98
H'graph Detention Time:	0.22 hrs
Dewater Time:	0.59 days
Trap Efficiency:	37.03 %

Dewatering time is calculated from peak stage to lowest spillway

Elevation-Capacity-Discharge Table

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)	
611.26	0.316	0.000	0.000		Top of Sed. Storage
611.50	0.324	0.078	0.000		Low hole SPW #2
612.00	0.341	0.245	7.131	5.55	Low hole SPW #3
612.50	0.358	0.419	17.215	5.45	
613.00	0.376	0.603	29.566	1.50	Spillway #3
613.50	0.394	0.796	36.697	0.55	Spillway #2
614.00	0.413	0.997	62.382	0.40	
614.50	0.431	1.208	90.823	0.10	
615.00	0.449	1.428	122.251	0.05	
615.50	0.467	1.657	138.761	0.05	
616.00	0.486	1.895	153.485		
616.50	0.505	2.143	166.905	0.05	
617.00	0.525	2.401	179.318	0.05	
617.50	0.545	2.668	187.185		
618.00	0.565	2.945	190.817	0.05	
618.50	0.586	3.233	194.286	0.05	
619.00	0.607	3.531	197.695	0.05	
619.50	0.628	3.840	201.045		
620.00	0.650	4.159	204.340	0.05	
620.50	0.669	4.489	207.583	0.05	
620.98	0.688	4.818	210.678	0.10	Peak Stage
621.00	0.688	4.829	210.776		Spillway #1
621.50	0.708	5.178	241.088		
622.00	0.728	5.537	271.354		

Elevation	Area (ac)	Capacity (ac-ft)	Discharge (cfs)	Dewater Time (hrs)
622.50	0.748	5.906	338.160	
623.00	0.769	6.285	413.479	
623.50	0.790	6.675	508.112	
624.00	0.811	7.075	621.920	

Detailed Discharge Table

Elevation	Emergency Spillway (cfs)	Perf. Riser (cfs)	Perf. Riser (cfs)	Combined Total Discharge (cfs)
611.26	0.000	0.000	0.000	0.000
611.50	0.000	8.00>0.000	0.000	0.000
612.00	0.000	7.131	8.00>0.000	7.131
612.50	0.000	8.00>10.084	7.131	17.215
613.00	0.000	19.482	10.084	29.566
613.50	0.000	24.346	12.351	36.697
614.00	0.000	28.296	34.086	62.382
614.50	0.000	34.086	56.737	90.823
615.00	0.000	56.737	65.514	122.251
615.50	0.000	65.514	73.247	138.761
616.00	0.000	73.247	80.238	153.485
616.50	0.000	80.238	86.667	166.905
617.00	0.000	86.667	92.651	179.318
617.50	0.000	92.651	94.534	187.185
618.00	0.000	94.534	96.284	190.817
618.50	0.000	96.284	98.003	194.286
619.00	0.000	98.003	99.692	197.695
619.50	0.000	99.692	101.353	201.045
620.00	0.000	101.353	102.987	204.340
620.50	0.000	102.987	104.596	207.583
621.00	0.000	104.596	106.180	210.776
621.50	27.166	106.180	107.742	241.088
622.00	54.332	107.742	109.280	271.354
622.50	118.082	109.280	110.798	338.160
623.00	190.387	110.798	112.295	413.479
623.50	282.045	112.295	113.772	508.112
624.00	392.918	113.772	115.230	621.920

Structure #19 (Null)

Subwatershed Hydrology Detail:

