Module 12: Erosion and Sedimentation Controls  
[§§77.458/77.461/77.466/77.525/77.527/77.531/Chapter 102]

12.1 Diversion Controls

Provide a plan for the collection and conveyance to a natural drainageway of the runoff from upslope undisturbed areas. Provide a separate general design for a temporary highwall diversion which limits the amount of runoff which can enter the pit (where applicable). Include design criteria, capacity calculations, profile of proposed channel slopes, typical cross-sections, required channel linings and applicable details on 12.1 Data Sheet.

One (1) diversion ditch labeled DD-1 is proposed for this operation. It discharges toward Unnamed Tributary 1B via an energy dissipator. All design criteria, calculations, and details are attached. See Exhibit 9 for the location of diversion ditch DD-1. A drainage analysis has been performed using Hydrocad software for the existing pond to ensure that the peak flow will not increase. The 10-year storm was analyzed since this is the maximum storm that the ditches are designed for. See attached Hydrocad report that confirms the peak flow has not been increased to the existing pond.

A temporary highwall diversion will not be necessary since all highwalls will be near the top of hills.

12.2 Erosion and Sediment Control

Provide a plan for the control of erosion and sedimentation for lands within the permit area to be disturbed by mining activities. Include a narrative describing the implementation of the plan, and detailed design and construction plans and specifications for structures or facilities used in the plan. The plan must include each phase or phases of mining. Include design criteria, capacity calculations, profile of proposed channel slopes, typical cross-sections, required channel linings and applicable details on 12.1 Diversion/Collection Ditch Data Sheet for collection and interceptor ditches. Provide documentation of the capacity of the existing drainage system and the effect proposed mining activities will have on the drainage. Show discharge points to natural drainageways and culverts that intercept upslope drainage or carry drainage away from the site. Show facilities to scale on Modules 9 and 16 as appropriate.

See Exhibit 9 for locations of all erosion and sedimentation controls.

Mining will be performed in two phases. Phase 1 will include the construction of the processing pad and haul road to the existing SMT permit, as well as the process ponds. Phase 2 will include haul road construction from the pad to the mining areas as well as the mining of Benwood Limestone. Before any earth disturbance for Phase 1, Sediment Pond SP-1 and SP-3 will be constructed followed by their contributory ditches. Sediment Pond SP-2 will be contructed followed by its contributory ditches before Phase 2 begins.

Runoff from the proposed processing pad area will be controlled by Sediment Pond SP-1. Four collection ditches labeled CD-1 to CD-4 along with three culverts labeled CULV-1 to CULV-3 will convey runoff to SP-1 from this area. The pad will be sloped to the east. Gaps will be left in the berm to allow for drainage.

Runoff from the process pond area will be controlled by sediment pond SP-3. Collection ditches CD-9 and CD-10 will convey runoff to SP-3 from this area. As process pond construction progresses to CD-10, a portion of CD-10 will be removed. Before any portion of CD-10 is removed, compost filter sock will be installed below the portion to be removed.

Runoff from the mineral extraction areas will be controlled by Sediment Pond SP-2. Three collection ditches labeled CD-6 to CD-8 and two culverts labeled CULV-4 and CULV-5 will convey runoff to SP-2 from these areas.

Runoff from the haul roads will be controlled by a combination of Sediment Ponds SP-1 and SP-2. Collection ditches labeled CD-1 through CD-4 along with three culverts labeled CULV-1 to CULV-3 will convey runoff from the haul roads to SP-1. Collection ditches labeled CD-5 through CD-8 along with two culverts labeled CULV-4 and CULV-5 will convey runoff from the haul roads to SP-2.

Calculations for all erosion and sedimentation controls are attached. All ditches will be designed to convey a 10-year, 24-hour storm event and contain a proper lining. Grass lined ditches will have R-4 riprap placed at abrupt changes in ditch direction. All culverts will be designed to convey the design flow of the ditch(es) that flow to them or the 10-year, 24-hour storm for culverts that are not fed by a ditch. Rip-Rap aprons or channels will provide outlet protection for all culverts. See Exhibit 9 for all culvert sizes and outlet protection. All sediment ponds are designed to have a minimum of 7,000 cubic feet per acre storage (2,000 c.f./acre sediment storage and 5,000 c.f./acre dewatering zone).
Alternate E&S controls consisting of compost filter sock will be utilized downgrade of all proposed ponds before any earth disturbance occurs. Compost filter sock will also be installed downgrade of the proposed haul road above the start of collection ditch CD-2. The compost filter sock will only receive sediment laden runoff during haul road construction. Once the haul road is constructed, runoff from the haul road will flow down the haul road and into a collection ditch to SP-1. The fill slopes of the proposed ponds and haul roads will immediately be seeded and mulched once final grade is established. Once vegetation is established, the compost filter socks may be removed or left in place. Compost filter socks will also be installed prior to any reclamation activities to these areas. See Exhibit 9 for locations and sizing. All compost filter socks were designed in accordance with Chapter 102 requirements.

12.3 Haul Roads

Provide the following information for each haul road to be constructed, reconstructed or used in the operation:

Note: Activities proposed to be conducted under General permit for Temporary Road Crossings (BMR-GP-101) and General Permit for Access Road Crossings (BMR-GP-102) must include a completed Notification Form, with attachments, for the respective General Permit (i.e., Form 5600-FM-MR0054 for BMR-GP-101 and Form 5600-FM-MR0059 for BMR-GP-102). BMR-GP-102 may not be used for haul roads.

a) Location; show on Exhibit 9 (and Exhibit 18 if road will remain as part of postmining land use);

Please see Exhibit 9 for haul road location and Exhibit 18 for the location of the haul road to remain.

b) Description and typical cross-sections showing the construction of the haul road including existing ground, grades, slopes, culvert locations, outlet protection and other drainage control;

The proposed haul roads will connect the proposed processing pad to the existing SMT permit and site access points to public roadways. Another haul road will extend from the proposed processing pad to the proposed mineral extraction areas. The travel way width will be 50' from the proposed pad to the existing SMT permit and to the proposed mineral extraction areas. There will be a 30' wide travel way at the location where the haul road crosses Enterprise and Buckeye gas lines. The haul road will have a maximum slope of 10% with a 1-2% cross slope for drainage. A safety berm will be installed along edges where vehicle overturnment is possible. Where the haul road contains fill slopes and berms on both sides, a three-foot gap in the berm will be left every 100 feet on the side(s) with a collection ditch downgrade for drainage. Where the haul road contains a cut slope on one side and a fill slope on the other side, the haul road will be sloped towards the cut slope with a collection ditch at the bottom of the cut slope. Where the haul road contains a cut slope on both sides, small channels will be created on the edges of the road surface to convey runoff to a point where it can discharge to a collection ditch. A culvert will be installed under the haul road where collection ditches cross the haul road. Outlet protection for culverts will be rip-rap aprons or channels.

c) Measures to control and prevent erosion and sedimentation; include proposed spacing of sediment traps, turnouts, culverts, check dams, etc.;

Collection ditches will be installed to collect runoff from the haul roads and convey it to either SP-1 or SP-2. The haul road will be topped with a non-acid producing stone to prevent soils and other material from accumulating. A rock construction entrance will be installed as per Standard Construction Detail #3-1 where the haul road meets T-970. Minimal grading is anticipated for the haul road connecting to T-970. This road is existing. Clean stone will be placed and the road will be paved to the scalehouse.

d) Plan for reclamation after mining is completed;

The haul road will be reclaimed to AOC after mining activities are completed, except for the portion of the haul road that is to remain post-mining that is shown on Exhibit 18.

e) If the haul road involves the crossing of any intermittent or perennial stream or wetland include Module 14 Streams/Wetlands;

N/A. The haul road does not cross any intermittent or perennial streams or wetlands.

f) Will a PennDOT highway occupancy permit be needed? □ Yes ☒ No

If yes, PennDOT Occupancy Permit number must be submitted prior to permit activation.
PROPERTY OWNER REQUEST TO LEAVE POND 1, ITS DITCHES, AND THE HAUL ROAD

TO: The PA Department of Environmental Protection
   Bureau of Mining & Reclamation, or
   To Whom it May Concern:

I, David S. Herrholtz – President of Ligonier Stone & Lime Company, the owner of the property located approximately 1.0 mile southwest of Blairsville, on the western side of State Route 217, in Derry Township, Westmoreland County, PA, hereby request that Ligonier Stone & Lime Company leave Sediment Pond 1, the corresponding portions of the associated ditches and the haul road following reclamation for my use. Once all of the reclamation has been completed, I want this pond, portions of its ditches, and the haul road to permanently remain as part of the post-mining landuse. I then accept all of the maintenance and liability of the previously listed items.

Owner’s Signature(s) /David S. Herrholtz – President of Ligonier Stone & Lime Company

State of Pennsylvania
County of Westmoreland

Before me, the undersigned notary, personally appeared David S. Herrholtz, known to me (or satisfactorily proven) to be the person subscribed to in this instrument and who executed the same,

this 25 day of November , 2020.