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#16	1	11.100	0.129	0.000	0.000	81.000	M	22.15	2.599
	Σ	**11.100**						**22.15**	**2.599**
#12	1	0.540	0.017	0.000	0.000	81.000	M	1.54	0.126
	Σ	**0.540**						**1.54**	**0.126**
#13	1	13.500	0.212	0.000	0.000	81.000	M	25.64	3.160
	Σ	**14.040**						**27.04**	**3.287**
#14	1	25.200	0.200	0.000	0.000	81.000	M	48.32	5.900
	Σ	**39.240**						**71.63**	**9.186**
#15	1	11.300	0.052	0.000	0.000	81.000	M	32.28	2.645
	Σ	**50.540**						**99.35**	**11.832**
#17	1	9.800	0.060	0.000	0.000	81.000	M	28.00	2.294
	Σ	**71.440**						**140.48**	**16.725**
#18	1	10.500	0.031	0.000	0.000	81.000	M	30.00	2.458
	Σ	**81.940**						**170.48**	**19.183**
#6	1	3.800	0.055	0.000	0.000	81.000	M	10.86	0.890
	Σ	**3.800**						**10.86**	**0.890**
#7	1	27.000	0.190	0.000	0.000	81.000	M	52.50	6.321
	Σ	**30.800**						**63.78**	**7.211**
#8	1	18.270	0.154	0.000	0.000	81.000	M	36.46	4.277
	Σ	**49.070**						**98.45**	**11.488**
#9	1	21.100	0.080	0.000	0.000	81.000	M	60.28	4.940
	Σ	**70.170**						**151.35**	**16.427**
#1	1	4.400	0.076	0.000	0.000	81.000	M	12.57	1.030
	Σ	**4.400**						**12.57**	**1.030**
#2	1	4.490	0.073	0.000	0.000	81.000	M	12.83	1.051
	Σ	**8.890**						**25.40**	**2.081**
#3	1	14.700	0.130	0.000	0.000	81.000	M	29.33	3.441
	Σ	**23.590**						**52.75**	**5.523**
#4	1	25.700	0.148	0.000	0.000	81.000	M	51.28	6.017
	Σ	**49.290**						**102.84**	**11.539**

Stru #	SWS #	SWS Area (ac)	Time of Conc (hrs)	Musk K (hrs)	Musk X	Curve Number	UHS	Peak Discharge (cfs)	Runoff Volume (ac-ft)
#5	1	24.600	0.116	0.000	0.000	81.000	M	70.28	5.759
	Σ	**73.890**						**168.22**	**17.298**
#10	1	4.600	0.046	0.000	0.000	81.000	M	13.14	1.077
	Σ	**148.660**						**332.70**	**34.802**
#11	1	6.280	0.034	0.000	0.000	81.000	M	17.94	1.470
	Σ	**154.940**						**350.64**	**36.273**
#19	Σ	**236.880**						**352.59**	**55.456**

Subwatershed Sedimentology Detail:

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#16	1	0.350	190.00	25.00	0.0420	0.1500	1	13.1	8,484	2.29	1.23
	Σ							**13.1**	**8,484**	**2.29**	**1.23**
#12	1	0.350	110.00	25.00	0.0420	0.1500	1	0.4	4,188	1.52	0.83
	Σ							**0.4**	**4,188**	**1.52**	**0.83**
#13	1	0.350	160.00	25.00	0.0420	0.1500	1	14.3	7,755	1.98	1.06
	Σ							**14.7**	**7,420**	**1.92**	**1.05**
#14	1	0.350	210.00	25.00	0.0420	0.2000	1	45.3	13,177	3.40	1.82
	Σ							**60.0**	**11,545**	**2.98**	**1.54**
#15	1	0.350	190.00	25.00	0.0420	0.1500	1	16.3	8,355	3.03	1.64
	Σ							**76.3**	**10,917**	**3.07**	**1.57**
#17	1	0.350	420.00	25.00	0.0030	0.1500	1	1.6	947	0.34	0.19
	Σ							**91.0**	**9,511**	**2.67**	**1.30**
#18	1	0.350	275.00	25.00	0.0030	0.1500	1	1.3	741	0.27	0.15
	Σ							**92.3**	**9,045**	**2.55**	**1.13**
#6	1	0.350	125.00	25.00	0.0420	0.1500	1	3.7	5,708	2.07	1.12
	Σ							**3.7**	**5,708**	**2.07**	**1.12**
#7	1	0.350	200.00	25.00	0.0420	0.1500	1	36.0	9,693	2.54	1.36
	Σ							**39.7**	**9,327**	**2.54**	**1.33**
#8	1	0.350	200.00	25.00	0.0420	0.1500	1	23.6	9,285	2.51	1.34
	Σ							**63.3**	**9,328**	**2.53**	**1.33**