Notary Public

My Commission Expires: November 30, 2023
### PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)

<table>
<thead>
<tr>
<th>Duration</th>
<th>Average recurrence interval (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5-min</td>
<td>0.315</td>
</tr>
<tr>
<td>10-min</td>
<td>0.489</td>
</tr>
<tr>
<td>15-min</td>
<td>0.599</td>
</tr>
<tr>
<td>30-min</td>
<td>0.753</td>
</tr>
<tr>
<td>60-min</td>
<td>0.968</td>
</tr>
<tr>
<td>2-hr</td>
<td>1.13</td>
</tr>
<tr>
<td>3-hr</td>
<td>1.22</td>
</tr>
<tr>
<td>6-hr</td>
<td>1.47</td>
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<tr>
<td>12-hr</td>
<td>1.78</td>
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<td>2.46</td>
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<td>3-day</td>
<td>2.64</td>
</tr>
<tr>
<td>4-day</td>
<td>2.82</td>
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<td>3.31</td>
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<tr>
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<td>5.53</td>
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<tr>
<td>30-day</td>
<td>6.89</td>
</tr>
<tr>
<td>45-day</td>
<td>8.95</td>
</tr>
<tr>
<td>60-day</td>
<td>10.8</td>
</tr>
</tbody>
</table>

1 Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not corrected against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PDS-based depth-duration-frequency (DDF) curves
Latitude: 40.4104°, Longitude: -79.2712°

Average recurrence interval (years)
- 1
- 2
- 5
- 10
- 25
- 50
- 100
- 200
- 500
- 1000

Duration
- 5-min
- 10-min
- 15-min
- 30-min
- 60-min
- 2-hr
- 3-hr
- 6-hr
- 12-hr
- 24-hr
- 2-day
- 3-day
- 4-day
- 7-day
- 10-day
- 20-day
- 30-day
- 45-day
- 60-day

NOAA Atlas 14, Volume 2, Version 3
Created (GMT): Tue Aug 11 13:09:21 2020
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Maps & aerials
Small scale terrain
## 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yr)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's n</th>
<th>Channel Bed Slope (%)</th>
<th>Freeboard (ft)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H:V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>With Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>0.0</td>
<td>33.6</td>
<td>33.6</td>
<td>10</td>
<td>15.0%</td>
<td>69.3</td>
<td>85</td>
<td>69.3</td>
<td>0.8%</td>
<td>8.0</td>
<td>2 : 1</td>
<td>16.4</td>
<td>2.10</td>
<td>2.82</td>
<td>72.3</td>
<td>2.63</td>
<td>18.5</td>
</tr>
<tr>
<td>3 + 88</td>
<td>1030.0</td>
<td>3</td>
<td>33.6</td>
<td>10</td>
<td>15.0%</td>
<td>69.3</td>
<td>85</td>
<td>69.3</td>
<td>0.8%</td>
<td>8.0</td>
<td>2 : 1</td>
<td>16.4</td>
<td>2.10</td>
<td>2.82</td>
<td>72.3</td>
<td>2.63</td>
<td>18.5</td>
</tr>
<tr>
<td>4 + 36</td>
<td>1018.0</td>
<td>0.0</td>
<td>33.6</td>
<td>10</td>
<td>15.0%</td>
<td>69.3</td>
<td>85</td>
<td>69.3</td>
<td>25.0%</td>
<td>8.0</td>
<td>2 : 1</td>
<td>11.4</td>
<td>0.85</td>
<td>9.11</td>
<td>75.1</td>
<td>1.35</td>
<td>13.4</td>
</tr>
</tbody>
</table>

### Ditch Profile

- **Elevation**
- **Stations**

**Permit Number:** 65210301

**Company:** LIGNONIER STONE & LIME

**Date:** DECEMBER 2021

**Sheet:** 1 of 3
### Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Given:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow Depth, d (ft)</strong></td>
<td>= 2.1</td>
</tr>
<tr>
<td><strong>Bottom Width (ft)</strong></td>
<td>= 8</td>
</tr>
<tr>
<td><strong>Side Slopes (H:1)</strong></td>
<td>= 2</td>
</tr>
<tr>
<td><strong>What size Rip Rap</strong></td>
<td>= GRASS</td>
</tr>
<tr>
<td><strong>d_{50} size (inches)</strong></td>
<td>= #N/A</td>
</tr>
<tr>
<td><strong>Manning’s Coefficient</strong></td>
<td>= 0.060</td>
</tr>
<tr>
<td><strong>Channel Slope, s (ft/ft)</strong></td>
<td>= 0.77%</td>
</tr>
</tbody>
</table>

**Flow Rate, Q_{design} (cfs):**

\[
Q = (1.486/n) \times a \times t^{0.2} \times s^{0.4}
\]

\[
Q = 72.33 \text{ cfs}
\]

**Velocity, V (fps):**

\[
V = \frac{Q}{A}
\]

\[
V_{MAX} = 2.82 \text{ fps}
\]

**Account for 40% Void Space in Rip Rap:**

If s ≥ 10%

\[
A_{void} = 0.4 \times A_{t}
\]

\[
A_{in-channel} = A - A_{void}
\]

\[
d_{in-channel} = \frac{b + \sqrt{b^2 + 4 \times A_{in-channel}}}{2}
\]

\[
S_{h} = 62.4 \times d_{in-channel} \times s
\]

**Shear Stress Calculation:**

Use Sh to size rip rap if s > 10%

**Ditch Sizing Check:**

\[
Q \text{ CHECK} = \text{PASS}
\]

**VELOCITY CHECK =**

\[
\text{PASS}
\]

**SHEAR STRESS CHECK =**

\[
\text{USE VELOCITY}
\]

**OVERALL CHECK =**

\[
\text{PASS}
\]
# Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-1</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>2</td>
<td>Peak Discharge (Cum):</td>
<td>69.3</td>
</tr>
<tr>
<td>End Station:</td>
<td>4 + 36</td>
<td>Drainage Acreage:</td>
<td>0.0</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,018.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

## Given:
- Flow Depth, \( d \) (ft) = 0.85
- Bottom Width (ft) = \( b \)
- Side Slopes (H:1) = 2
- What size Rip Rap = R-5
- \( d_{90} \) size (inches) = 9
- Manning's Coefficient = 0.064
- Channel Slope (ft/ft) = 25.00%

## Flow Rate, \( Q_{design} \) (cfs)

\[
Q = (1.486/b) x a x r^{0.7} x s^{0.2}
\]

- \( Q_{design} = 75.11 \) cfs
- \( Q = 170.57 \) cfs WITH FREEBOARD

## Velocity, \( V \) (fps)

\[
V = Q/A
\]

- \( V = 9.11 \) fps
- \( V_{max} = 11.50 \) fps

## Account for 40% Void Space in Rip Rap if \( s \geq 10\% \)

\[
A_{void} = 0.40 \times b \times t
\]

- \( A_{void} = 7.20 \) sq.ft.

\[
A_{in-channel flow} = A - A_{void}
\]

- \( A_{in-channel flow} = 1.05 \) sq.ft.

\[
h_{in-channel flow} = \frac{-b + \sqrt{b^2 + 4 \times \pi \times A_{in-channel flow}}}{2 \times \pi}
\]

- \( h_{in-channel flow} = 0.13 \) ft

## Shear Stress Calculation

- Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = \frac{62.4 \times d_{90} x \times t \times s}{5}
\]

- Allowable Shear Stress = 3.00 psf
- Calculated Shear Stress = 1.98 psf

## Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = bd + zd^2
\]

- \( A = 8.25 \) sq.ft.
- \( A = 14.45 \) sq.ft. WITH FREEBOARD

\[
P = b + 2d \sqrt{d^2 + 1}
\]

- \( P = 11.80 \) feet
- \( P = 14.04 \) feet WITH FREEBOARD

- \( r = A/P \)
- \( r = 0.70 \) feet
- \( r = 1.03 \) feet WITH FREEBOARD

## Top Width (feet)

\[
T = b + 2d^2
\]

- \( T = 11.40 \) feet
- \( T = 13.40 \) feet WITH FREEBOARD

## Ditch Sizing Check

- \( Q \) CHECK = PASS
- VELOCITY CHECK = GREATER THAN 10% SLOPE
- SHEAR STRESS CHECK = PASS
- OVERALL CHECK = PASS
Graphical Peak Discharge

Project: SMT EAST
Location: CD-1

Developed

1. Data:
   Drainage area: ................. .A = 33.6000 Acres

   Runoff Curve Number: .......... .CN = 85

   Time of Concentration: ......... .Tc = 21.00 min

   Storm Type: ..................... = II

   Pond and swamp areas spread throughout watershed.............. = 0.00 percent of A
   0.0000 Acres

2. Frequency: ..................... yr = 10

3. Rainfall, P(24-hour)............. .in = 3.560

4. Initial abstraction, Ia.......... = 0.3529

5. Compute Ia/P...................... = 0.0991

6. Unit peak discharge, qu........ .csm/in = 638.529

7. Runoff, Q......................... .in = 2.069

8. Pond & swamp adjustment factor,.. Fp = 1.00

9. Peak Discharge, qp............... .cfs = 69.349
Time of Concentration (SCS)

Project:  SMT EAST
Location:  CD-1

Developed

Curve Number : 85
Length of Flow : 2290.00 ft
Average Land Slope : 6.20 %
Time of Concentration : 0.350 hrs, 21.0 mins
### 12.1 Diversion/Collection Ditch Data Sheet

**Title:** COLLECTION DITCH CD-2  
**Site:** SMT EAST  
**Company:** LIGONIER STONE & LIME  
**Permit Number:** 65210301

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H : V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>With Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>0 + 00</td>
<td>1080.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>End</td>
<td>3 + 04</td>
<td>1061.0</td>
<td>2.4</td>
<td>2.4</td>
<td>10</td>
<td>15.0%</td>
<td>6.3%</td>
<td>0.5</td>
<td>R-4</td>
<td>6.0</td>
<td>2 : 1</td>
<td>2.7</td>
<td>0.40</td>
<td>7.6</td>
</tr>
<tr>
<td></td>
<td>11 + 04</td>
<td>1038.0</td>
<td>14.9</td>
<td>17.3</td>
<td>10</td>
<td>15.0%</td>
<td>2.6%</td>
<td>0.5</td>
<td>R-4</td>
<td>6.0</td>
<td>2 : 1</td>
<td>9.0</td>
<td>1.10</td>
<td>10.4</td>
</tr>
</tbody>
</table>

**Ditch Profile**

![Ditch Profile Graph](image-url)
## Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-2</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>5.5</td>
</tr>
<tr>
<td>End Station:</td>
<td>3 + 04</td>
<td>Drainage Acreage:</td>
<td>2.4</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,061.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

### Given:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Depth, ( d ) (ft)</td>
<td>0.4</td>
</tr>
<tr>
<td>Bottom Width (ft)</td>
<td>6</td>
</tr>
<tr>
<td>Side Slopes (H:1)</td>
<td>2</td>
</tr>
<tr>
<td>What size Rip Rap</td>
<td>R-4</td>
</tr>
<tr>
<td>( d_{50} ) size (inches)</td>
<td>6</td>
</tr>
<tr>
<td>Manning's Coefficient</td>
<td>0.072</td>
</tr>
<tr>
<td>Channel Slope, ( s ) (H/ft)</td>
<td>6.25%</td>
</tr>
</tbody>
</table>

### Flow Rate, \( Q_{design} \) (cfs)

\[
Q = (1.485/n) \times a \times r^{0.3} \times s^{0.75}
\]

- \( Q = 6.93 \) cfs WITH FREEBOARD
- \( Q = 28.49 \) cfs WITH FREEBOARD

### Velocity, \( V \) (fps)

Use \( V \) to size rip rap if \( s < 10\% \), grouted, or \( d_{50} \) actual \( \leq 0 \)

\[
V = \frac{Q}{A}
\]

- \( V = 2.55 \) fps
- \( V_{MAX} = 9.00 \) fps

### Account for 40% Void Space in Rip Rap

If \( s \geq 10\% \)

\[
A_{void} = 0.4 \times b \times t
\]

- \( A_{void} = 18 \) sq. ft.

\[
A_{void} = N/A \text{ sq. ft.}
\]

\[
A_{no-channel flow} = A - A_{void}
\]

\[
A_{no-channel flow} = \#VALUE! \text{ sq. ft.}
\]

\[
Q_{no-channel flow} = \frac{-b + \sqrt{b^2 + 4 \times z \times A_{no-channel flow}}}{2 \times z}
\]

\[
d_{no-channel flow} = \#VALUE! \text{ ft.}
\]

### Shear Stress Calculation

Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = 62.4 \times d_{no-channel flow} \times s
\]

- Allowable Shear Stress = 2.00 psf
- Calculated Shear Stress = 1.56 psf

### Cross sectional Area, Wetted Perimeter &

### Hydraulic Radius

\[
A = bd + zd^2
\]

- \( A = 2.72 \) sq. ft. WITH FREEBOARD
- \( A = 7.02 \) sq. ft. WITH FREEBOARD

\[
P = b + 2d \times \sqrt{z^2 + 1}
\]

- \( P = 7.79 \) feet WITH FREEBOARD
- \( P = 10.02 \) feet WITH FREEBOARD

\[
r = \frac{A}{P}
\]

- \( r = 0.35 \) feet WITH FREEBOARD
- \( r = 0.70 \) feet WITH FREEBOARD

### Top Width (feet)

\[
T = b + 2z^2d
\]

- \( T = 7.60 \) feet WITH FREEBOARD
- \( T = 9.60 \) feet WITH FREEBOARD

### Ditch Sizing Check

- **Q CHECK =** PASS
- **VELOCITY CHECK =** PASS
- **SHEAR STRESS CHECK =** USE VELOCITY
- **OVERALL CHECK =** PASS
**Trapezoidal/Triangle Section Ditch**

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-2</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>33.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>2</td>
<td>Peak Discharge (Cum):</td>
<td>39.4</td>
</tr>
<tr>
<td>End Station:</td>
<td>11</td>
<td>Drainage Area:</td>
<td>14.9</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,038.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

**Given:**
- Flow Depth, d (ft) = 1.1
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = R-4
- d_{fa} Size (inches) = 6
- Manning's Coefficient = 0.047
- Channel Slope, s (ft/m) = 2.61%

**Flow Rate, Q_{design} (cfs)**

\[
Q = (1.488/n) \times a \times t^{0.5} \times s^{1.25}
\]

Q = 40.15 cfs
Q = 60.29 cfs WITH FREEBOARD

**Velocity, V (fps)**

\[
V = \frac{Q}{A}
\]

V = 4.45 fps
V_{MAX} = 9.00 fps

**Account for 40% Void Space in Rip Rap**

- If s ≤ 10%)
- Rip Rap Thickness, t (inches) = 18

\[
A_{WA} = 0.4 \times b \times t
\]

\[
A_{void} = \text{N/A sq. ft.}
\]

\[
A_{in-channel flow} = A - A_{void}
\]

\[
A_{in-channel flow} = \#VALUE! sq. ft.
\]

\[
H_{in-channel flow} = \frac{-b + \sqrt{b^2 + 4 \times z \times A_{in-channel flow}}}{2 \times z}
\]

\[
d_{in-channel flow} = \#VALUE! ft
\]

**Shear Stress Calculation**

Use Sh to size rip rap if s > 10%

\[
Sh = 62.4 \times d_{in-channel flow} \times s
\]

Allowable Shear Stress = 2.00 psf
Calculated Shear Stress = 1.79 psf

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

\[
A = bd + zd^2
\]

\[
A = 9.02 \text{ sq. ft.}
\]

\[
A = 14.72 \text{ sq. ft.}
\]

\[
P = b + 2d \text{ SORT}(z^2 + 1)
\]

\[
P = 10.92 \text{ feet}
\]

\[
P = 13.16 \text{ feet}
\]

\[
T = 2z \times d
\]

\[
T = 10.40 \text{ feet}
\]

\[
T = 12.40 \text{ feet}
\]

**Ditch Sizing Check**

Q CHECK = PASS
VELOCITY CHECK = PASS
SHEAR STRESS CHECK = USE VELOCITY
OVERALL CHECK = PASS
Graphical Peak Discharge

Project: SMT EAST  By: CGY  Date: 01/04/22
Location: CD-2(1)  Checked:  Date:

Developed

1. Data:

   Drainage area: .................A = 2.4000 Acres

   Runoff Curve Number: ..........CN = 85

   Time of Concentration: ..........Tc = 16.80 min

   Storm Type: ...................... = II

   Pond and swamp areas spread throughout watershed ............... = 0.00 percent of A
   0.0000 Acres

2. Frequency: ........................yr = 10

3. Rainfall, P(24-hour) .............in = 3.560

4. Initial abstraction, Ia .......... = 0.3529

5. Compute Ia/P ..................... = 0.0991

6. Unit peak discharge, qu .........csm/in = 702.915

7. Runoff, Q .......................in = 2.069

8. Pond & swap adjustment factor, Fp = 1.00

9. Peak Discharge, qp .............cfs = 5.453
Graphical Peak Discharge

Project: SMT EAST
Location: CD-2(2)

Developed

1. Data:

Drainage area: ..................A = 14.9000 Acres

Runoff Curve Number: ............CN = 85

Time of Concentration: ..........Tc = 16.80 min

Storm Type: ...................... = II

Pond and swamp areas spread throughout watershed: .................. = 0.00 percent of A

0.0000 Acres

2. Frequency: .................yr = 10

3. Rainfall, P(24-hour) ..........in = 3.560

4. Initial abstraction, Ia ..........= 0.3529

5. Compute Ia/P .....................= 0.0991

6. Unit peak discharge, qu ........csm/in = 702.915

7. Runoff, Q .........................in = 2.069

8. Pond & swamp adjustment factor, Fp = 1.00

9. Peak Discharge, qP ..............cfs = 33.854
Time of Concentration (SCS)

Project: SMT EAST
Location: CD-2

Developed

Curve Number: 85
Length of Flow: 1816.00 ft
Average Land Slope: 6.70 %

Time of Concentration: 0.280 hrs, 16.8 mins
# 12.1 Diversion/Collection Ditch Data Sheet

**Title:** COLLECTING DITCH CD-3  
**Site:** SMT EAST  
**Company:** LIGONIER STONE & LIME  
**Permit Number:** 65210301

**Prepared By:** Earthtech, Inc.  
**Initials:** CGY  
**Telephone Number:** (724) 439-1313  
**Date:** DECEMBER 2021  
**Sheet 1 of 2**

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning’s Coefficient (n)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H: V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>Channel Depth (ft)</th>
<th>Top Channel Width (ft)</th>
<th>Q Available (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>1.7 1.7 10 15.0% 85</td>
<td>4.7 4.7 2.0% 0.5</td>
<td>0.060 4.0 2:1 3.1 0.60 6.4 2.08</td>
<td>6.5 1.10 8.4 19.8</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Ditch Profile

![Ditch Profile Graph](image-url)
Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-3</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>4.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>4.7</td>
</tr>
<tr>
<td>End Station:</td>
<td>0 + 51</td>
<td>Drainage Acreage:</td>
<td>1.7</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,042.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

**Given:**
- Flow Depth, d (ft) = 0.6
- Bottom Width (ft) = 4
- Side Slopes (H:1) = 2
- What size Rip Rap = GRASS
- d_{50} size (inches) = #N/A
- Manning's Coefficient = 0.080
- Channel Slope, s (ft/ft) = 1.96%

**Flow Rate, Q_{design} (cfs):**

\[ Q = (1.466/n) \times a \times d^{2/3} \times s^{1/2} \]

\[ Q = 6.49 \text{ cfs} \]

**Velocity, V (fps):**

\[ V = \frac{Q}{A} \]

\[ V = 2.08 \text{ fps} \]

\[ V_{MAX} = 3.80 \text{ fps} \]

**Account for 40% Void Space in Rip Rap**

If s ≥ 10%

- Rip Rap Thickness, t (inches) = #N/A

\[ A_{void} = \frac{N/A}{\text{sq ft}} \]

\[ A_{t=0.45} = A_{void} \]

\[ A_{in-channel-flow} = A_{t=0.45} \]

\[ A_{in-channel-flow} = \#VALUE! \text{ sq ft} \]

\[ A_{in-channel-flow} = \frac{-b + \sqrt{b^2 + 4 \times z \times A_{in-channel-flow}}}{2 \times z} \]

\[ d_{in-channel-flow} = \#VALUE! \text{ ft} \]

**Shear Stress Calculation**

Use Sh to size rip rap if s > 10%

\[ Sh = 62.4 \times d_{in-channel-flow} \times s \]

**Allowable Shear Stress =** #N/A psf

**Calculated Shear Stress =** 0.73 psf
Graphical Peak Discharge

Project: SMT EAST
Location: CD-3

By: CGY
Checked:

Date: 01/04/22

1. Data:

   Drainage area: .................. A = 1.7000 Acres

   Runoff Curve Number: ........... CN = 85

   Time of Concentration: .......... Tc = 9.70 min

   Storm Type: ...................... = II

   Pond and swamp areas spread 
   throughout watershed............. = 0.00 percent of A 
   0.0000 Acres