Stru #	SWS #	Soil K	L (ft)	S (%)	C	P	PS #	Sediment (tons)	Peak Sediment Conc. (mg/l)	Peak Settleable Conc (ml/l)	24VW (ml/l)
#9	1	0.350	100.00	33.33	0.0420	0.1500	1	30.1	8,270	3.00	1.63
	Σ							**93.4**	**8,907**	**2.68**	**1.43**
#1	1	0.350	130.00	25.00	0.0420	0.1500	1	4.5	5,947	2.16	1.17
	Σ							**4.5**	**5,947**	**2.16**	**1.17**
#2	1	0.350	150.00	25.00	0.0420	0.1500	1	5.0	6,495	2.36	1.28
	Σ							**9.5**	**6,224**	**2.26**	**1.22**
#3	1	0.350	210.00	25.00	0.0420	0.1500	1	19.0	9,315	2.51	1.35
	Σ							**28.6**	**14,183**	**4.27**	**1.29**
#4	1	0.350	200.00	25.00	0.0420	0.1500	1	34.5	9,672	2.61	1.40
	Σ							**63.1**	**11,919**	**3.39**	**1.35**
#5	1	0.350	120.00	33.33	0.0420	0.1500	1	39.9	9,393	3.41	1.85
	Σ							**103.0**	**9,114**	**2.87**	**1.53**
#10	1	0.350	575.00	36.50	0.0030	0.1500	1	1.2	1,541	0.56	0.30
	Σ							**197.6**	**8,721**	**2.69**	**1.44**
#11	1	0.350	425.00	36.50	0.0030	0.1500	1	1.4	1,335	0.48	0.26
	Σ							**199.1**	**8,345**	**2.58**	**1.39**
#19	Σ							**187.1**	**5,159**	**0.47**	**0.00**

Subwatershed Time of Concentration Details:

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#1	1	3. Short grass pasture	25.00	29.00	116.00	4.000	0.008
		8. Large gullies, diversions, and low flowing streams	2.25	25.00	1,112.00	4.490	0.068
#1	**1**	**Time of Concentration:**					**0.076**
#2	1	3. Short grass pasture	25.00	25.50	102.00	4.000	0.007
		6. Grassed waterway	2.00	5.74	287.00	2.120	0.037
		8. Large gullies, diversions, and low flowing streams	24.81	64.00	258.00	14.940	0.004
		8. Large gullies, diversions, and low flowing streams	2.67	12.00	449.00	4.900	0.025
#2	**1**	**Time of Concentration:**					**0.073**
#3	1	3. Short grass pasture	25.00	45.50	182.00	4.000	0.012
		6. Grassed waterway	2.00	8.26	413.00	2.120	0.054
		8. Large gullies, diversions, and low flowing streams	25.73	184.00	715.00	15.210	0.013

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
		8. Large gullies, diversions, and low flowing streams	1.48	10.00	676.04	3.640	0.051
#3	**1**	**Time of Concentration:**					**0.130**
#4	1	3. Short grass pasture	25.00	14.25	57.00	4.000	0.003
		6. Grassed waterway	2.00	7.78	389.00	2.120	0.050
		8. Large gullies, diversions, and low flowing streams	25.00	231.50	926.00	15.000	0.017
		8. Large gullies, diversions, and low flowing streams	1.12	10.00	892.00	3.170	0.078
#4	**1**	**Time of Concentration:**					**0.148**
#5	1	3. Short grass pasture	25.00	37.25	149.00	4.000	0.010
		6. Grassed waterway	2.00	10.04	502.00	2.120	0.065
		8. Large gullies, diversions, and low flowing streams	23.88	154.00	645.00	14.650	0.012
		8. Large gullies, diversions, and low flowing streams	17.94	244.00	1,360.01	12.700	0.029
#5	**1**	**Time of Concentration:**					**0.116**
#6	1	3. Short grass pasture	25.00	39.75	159.00	4.000	0.011
		8. Large gullies, diversions, and low flowing streams	2.93	24.00	818.00	5.130	0.044
#6	**1**	**Time of Concentration:**					**0.055**
#7	1	3. Short grass pasture	25.00	25.75	103.00	4.000	0.007
		6. Grassed waterway	2.00	12.86	643.00	2.120	0.084
		8. Large gullies, diversions, and low flowing streams	24.91	200.00	803.00	14.970	0.014
		8. Large gullies, diversions, and low flowing streams	2.00	26.00	1,300.00	4.240	0.085
#7	**1**	**Time of Concentration:**					**0.190**
#8	1	3. Short grass pasture	25.00	65.00	260.00	4.000	0.018
		6. Grassed waterway	2.00	9.22	461.00	2.120	0.060
		8. Large gullies, diversions, and low flowing streams	25.00	165.00	660.00	15.000	0.012
		8. Large gullies, diversions, and low flowing streams	1.10	8.00	730.06	3.140	0.064
#8	**1**	**Time of Concentration:**					**0.154**
#9	1	3. Short grass pasture	33.33	22.00	66.00	4.610	0.003
		6. Grassed waterway	1.86	4.00	215.00	2.040	0.029
		8. Large gullies, diversions, and low flowing streams	24.93	91.00	365.00	14.970	0.006
		8. Large gullies, diversions, and low flowing streams	13.82	236.00	1,708.00	11.150	0.042
#9	**1**	**Time of Concentration:**					**0.080**
#10	1	3. Short grass pasture	36.50	265.00	726.02	4.830	0.041
		8. Large gullies, diversions, and low flowing streams	5.44	8.00	147.00	6.990	0.005
#10	**1**	**Time of Concentration:**					**0.046**