2. Frequency....................... yr = 10

3. Rainfall, P(24-hour).......... in = 3.560

4. Initial abstraction, Ia........ = 0.3529

5. Compute Ia/P................... = 0.0991

6. Unit peak discharge, qu........ csm/in = 861.396

7. Runoff, Q....................... in = 2.069

8. Pond & swamp adjustment factor, Fp = 1.00

9. Peak Discharge, qp............ cfs = 4.733
Curve Number : 85
Length of Flow  : 1120.00 ft
Average Land Slope : 9.30 %
Time of Concentration : 0.161 hrs, 9.7 mins
## 12.1 Diversion/Collection Ditch Data Sheet

**Title:** COLLECTION DITCH CD-4

**Site:** SMT EAST

**Company:** LIGONIER STONE & LIME

**Permit Number:** 65210301

**Prepared By:** Earthtech, Inc.

**Telephone Number:** (724) 439-1313

**Date:** DECEMBER 2021

**Sheet 1 of 3**

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (hrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H : V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>1041.0</td>
<td>11.2</td>
<td>10</td>
<td>85</td>
<td>27.3</td>
<td>GRASS</td>
<td>0.060</td>
<td>6.0</td>
<td>2 : 1</td>
<td>13.5</td>
<td>1.50</td>
<td>12.0</td>
<td>2.40</td>
<td>32.4</td>
</tr>
<tr>
<td>4 + 62</td>
<td>1037.0</td>
<td>11.2</td>
<td>10</td>
<td>85</td>
<td>0.0</td>
<td>R-4</td>
<td>0.064</td>
<td>6.0</td>
<td>2 : 1</td>
<td>3.5</td>
<td>0.50</td>
<td>8.0</td>
<td>8.55</td>
<td>29.9</td>
</tr>
<tr>
<td>5 + 07</td>
<td>1018.0</td>
<td>11.2</td>
<td>10</td>
<td>85</td>
<td>27.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ditch Profile**

![Ditch Profile Graph](image-url)
**Trapezoidal/Triangle Section Ditch**

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
</tr>
<tr>
<td>End Station:</td>
<td>4 + 62</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,037.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peak Disch &amp; Base Flow:</th>
<th>27.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Discharge (Cum):</td>
<td>27.3</td>
</tr>
<tr>
<td>Drainage Acreage:</td>
<td>11.2</td>
</tr>
<tr>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

**Given:**
- Flow Depth, d (ft) = 1.5
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = GRASS
- d<sub>50</sub> Size (inches) = N/A
- Manning's Coefficient = 0.060
- Channel Slope, s (Vf) = 0.87%

**Flow Rate, Q<sub>Design</sub> (cfs):**

\[
Q = (1.486/n) \times a \times r^{0.5} \times s^{0.25} \\
Q = 32.40 \text{ cfs} \quad \text{WITH FREEBOARD} \\
Q = 56.03 \text{ cfs} \quad \text{WITH FREEBOARD} 
\]

**Velocity, V (fps):**

\[
V = Q/A \\
V = 2.40 \text{ fps} \\
V_{max} = 3.50 \text{ fps} 
\]

**Account for 40% Void Space in Rip Rap if s ≤ 10%**

\[
A_{void} = \frac{A_{rip}}{0.4} \\
A_{chan} = A - A_{void} \\
A_{chan} = \frac{-b + \sqrt{b^2 - 4a + z \times A_{chan}}} {2 \times z} \\
d_{chan} = \frac{A_{chan}} {2 \times \pi} 
\]

**Shear Stress Calculation**

Use Sh to size rip rap if s > 10%

\[
Sh = 62.4 \times d_{chan} \times s \\
\text{Allowable Shear Stress} = \text{N/A psi} \\
\text{Calculated Shear Stress} = 0.81 \text{ psi} 
\]

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius:**

\[
A = bd + zd^2 \\
A = 13.50 \text{ sq ft} \\
A = 20.00 \text{ sq ft} \quad \text{WITH FREEBOARD} \\
P = b + 2d \sqrt{d^2 + 1} \\
P = 12.71 \text{ feet} \\
P = 14.94 \text{ feet} \quad \text{WITH FREEBOARD} \\
r = A/P \\
r = 1.06 \text{ feet} \\
r = 1.34 \text{ feet} \quad \text{WITH FREEBOARD} \\
T = b + 2z^2d \\
T = 12.00 \text{ feet} \\
T = 14.00 \text{ feet} \quad \text{WITH FREEBOARD} \\

**Ditch Sizing Check**

Q CHECK = PASS

VELOCITY CHECK = PASS

SHEAR STRESS CHECK = USE VELOCITY

OVERALL CHECK = PASS
### Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-4</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>2</td>
<td>Peak Discharge (Cum):</td>
<td>27.3</td>
</tr>
<tr>
<td>End Station:</td>
<td>5 + 07</td>
<td>Drainage Acreage:</td>
<td>0.0</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,018.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

#### Given:
- Flow Depth, d (ft) = 0.5
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = R-4
- d<sub>rp</sub> size (inches) = 6
- Manning's Coefficient = 0.064
- Channel Slope, s (ft/ft) = 42.22%

#### Flow Rate, Q<sub>design</sub> (cfs)

\[
Q = (1.486/b) \times s \times r^{0.6} \times s^{0.52}
\]

| Q = 29.93 cfs | WITH FREEBOARD |
| Q = 101.35 cfs | WITH FREEBOARD |

#### Velocity, V (fps)

Use V to size rip rap if s < 10%, grouted, or d<sub>actual</sub> ≤ 0

\[
V = \frac{Q}{A}
\]

| V = 8.55 fps | WITH FREEBOARD |
| V<sub>MAX</sub> = 9.00 fps | WITH FREEBOARD |

#### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = bd + zd^2
\]

| A = 3.50 sq ft | WITH FREEBOARD |
| A = 8.00 sq ft | WITH FREEBOARD |

\[
P = b + 2d \sqrt{a^2 + d^2}
\]

| P = 8.24 feet | WITH FREEBOARD |
| P = 10.47 feet | WITH FREEBOARD |

\[
r = \frac{A}{P}
\]

| r = 0.42 feet | WITH FREEBOARD |
| r = 0.76 feet | WITH FREEBOARD |

#### Top Width (feet)

\[
T = b + 2d
\]

| T = 8.00 feet | WITH FREEBOARD |
| T = 10.00 feet | WITH FREEBOARD |

#### Ditch Sizing Check

- Q CHECK = PASS
- VELOCITY CHECK = PASS
- SHEAR STRESS CHECK = USE VELOCITY
- OVERALL CHECK = PASS

#### Account for 40% Void Space in Rip Rap

If s ≥ 10%

\[
A_{void} = 0.4 \times A
\]

\[
A_{void} = 3.60 \text{ sq ft}
\]

\[
A_{in-channel-flow} = A - A_{void}
\]

\[
A_{in-channel-flow} = -0.10 \text{ sq ft}
\]

\[
d_{in-channel-flow} = -b + \sqrt{b^2 + 4 \times z \times A_{in-channel-flow}}
\]

\[
d_{in-channel-flow} = -0.02 \text{ ft}
\]

#### Shear Stress Calculation

Use Sh to size rip rap if s > 10%

\[
Sh = 68.4 \times d_{in-channel-flow} \times s
\]

| Allowable Shear Stress = 2.00 psf |
| Calculated Shear Stress = N/A psf |
Graphical Peak Discharge

Project: SMT EAST
Location: CD-4

By: CGY
Checked:

Date: 01/04/22
Date:

Developed

1. Data:

   Drainage area: .................. A = 11.2000 Acres
   Runoff Curve Number: ............ CN = 85
   Time of Concentration: ........... Tc = 14.10 min
   Storm Type: ....................... = II
   Pond and swamp areas spread throughout watershed ....... = 0.00 percent of A
                        0.0000 Acres

2. Frequency: ...................... yr = 10

3. Rainfall, P(24-hour) ..........in = 3.560

4. Initial abstraction, Ia ........... = 0.3529

5. Compute Ia/P .................... = 0.0991

6. Unit peak discharge, q ........... csm/in = 753.468

7. Runoff, Q ....................... in = 2.069

8. Pond & swap adjustment factor, Fp = 1.00

9. Peak Discharge, q ............ cfs = 27.278
Time of Concentration (SCS)

Project: SMT EAST
Location: CD-4
Developed

Curve Number : 85
Length of Flow : 1629.00 ft
Average Land Slope : 8.00 %

Time of Concentration : 0.235 hrs, 14.1 mins
# 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (in.)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bed Slope (%)</th>
<th>Free-board (ft)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H : V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>With Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 + 00</td>
<td>1136.0</td>
<td>1.1</td>
<td>10</td>
<td>15.0%</td>
<td>85</td>
<td>2.7</td>
<td>0.5</td>
<td>GRASS</td>
<td>0.070</td>
<td>6.0</td>
<td>2 : 1</td>
<td>0.40</td>
<td>7.6</td>
<td>1.64</td>
<td>4.5</td>
<td>0.90</td>
<td>9.6</td>
</tr>
<tr>
<td>4 + 50</td>
<td>1125.0</td>
<td>1.1</td>
<td>10</td>
<td>15.0%</td>
<td>85</td>
<td>2.7</td>
<td>0.5</td>
<td>R-4</td>
<td>0.072</td>
<td>6.0</td>
<td>2 : 1</td>
<td>0.40</td>
<td>7.6</td>
<td>2.69</td>
<td>7.3</td>
<td>0.90</td>
<td>9.6</td>
</tr>
<tr>
<td>6 + 36</td>
<td>1112.0</td>
<td>0.4</td>
<td>10</td>
<td>15.0%</td>
<td>85</td>
<td>1.0</td>
<td>0.5</td>
<td>R-4</td>
<td>0.072</td>
<td>6.0</td>
<td>2 : 1</td>
<td>0.40</td>
<td>7.6</td>
<td>2.69</td>
<td>7.3</td>
<td>0.90</td>
<td>9.6</td>
</tr>
<tr>
<td>8 + 57</td>
<td>1108.0</td>
<td>0.9</td>
<td>10</td>
<td>15.0%</td>
<td>85</td>
<td>2.2</td>
<td>0.5</td>
<td>GRASS</td>
<td>0.060</td>
<td>6.0</td>
<td>2 : 1</td>
<td>0.60</td>
<td>8.4</td>
<td>2.09</td>
<td>9.0</td>
<td>1.10</td>
<td>10.4</td>
</tr>
</tbody>
</table>

**Ditch Profile**

![Ditch Profile Graph](image-url)
### Trapezoidal/Triangle Section Ditch

**Channel Name:** COLLECTION DITCH CD-5  
**Section Number:** 1  
**End Station:** 4+50  
**End Elevation:** 1,125.0  
**Peak Disch & Base Flow:** 2.7  
**Peak Discharge (Cum):** 2.7  
**Drainage Acreage:** 1.1  
**Watershed Slope:** 15.0%

### Given:
- **Flow Depth, d (ft):** 0.4
- **Bottom Width (ft):** 6
- **Side Slopes (H:1):** 2
- **What size Rip Rap:** GRASS
- **d<sub>so</sub> size (inches):** #N/A
- **Mannings Coefficient:** 0.070
- **Channel Slope, s (ft/ft):** 2.44%

### Flow Rate, Q<sub>design</sub> (cfs)

\[
Q = (1.466/n) \times a \times r^{0.5} \times s^{1/2}
\]

- \(Q = 4.46 \text{ cfs}\)  
- **Q = 18.35 cfs WITH FREEBOARD**

### Velocity, V (fps)

- **Use V to size rip rap if s < 10%, grouted, or d<sub>so</sub> < 0**
- **V = Q/A**
- **V = 1.64 fps**
- **V<sub>MASS</sub> = 3.50 fps**

### Account for 40% Void Space in Rip Rap

- **if s < 10%**
- **Rip Rap Thickness, t (inches):** #N/A
- **A<sub>void</sub> = 0.4" x t**
- **A<sub>void</sub> = N/A sq.ft.**

### Ditch Sizing Check
- **Q CHECK = PASS**
- **VELOCITY CHECK = PASS**
- **SHEAR STRESS CHECK = USE VELOCITY**
- **OVERALL CHECK = PASS**

### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = bd + zd^2
\]

- **A = 2.72 sq.ft.**
- **A = 7.02 sq.ft. WITH FREEBOARD**

\[
P = b + 2d \sqrt{r^2 + 1}
\]

- **P = 7.79 feet**
- **P = 10.02 feet WITH FREEBOARD**

- **r = A/P**
- **r = 0.35 feet**
- **r = 0.70 feet WITH FREEBOARD**

### Top Width (feet)

\[
T = b + 2dz^2
\]

- **T = 7.60 feet**
- **T = 9.60 feet WITH FREEBOARD**

### Shear Stress Calculation

- **Use Sh to size rip rap if s > 10%**
- **Sh = 62.4 \times d<sub>so</sub> \times c<sub>so</sub> \times s**
- **Allowable Shear Stress = #N/A psf**
- **Calculated Shear Stress = 0.61 psf**
## Trapezoidal/Triangle Section Ditch

### Given:
- **Flow Depth, \( d \) (ft)**: 0.4
- **Bottom Width (ft)**: 6
- **Side Slopes (H:1)**: 2
- **What size Rip Rap**: R-4
- **\( d_{so} \) size (inches)**: 6
- **Manning's Coefficient**: 0.072
- **Channel Slope, \( s \) (ft/ft)**: 6.96%

### Flow Rate, \( Q_{design} \) (cfs)

\[
Q = (1.486 \ln x) \times a \times r^{2.5} \times s^{0.5} \\
Q = 7.32 \text{ cfs} \\
Q = 30.13 \text{ cfs WITH FREEBOARD}
\]

### Velocity, \( V \) (fps)

Use \( V \) to size rip rap if \( s < 10\% \), grouted, or \( d_{mant} < 0\)

\[
V = \frac{Q}{A} \\
V = 2.69 \text{ fps} \\
V_{max} = 9.03 \text{ fps}\]

### Account for 40% Void Space in Rip Rap

\( s \leq 10\% \)

- Rip Rap Thickness, \( t \) (inches): 16

\[
A_{void} = 0.4 \times t^2 \times t \\
A_{void} = N/A \text{ sq.ft.} \\
A_{in-channel-flow} = A - A_{void} \\
A_{in-channel-flow} = \#VALUE! \text{ sq.ft.} \\
A_{in-channel-flow} = -b + \sqrt{b^2 - 4 \times z \times A_{in-channel-flow}} \\
\frac{2}{2} \\
d_{in-channel-flow} = \#VALUE! \text{ ft}
\]

### Shear Stress Calculation

Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = 62.4 \times d_{in-channel-flow} \times s \\
Allowable \text{ Shear Stress} = 2.00 \text{ psf} \\
Calculated \text{ Shear Stress} = 1.74 \text{ psf}
\]

### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = bd + zd^2 \\
A = 2.72 \text{ sq.ft.} \\
A = 7.02 \text{ sq.ft. WITH FREEBOARD}
\]

\[
P = b + 2d \sqrt{(d^2 + 1)} \\
P = 7.79 \text{ feet} \\
P = 10.02 \text{ feet WITH FREEBOARD}
\]

\[
r = \frac{A}{P} \\
r = 0.35 \text{ feet} \\
r = 0.7 \text{ feet WITH FREEBOARD}
\]

### Top Width (feet)

\[
T = b + 2d^2 \\
T = 7.60 \text{ feet} \\
T = 9.90 \text{ feet WITH FREEBOARD}
\]

### Ditch Sizing Check

- \( Q \) CHECK = PASS
- \( VELLOCITY \) CHECK = PASS
- \( SHEAR \) \( STRESS \) CHECK = USE VELOCITY

- OVERALL CHECK = PASS
### Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-5</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>3</td>
<td>Peak Discharge (Cum):</td>
<td>5.9</td>
</tr>
<tr>
<td>End Station:</td>
<td>8 + 57</td>
<td>Drainage Acreage:</td>
<td>0.5</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,108.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

#### Given:

- Flow Depth, \( d \) (ft) = 0.6
- Bottom Width (ft) = 6
- Side Slopes (1:1) = 2
- What size Rip Rap = GRASS
- \( d_{cr} \) Size (inches) = \#N/A
- Mannings Coefficient = 0.060
- Channel Slope, \( s \) (ft) = 1.81%

#### Flow Rate, \( Q_{design} \) (Cfs)

\[
Q = (1.486/n) \times a \times c^{0.12} \times s^{0.5}
\]

\[
Q = 9.02 \text{ cfs}
\]

\[
Q = 26.44 \text{ cfs} \quad \text{WITH FREEBOARD}
\]

#### Velocity, \( V \) (fps)

Use \( V \) to size rip rap if \( s < 10\% \), grouted, or \( d_{cr} \)\text{in} \( \leq 0 \)

\[
V = V/Qa
\]

\[
V = 2.09 \text{ fps}
\]

\[
V_{MAX} = 3.50 \text{ fps}
\]

#### Account for 40% Void Space in Rip Rap

If \( s \leq 10\% \)

\[
A_{void} = 0.4 \times b \times t
\]

\[
A_{void} = \text{N/A sq. ft.}
\]

\[
A_{in-channel} = A - A_{void}
\]

\[
A_{in-channel} = \#VALUE! sq. ft.
\]

\[
d_{in-channel} = -b + \sqrt{b^2 + 4 \times z \times A_{in-channel}}
\]

\[
d_{in-channel} = \#VALUE! ft.
\]

#### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = b d + z d^2
\]

\[
A = 4.32 \text{ sq. ft.}
\]

\[
A = 9.02 \text{ sq. ft.}
\]

\[
P = b + 2d \sqrt{z^2 + 1}
\]

\[
P = 8.68 \text{ feet}
\]

\[
P = 10.92 \text{ feet}
\]

\[
r = A/P
\]

\[
r = 0.50 \text{ feet}
\]

\[
r = 0.83 \text{ feet}
\]

#### Top Width (feet)

\[
T = b + 2z \times d
\]

\[
T = 8.40 \text{ feet}
\]

\[
T = 10.40 \text{ feet}
\]

#### Ditch Sizing Check

\[
Q \text{ CHECK} = \text{PASS}
\]

\[
VELOCITY \text{ CHECK} = \text{PASS}
\]

\[
SHEAR \text{ STRESS CHECK} = \text{USE VELOCITY}
\]

\[
OVERALL \text{ CHECK} = \text{PASS}
\]

#### Shear Stress Calculation

Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = 62.4 \times d_{in-channel} \times s \times 5
\]

Allowable Shear Stress = \#N/A psf

Calculated Shear Stress = 0.88 psf
Graphical Peak Discharge

Project: SMT EAST  By: CGY  Date: 01/04/22
Location: CD-5(1)  Checked:  Date:

Developed

1. Data:

   Drainage area:..................A = 1.1000 Acres

   Runoff Curve Number:.............CN = 85

   Time of Concentration:..........Tc = 14.00 min

   Storm Type:...................... = II

   Pond and swamp areas spread throughout watershed............. = 0.00 percent of A

   0.0000 Acres

2. Frequency......................yr = 10

3. Rainfall, P(24-hour)..............in = 3.560

4. Initial abstraction, Ia........... = 0.3529

5. Compute Ia/P.................... = 0.0991

6. Unit peak discharge, qu...........csm/in = 755.522

7. Runoff, Q..............in = 2.069

8. Pond & swamp adjustment factor,...Fp = 1.00

9. Peak Discharge, qp..............cfs = 2.686
Graphical Peak Discharge

Project: SMT EAST

Location: CD-5(2)

By: CGY

Date: 01/04/22

Checked:

Date:

Developed

1. Data:

Drainage area: .................. A = 0.4000 Acres

Runoff Curve Number: .......... CN = 85

Time of Concentration: ........ Tc = 14.00 min

Storm Type: .................. = II

Pond and swamp areas spread throughout watershed: ........ = 0.00 percent of A

0.0000 Acres

2. Frequency: .................... yr = 10


4. Initial abstraction, Ia: ........ = 0.3529

5. Compute Ia/P: ................. = 0.0991

6. Unit peak discharge, qu: ..... csm/in = 755.522

7. Runoff, Q: .................... in = 2.069

8. Pond & swap adjustment factor, ... Fp = 1.00

9. Peak Discharge, qp: ............ cfs = 0.977
Graphical Peak Discharge

Project: SMT EAST  
Location: CD-5(3)

By: CGY  
Checked:

Date: 01/04/22

Developed

1. Data:

   Drainage area: \( A = 0.9000 \text{ Acres} \)