Stru #	SWS #	Land Flow Condition	Slope (%)	Vert. Dist. (ft)	Horiz. Dist. (ft)	Velocity (fps)	Time (hrs)
#11	1	3. Short grass pasture	36.50	219.73	602.00	4.830	0.034
#11	**1**	**Time of Concentration:**					**0.034**
#12	1	3. Short grass pasture	25.22	29.00	115.00	4.010	0.007
		8. Large gullies, diversions, and low flowing streams	1.57	2.25	143.00	3.760	0.010
#12	**1**	**Time of Concentration:**					**0.017**
#13	1	3. Short grass pasture	25.00	33.50	134.00	4.000	0.009
		6. Grassed waterway	1.99	10.50	528.00	2.110	0.069
		8. Large gullies, diversions, and low flowing streams	24.91	72.00	289.00	14.970	0.005
		8. Large gullies, diversions, and low flowing streams	1.00	14.00	1,395.11	3.000	0.129
#13	**1**	**Time of Concentration:**					**0.212**
#14	1	3. Short grass pasture	24.79	29.00	117.00	3.980	0.008
		6. Grassed waterway	2.01	11.00	548.00	2.120	0.071
		8. Large gullies, diversions, and low flowing streams	17.55	172.00	980.00	12.560	0.021
		8. Large gullies, diversions, and low flowing streams	1.07	12.00	1,120.02	3.100	0.100
#14	**1**	**Time of Concentration:**					**0.200**
#15	1	3. Short grass pasture	25.15	42.00	167.00	4.010	0.011
		6. Grassed waterway	2.00	3.50	175.00	2.120	0.022
		8. Large gullies, diversions, and low flowing streams	25.00	186.75	747.00	15.000	0.013
		8. Large gullies, diversions, and low flowing streams	1.39	1.10	79.00	3.540	0.006
#15	**1**	**Time of Concentration:**					**0.052**
#16	1	3. Short grass pasture	25.00	40.50	162.00	4.000	0.011
		6. Grassed waterway	2.00	1.30	65.00	2.120	0.008
		8. Large gullies, diversions, and low flowing streams	25.04	166.00	663.00	15.010	0.012
		8. Large gullies, diversions, and low flowing streams	1.52	20.00	1,315.01	3.690	0.098
#16	**1**	**Time of Concentration:**					**0.129**
#17	1	7. Paved area and small upland gullies	1.00	0.36	36.00	2.010	0.004
		8. Large gullies, diversions, and low flowing streams	6.38	99.00	1,552.00	7.570	0.056
#17	**1**	**Time of Concentration:**					**0.060**
#18	1	3. Short grass pasture	25.00	72.50	290.00	4.000	0.020
		8. Large gullies, diversions, and low flowing streams	10.00	38.00	380.00	9.480	0.011
#18	**1**	**Time of Concentration:**					**0.031**

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