   Runoff Curve Number: \( CN = 85 \)

   Time of Concentration: \( T_c = 14.00 \text{ min} \)

   Storm Type: \( = II \)

   Pond and swamp areas spread throughout watershed: \( \frac{0.00 \text{ percent of } A}{0.0000 \text{ Acres}} \)

2. Frequency: \( yr = 10 \)

3. Rainfall, \( P(24\text{-hour}) \): \( \text{in} = 3.560 \)

4. Initial abstraction, \( I_a \): \( = 0.3529 \)

5. Compute \( I_a/P \): \( = 0.0991 \)

6. Unit peak discharge, \( q_u \): \( \text{csm/in} = 755.522 \)

7. Runoff, \( Q \): \( \text{in} = 2.069 \)

8. Pond & swamp adjustment factor, \( F_p \): \( = 1.00 \)

9. Peak Discharge, \( q_P \): \( \text{cfs} = 2.198 \)
Project: SMT EAST  By: CGY  Date: 01/04/22
Location: CD-5  Checked:  Date: 01/04/22

Curve Number: 85
Length of Flow: 1035.00 ft
Average Land Slope: 3.90 %

Time of Concentration: 0.234 hrs, 14.0 mins
## 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Bed Slope (%)</th>
<th>Freeboard (ft)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H : V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>1109.0</td>
<td></td>
<td>15.0%</td>
<td>85</td>
<td>23.8</td>
<td>1.0%</td>
<td>0.5</td>
<td>GRASS</td>
<td>60.2 : 1</td>
<td>12.3</td>
<td>14.0</td>
<td>11.6</td>
<td>2.12</td>
<td>26.1</td>
<td>1.90</td>
</tr>
<tr>
<td>9 + 08</td>
<td>1100.0</td>
<td></td>
<td>15.0%</td>
<td>85</td>
<td>0.0</td>
<td>23.8</td>
<td>37.5%</td>
<td>R-4</td>
<td>60.2 : 1</td>
<td>3.5</td>
<td>5.0</td>
<td>8.0</td>
<td>8.06</td>
<td>26.2</td>
<td>1.00</td>
</tr>
<tr>
<td>9 + 48</td>
<td>1085.0</td>
<td></td>
<td>15.0%</td>
<td>85</td>
<td>0.0</td>
<td>23.8</td>
<td>37.5%</td>
<td>R-4</td>
<td>60.2 : 1</td>
<td>3.5</td>
<td>5.0</td>
<td>8.0</td>
<td>8.06</td>
<td>26.2</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### Ditch Profile

![Ditch Profile Graph](image-url)
# Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-6</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>23.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>23.8</td>
</tr>
<tr>
<td>End Station:</td>
<td>9 + 08</td>
<td>Drainage Area:</td>
<td>13.3</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,100.0</td>
<td>Watershed Slope:</td>
<td>16.0%</td>
</tr>
</tbody>
</table>

## Given:
- Flow Depth, d (ft) = 1.4
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = GRASS
- d_{so} size (inches) = \#N/A
- Manning's Coefficient = 0.070
- Channel Slope, s (ft/ft) = 0.05%

### Flow Rate, Q_{design} (cfs)

\[ Q = (1.486/n) \times b \times d^{0.5} \times s^{0.5} \]

- \[ Q = 26.12 \text{ cfs} \] WITH FREEBOARD
- \[ Q = 46.54 \text{ cfs} \] WITH FREEBOARD

### Velocity, V (fps)

\[ V = Q/A \]

- \[ V = 2.12 \text{ fps} \]
- \[ V_{max} = 3.50 \text{ fps} \]

### Account for 40% Void Space in Rip Rap

- Rip Rap Thickness, t (inches) = \#N/A
- \[ A_{void} = 0.4t^2 \]
- \[ A_{void} = \text{N/A sq.ft.} \]

### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[ A = bd + 2d^2 \]

- \[ A = 12.32 \text{ sq.ft.} \] WITH FREEBOARD
- \[ A = 18.62 \text{ sq.ft.} \] WITH FREEBOARD

\[ P = b + 2d \sqrt{d^2 + 1} \]

- \[ P = 12.26 \text{ feet} \] WITH FREEBOARD
- \[ P = 14.50 \text{ feet} \] WITH FREEBOARD

\[ r = A/P \]

- \[ r = 1.00 \text{ feet} \] WITH FREEBOARD
- \[ r = 1.28 \text{ feet} \] WITH FREEBOARD

### Top Width (feet)

\[ T = b + 2t^2d \]

- \[ T = 11.60 \text{ feet} \] WITH FREEBOARD
- \[ T = 13.60 \text{ feet} \] WITH FREEBOARD

### Ditch Sizing Check

- Q CHECK = PASS
- VELOCITY CHECK = PASS
- SHEAR STRESS CHECK = USE VELOCITY
- OVERALL CHECK = PASS

### Shear Stress Calculation

\[ Sh = 624 \times d_{in-channel \ flow} \times 5 \]

- Allowable Shear Stress = \#N/A psf
- Calculated Shear Stress = 0.87 psf
### Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>2</td>
</tr>
<tr>
<td>End Station:</td>
<td>9 + 48</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,085.0</td>
</tr>
</tbody>
</table>

| Peak Disch & Base Flow:    | 0.0                   |
| Peak Discharge (Cum):      | 23.6                  |
| Drainage Acreage:          | 0.0                   |
| Watershed Slope:           | 15.0%                 |

**Given:**
- Flow Depth, d (ft) = 0.5
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = R-4
- $d_{ag}$ size (inches) = 6
- Manning's Coefficient = 0.064
- Channel Slope, s (ft/ft) = 37.50%

**Flow Rate, $Q_{design}$ (cfs):**

\[
Q = \left(1.486/n\right) \times a \times r^{3/2} \times s^{3/2}
\]

\[
Q = 28.21 \text{ cfs}
\]

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

\[
A = bd + 2d^2
\]

\[
A = 3.50 \text{ sq ft}
\]

\[
A = 8.00 \text{ sq ft WITH FREEBOARD}
\]

\[
P = b + 2d \sqrt{z^2 + 1}
\]

\[
P = 8.24 \text{ feet WITH FREEBOARD}
\]

\[
P = 10.47 \text{ feet WITH FREEBOARD}
\]

**Velocity, V (fps):**

Use $V$ to size rip rap if $s < 10\%$, grouted, or $d_{ag,min} \leq 6$

\[
V = \frac{Q}{A}
\]

\[
V = 8.06 \text{ fps}
\]

**Top Width (feet):**

\[
T = b + 2d \text{ with FREEBOARD}
\]

\[
T = 8.00 \text{ feet}
\]

\[
T = 10.00 \text{ feet}
\]

**Ditch Sizing Check:**

Q CHECK = PASS

VELOCITY CHECK = PASS

SHEAR STRESS CHECK = USE VELOCITY

OVERALL CHECK = PASS

**Account for 40% Void Space in Rip Rap:**

If $s \geq 10\%$

Rip Rap Thickness, $t$ (inches) = 18

\[
A_{void} = 0.4 \times b \times t
\]

\[
A_{void} = 3.60 \text{ sq ft}
\]

**Shear Stress Calculation**

Use $S_h$ to size rip rap if $s > 10\%$

\[
S_h = 62.4 \times \frac{d_{ag,min} \times k}{s}
\]

Allowable Shear Stress = 2.00 psf

Calculated Shear Stress = N/A psf
Graphical Peak Discharge

Project: SMT EAST
Location: CD-6

By: CGY
Checked:

Date: 01/04/22

1. Data:

   Drainage area: ................. A = 13.3000 Acres

   Runoff Curve Number: .......... CN = 85

   Time of Concentration: .......... Tc = 28.00 min

   Storm Type: ..................... = II

   Pond and swamp areas spread throughout watershed .......... = 0.00 percent of A
   0.0000 Acres

2. Frequency: ..................... yr = 10

3. Rainfall, P(24-hour) ............. in = 3.560

4. Initial abstraction, Ia .......... = 0.3529

5. Compute Ia/P .................. = 0.0991

6. Unit peak discharge, qu .......... csm/in = 554.378

7. Runoff, Q ...................... in = 2.069

8. Pond & swap adjustment factor, Fp .......... = 1.00

9. Peak Discharge, qP .............. cfs = 23.833
Time of Concentration (SCS)

Project: SMT EAST
Location: CD-6

By: CGY
Checked:

Date: 01/04/22
Date: 01/04/22

Developed

Curve Number: 85
Length of Flow: 2084.00 ft
Average Land Slope: 3.00 %

Time of Concentration: 0.466 hrs, 28.0 mins
### 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H:V)</th>
<th>Flow Area (sq ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>With Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>1145.0</td>
<td>2.7</td>
<td>2.7</td>
<td>10.0%</td>
<td>85</td>
<td>7.4</td>
<td>7.4</td>
<td>5.2%</td>
<td>0.5</td>
<td>0.058</td>
<td>4.0</td>
<td>2 : 1</td>
<td>3.1</td>
<td>6.4</td>
</tr>
<tr>
<td>7 + 17</td>
<td>1108.0</td>
<td>2.7</td>
<td>2.7</td>
<td>10.0%</td>
<td>85</td>
<td>7.4</td>
<td>7.4</td>
<td>5.2%</td>
<td>0.5</td>
<td>0.058</td>
<td>4.0</td>
<td>2 : 1</td>
<td>3.1</td>
<td>6.4</td>
</tr>
</tbody>
</table>

**Ditch Profile**

![Ditch Profile Graph]

- **Elevation** vs. **Stations**
## Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-7</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>7.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>7.4</td>
</tr>
<tr>
<td>End Station:</td>
<td>7</td>
<td>Drainage Acreage:</td>
<td>2.7</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,108.0</td>
<td>Watershed Slope:</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

### Given:
- Flow Depth, \( d \) (ft) = 0.6
- Bottom Width (ft) = 4
- Side Slopes (H:V) = 2
- What size Rip Rap = R-4
- \( d_{rr} \) size (inches) = 6
- Manning's Coefficient = 0.058
- Channel Slope, \( s \) (ft/ft) = 5.16%

### Flow Rate, \( Q_{\text{design}} \) (cfs)

\[
Q = (1.486/m) \times a \times r^{2/3} \times s^{1/6}
\]

\[
Q = 10.81 \text{ cfs}
\]

\[
Q = 32.50 \text{ cfs WITH FREEBOARD}
\]

### Velocity, \( V \) (fps)

\[
V = \frac{Q}{A}
\]

\[
V = 3.42 \text{ fps}
\]

\[
V_{\text{MAX}} = 0.00 \text{ fps}
\]

**Account for 40\% Void Space in Rip Rap**

If \( s \geq 10\% \):
- Rip Rap Thickness, \( t \) (inches) = 18
- \( A_{\text{void}} \) = 0.4 \( b \times t \)
- \( A_{\text{void}} \) = N/A sq. ft.

\[
A_{\text{void}} = A_{\text{void}} \text{ sq. ft.}
\]

\[
A_{\text{in-channel flow}} = A_{\text{void}}
\]

\[
A_{\text{in-channel flow}} = \text{VALUE! sq. ft.}
\]

\[
H_{\text{in-channel flow}} = \frac{-b + \sqrt{b^2 + 4 \times z \times A_{\text{in-channel flow}}}}{2 \times z}
\]

\[
d_{\text{in-channel flow}} = \text{VALUE! ft}
\]

### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = \frac{b \times d_{rr}^2}{2}
\]

\[
A = 3.12 \text{ sq. ft.}
\]

\[
A = 6.82 \text{ sq. ft. WITH FREEBOARD}
\]

\[
P = b + 2d \text{ SORT}(z^2 + 1)
\]

\[
P = 6.68 \text{ feet}
\]

\[
P = 8.92 \text{ feet WITH FREEBOARD}
\]

\[
\frac{r}{A} = \frac{b}{A}
\]

\[
r = 0.47 \text{ feet}
\]

\[
r = 0.76 \text{ feet WITH FREEBOARD}
\]

### Top Width (feet)

\[
T = b + 2z^2d
\]

\[
T = 6.40 \text{ feet}
\]

\[
T = 8.40 \text{ feet WITH FREEBOARD}
\]

### Ditch Sizing Check

- Q CHECK = PASS
- VELOCITY CHECK = PASS
- SHEAR STRESS CHECK = USE VELOCITY
- OVERALL CHECK = PASS

### Shear Stress Calculation

Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = 62.4 \times d_{\text{in-channel flow}} \times s
\]

- Allowable Shear Stress = 2.00 psf
- Calculated Shear Stress = 1.93 psf
Graphical Peak Discharge

Project: SMT EAST
Location: CD-7

By: CGY
Checked:

Date: 01/04/22

Developed

1. Data:

   Drainage area: .................. A = 2.7000 Acres
   Runoff Curve Number: .......... CN = 85
   Time of Concentration: ........... Tc = 10.00 min
   Storm Type: ..................... = II
   Pond and swamp areas spread throughout watershed: = 0.00 percent of A = 0.0000 Acres

2. Frequency: ..................... yr = 10


4. Initial abstraction, Ia: ........ = 0.3529

5. Compute Ia/P: .................. = 0.0991

6. Unit peak discharge, qu: ...... csm/in = 852.607

7. Runoff, Q: ..................... in = 2.069

8. Pond & swap adjustment factor, Fp = 1.00

9. Peak Discharge, qp: .......... cfs = 7.441
Time of Concentration (SCS)  

Project: SMT EAST  
Location: CD-7  
Developed  

Curve Number : 85  
Length of Flow : 765.00 ft  
Average Land Slope : 4.70 %  

Time of Concentration : 0.167 hrs, 10.0 mins
### 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bed Slope (%)</th>
<th>Freeboard (ft)</th>
<th>Channel Bottom Width (ft)</th>
<th>Channel Side Slopes (H:V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>Channel Depth (ft)</th>
<th>Top Channel Width (ft)</th>
<th>Q Available (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>0.25</td>
<td>10</td>
<td>10.0%</td>
<td>85</td>
<td>6.2</td>
<td>R-4</td>
<td>0.072</td>
<td>8.0</td>
<td>2</td>
<td>1.3</td>
<td>3.5</td>
<td>0.40</td>
<td>9.6</td>
<td>2.40</td>
<td>8.4</td>
<td>0.90</td>
<td>11.6</td>
<td>34.1</td>
<td></td>
</tr>
<tr>
<td>4 + 32</td>
<td>0.32</td>
<td>10</td>
<td>10.0%</td>
<td>85</td>
<td>11.5</td>
<td>R-4</td>
<td>0.055</td>
<td>8.0</td>
<td>2</td>
<td>1.6</td>
<td>3.5</td>
<td>0.40</td>
<td>10.8</td>
<td>2.92</td>
<td>19.2</td>
<td>1.20</td>
<td>12.8</td>
<td>49.5</td>
<td></td>
</tr>
<tr>
<td>9 + 42</td>
<td>0.42</td>
<td>10</td>
<td>10.0%</td>
<td>85</td>
<td>3.2</td>
<td>R-4</td>
<td>0.055</td>
<td>8.0</td>
<td>2</td>
<td>1.6</td>
<td>3.5</td>
<td>0.40</td>
<td>10.8</td>
<td>4.18</td>
<td>27.5</td>
<td>1.20</td>
<td>12.8</td>
<td>70.9</td>
<td></td>
</tr>
<tr>
<td>10 + 87</td>
<td>0.87</td>
<td>10</td>
<td>10.0%</td>
<td>85</td>
<td>0.0</td>
<td>R-4</td>
<td>0.072</td>
<td>8.0</td>
<td>2</td>
<td>1.3</td>
<td>3.5</td>
<td>0.40</td>
<td>9.6</td>
<td>7.27</td>
<td>25.6</td>
<td>0.90</td>
<td>11.6</td>
<td>103.3</td>
<td></td>
</tr>
<tr>
<td>11 + 34</td>
<td>1.84</td>
<td>10</td>
<td>10.0%</td>
<td>85</td>
<td>0.0</td>
<td>R-4</td>
<td>0.072</td>
<td>8.0</td>
<td>2</td>
<td>1.3</td>
<td>3.5</td>
<td>0.40</td>
<td>9.6</td>
<td>7.27</td>
<td>25.6</td>
<td>0.90</td>
<td>11.6</td>
<td>103.3</td>
<td></td>
</tr>
</tbody>
</table>

**Ditch Profile**

![Ditch Profile Graph](image-url)
Trapezoidal/Triangle Section Ditch

**Given:**
- Flow Depth, d (ft) = 0.4
- Bottom Width (ft) = 8
- Side Slopes (H:1) = 2
- What size Rip Rap = R-4
- d_max size (inches) = 8
- Manning's Coefficient = 0.072
- Channel Slope, s (ft/ft) = 5.32%

**Flow Rate, Q_{design} (cfs)**

\[ Q = (1.486 / n) \times a \times r^{2/3} \times s^{1/2} \]

\[ Q = 8.44 \text{ cfs} \]

**Velocity, V (fps)**

\[ V = Q / A \]

\[ V = 2.40 \text{ fps} \]

\[ V_{\text{max}} = 9.00 \text{ fps} \]

**Account for 40% Void Space in Rip Rap**

if \( s \geq 10\% \)

Rip Rap Thickness, t (inches) = 18

\[ A_{\text{void}} = 0.4 \times t^2 \times t \]

\[ A_{\text{void}} = \text{N/A sq.ft.} \]

\[ A_{\text{in-channel flow}} = A - A_{\text{void}} \]

\[ A_{\text{in-channel flow}} = \#VALUE! sq.ft. \]

\[ A_{\text{in-channel flow}} = -b + \sqrt{b^2 + 4 \times z \times A_{\text{in-channel flow}}} \]

\[ d_{\text{in-channel flow}} = \#VALUE! ft \]

**Shear Stress Calculation**

Use Sh to size rip rap if \( s > 10\% \)

\[ Sh = 62.4 \times d_{\text{in-channel flow}} \times s \]

Allowable Shear Stress = 2.00 psf

Calculated Shear Stress = 1.33 psf

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

\[ A = bd + zd^2 \]

\[ A = 3.52 \text{ sq.ft.} \]

\[ A = 8.82 \text{ sq.ft.} \]

\[ P = b + 2d \times \text{SORT}(z^2+1) \]

\[ P = 9.79 \text{ feet} \]

\[ P = 12.02 \text{ feet} \]

\[ r = A/P \]

\[ r = 0.36 \text{ feet} \]

\[ r = 0.73 \text{ feet} \]

**Top Width (feet)**

\[ T = b + 2z^2d \]

\[ T = 8.60 \text{ feet} \]

\[ T = 11.60 \text{ feet} \]

**Ditch Sizing Check**

Q CHECK = PASS

VELOCITY CHECK = PASS

SHEAR STRESS CHECK = USE VELOCITY

OVERALL CHECK = PASS
<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-8</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>11.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>2</td>
<td>Peak Discharge (Cum):</td>
<td>17.7</td>
</tr>
<tr>
<td>End Station:</td>
<td>9 + 42</td>
<td>Drainage Acreage:</td>
<td>4.6</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,115.0</td>
<td>Watershed Slope:</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Given:
- Flow Depth, \( d \) (ft) = 0.7
- Bottom Width (ft) = 8
- Side Slopes (H:1) = 2
- What size Rip Rap = R-4
- \( D_{50} \) size (inches) = 6
- Manning's Coefficient = 0.055
- Channel Slope, \( s \) (ft/ft) = 2.35%  

Flow Rate, \( Q_{design} \) (cfs)

\[
Q = (1.446/n) \times a \times n^{0.5} \times s^{1.5}
\]

- \( Q = 19.20 \) cfs
- \( Q = 49.47 \) cfs  

Velocity, \( V \) (fps)

\[
V = \frac{Q}{A}
\]

- \( V = 2.02 \) fps
- \( V_{max} = 9.00 \) fps

Account for 40% Void Space in Rip Rap if \( s \leq 10\% \)

\[
A_{void} = 0.4 \times t^2
\]

- \( A_{void} = \) N/A sq. ft.

\[
A_{in-channel flow} = A - A_{void}
\]

- \( A_{in-channel flow} = \) #VALUE! sq. ft.

\[
A_{in-channel flow} = \frac{-b + \sqrt{b^2 + 4 \times c} \times A_{in-channel flow}}{2 \times c}
\]

- \( A_{in-channel flow} = \) #VALUE! ft

Shear Stress Calculation

Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = 62.4 \times d_{in-channel flow} \times s
\]

- Allowable Shear Stress = 2.00 psf
- Calculated Shear Stress = 1.03 psf

Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[
A = b \times d + z d^2
\]

- \( A = 6.58 \) sq. ft.
- \( A = 12.48 \) sq. ft. WITH FREEBOARD

\[
P = b + 2d \sqrt{z^2 + 1}
\]

- \( P = 11.13 \) feet
- \( P = 13.37 \) feet WITH FREEBOARD

Top Width (feet)

- \( T = 10.80 \) feet
- \( T = 12.80 \) feet WITH FREEBOARD

Ditch Sizing Check

- Q CHECK = PASS
- VELOCITY CHECK = PASS
- SHEAR STRESS CHECK = USE VELOCITY
- OVERALL CHECK = PASS
### Trapezoidal/Triangle Section Ditch

**Channel Name:** COLLECTION DITCH CD-8  
**Section Number:** 3  
**End Station:** 10 + 87  
**End Elevation:** 1,108.0

<table>
<thead>
<tr>
<th>Given:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Depth, d (ft)</td>
<td>0.7</td>
</tr>
<tr>
<td>Bottom Width (ft)</td>
<td>8</td>
</tr>
<tr>
<td>Side Slopes (H:1)</td>
<td>2</td>
</tr>
<tr>
<td>What size Rip Rap</td>
<td>R4</td>
</tr>
<tr>
<td>d50 size (inches)</td>
<td>6</td>
</tr>
<tr>
<td>Manning's Coefficient</td>
<td>0.055</td>
</tr>
<tr>
<td>Channel Slope, s (ft/ft)</td>
<td>4.83%</td>
</tr>
</tbody>
</table>

**Flow Rate, Q<sub>design</sub> (cfs)**

\[
Q = (1.4865 / n) \times a \times r^{0.67} \times s^{0.27}
\]

\[
Q = 27.50 \text{ cfs} \quad \text{WITH FREEBOARD}
\]

**Velocity, V (fps)**

\[
V = Q / A
\]

\[
V = 4.18 \text{ fps}
\]

**Account for 40% Void Space in Rip Rap**

\[
A_{void} = 0.4 \times b \times t
\]

\[
A_{void} = \text{N/A sq ft.}
\]

\[
A_{flow} = A - A_{void}
\]

\[
A_{flow} = \#VALUE! sq ft.
\]

\[
d_{flow} = -b + \sqrt{b^2 + 4 \times z \times A_{flow}}
\]

\[
d_{flow} = \#VALUE! ft.
\]

**Shear Stress Calculation**

Use Sh to size rip rap if s > 10%

\[
Sh = 62.4 \times A_{flow} \times b \times s
\]

\[
\text{Allowable Shear Stress} = 2.00 \text{ psf}
\]

\[
\text{Calculated Shear Stress} = 2.11 \text{ psf}
\]

**Peak Disch & Base Flow:** 3.2  
**Peak Discharge (Cum):** 20.9  
**Drainage Acreage:** 1.3  
**Watershed Slope:** 10.0%

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

\[
A = bd + zd^2
\]

\[
A = 6.58 \text{ sq ft. WITH FREEBOARD}
\]

\[
A = 12.48 \text{ sq ft. WITH FREEBOARD}
\]

\[
P = b + 2d \sqrt{z^2 + 1}
\]

\[
P = 11.13 \text{ feet WITH FREEBOARD}
\]

\[
P = 13.37 \text{ feet WITH FREEBOARD}
\]

\[
r = A / P
\]

\[
r = 0.59 \text{ feet WITH FREEBOARD}
\]

\[
r = 0.93 \text{ feet WITH FREEBOARD}
\]

**Top Width (feet)**

\[
T = b + 2z^2d
\]

\[
T = 10.66 \text{ feet WITH FREEBOARD}
\]

\[
T = 12.80 \text{ feet WITH FREEBOARD}
\]

**Ditch Sizing Check**

Q CHECK = PASS  
VELOCITY CHECK = PASS  
SHEAR STRESS CHECK = USE VELOCITY  
OVERALL CHECK = PASS
### Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-8</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>0.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>4</td>
<td>Peak Discharge (Cum):</td>
<td>20.9</td>
</tr>
<tr>
<td>End Station:</td>
<td>11 + 34</td>
<td>Drainage Acreage:</td>
<td>0.0</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1085.0</td>
<td>Watershed Slope:</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

**Given:**
- Flow Depth, d (ft) = 0.4
- Bottom Width (ft) = 8
- Side Slopes (H:1) = 2
- What size Rip Rap = R-4
- d50 size (inches) = 6
- Manning's Coefficient = 0.072
- Channel Slope, s (1/W) = 48.54%

**Flow Rate, Q (cfs)**

\[ Q = (1.486\pi)^{\frac{1}{2}} \times s^{\frac{1}{2}} \times S^{\frac{3}{2}} \]

\[ Q = 25.58 \text{ cfs} \]
\[ Q = 103.33 \text{ cfs} \]

**Velocity, V (fps)**

\[ V = \frac{Q}{A} \]
\[ V = \frac{7.27}{4.80} = 1.51 \text{ fps} \]
\[ V_{MAX} = \frac{9.00}{4.80} = 1.875 \text{ fps} \]

**Account for 40% Void Space in Rip Rap**

Rip Rap Thickness, t (inches) = 18

\[ A_{void} = 0.4\times b\times t \]
\[ A_{void} = 4.80 \text{ sq. ft.} \]

\[ A_{channel flow} = A - A_{void} \]
\[ A_{channel flow} = 2.28 \text{ sq. ft.} \]

\[ d_{min-channel flow} = \frac{b + \sqrt{b^2 + 4 \times \pi \times A_{channel flow}}}{2 \times \pi} \]
\[ d_{min-channel flow} = 0.17 \text{ ft} \]

**Shear Stress Calculation**

Use Sh to size rip rap if s < 10%

\[ Sh = 62.4 \times d_{min-channel flow} \times S \]

\[ Allowable \ Shear \ Stress = 2.00 \text{ psf} \]

\[ Calculated \ Shear \ Stress = \text{N/A} \text{ psf} \]

### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

\[ A = bd + zd^2 \]

\[ A = 3.52 \text{ sq. ft.} \]
\[ A = 8.62 \text{ sq. ft.} \]

\[ P = b + 2d \sqrt{z^2 + 1} \]

\[ P = 9.79 \text{ feet} \]
\[ P = 12.02 \text{ feet} \]

\[ r = \frac{A}{P} \]

\[ r = 0.36 \text{ feet} \]
\[ r = 0.73 \text{ feet} \]

### Top Width (feet)

\[ T = b + 2z \times d \]

\[ T = 9.60 \text{ feet} \]
\[ T = 11.60 \text{ feet} \]

### Ditch Sizing Check

\[ Q \ CHECK = \text{PASS} \]
\[ VELOCITY \ CHECK = \text{PASS} \]
\[ SHEAR \ STRESS \ CHECK = \text{USE \ VELOCITY} \]

**OVERALL CHECK = \text{PASS}**
Graphical Peak Discharge

Project: SMT EAST  By: CGY  Date: 01/04/22
Location: CD-8(1)  Checked: Date:

Developed

1. Data:
   Drainage area:.................A = 2.5000 Acres
   Runoff Curve Number:.........CN = 85
   Time of Concentration:.......Tc = 13.20 min
   Storm Type:..................... = II
   Pond and swamp areas spread throughout watershed.............. = 0.00 percent of A

2. Frequency.....................yr = 10

3. Rainfall,P(24-hour)............in = 3.560

4. Initial abstraction, Ia......... = 0.3529

5. Compute Ia/P................... = 0.0991

6. Unit peak discharge, qu......csm/in = 772.499

7. Runoff,Q.......................in = 2.069

8. Pond & swap adjustment factor,...Fp = 1.00

9. Peak Discharge,qp.............cfs = 6.243
Graphical Peak Discharge

Project: SMT EAST By: CGY Date: 01/04/22
Location: CD-8(2) Checked: Date:

Developed

1. Data:

   Drainage area: .................A = 4.6000 Acres

   Runoff Curve Number: .........CN = 85

   Time of Concentration: ......Tc = 13.20 min

   Storm Type: .................... = II

   Pond and swamp areas spread
   throughout watershed .......... = 0.00 percent of A
   0.0000 Acres

2. Frequency .....................yr = 10

3. Rainfall, P(24-hour) .........in = 3.560

4. Initial abstraction, Ia ...... = 0.3529

5. Compute Ia/P ..................... = 0.0991

6. Unit peak discharge, qu .......csm/in = 772.499

7. Runoff, Q ......................in = 2.069

8. Pond & swap adjustment factor,..Fp = 1.00

9. Peak Discharge, qp ...........cfs = 11.486
Graphical Peak Discharge

Project: SMT EAST  
Location: CD-8(3)  
By: CGY  
Checked:  
Date: 01/04/22

Developed

1. Data:
   Drainage area: \( A = 1.3000 \text{ Acres} \)
   Runoff Curve Number: \( CN = 85 \)
   Time of Concentration: \( T_c = 13.20 \text{ min} \)
   Storm Type: \( = II \)
   Pond and swamp areas spread throughout watershed: \( = 0.00 \% \text{ of } A \)
   \( 0.0000 \text{ Acres} \)

2. Frequency: \( yr = 10 \)

3. Rainfall, \( P(24\text{-hour}) \) in = 3.560

4. Initial abstraction, \( I_a \) = 0.3529

5. Compute \( I_a/P \): \( = 0.0991 \)

6. Unit peak discharge, \( q_u \) csm/in = 772.499

7. Runoff, \( Q \): in = 2.069

8. Pond & swap adjustment factor, \( F_p \) = 1.00

9. Peak Discharge, \( q_p \): cfs = 3.246
Time of Concentration (SCS)

Project: SMT EAST
Location: CD-8

Developed

Curve Number : 85
Length of Flow : 1244.00 ft
Average Land Slope : 5.90 %

Time of Concentration : 0.220 hrs, 13.2 mins
### 12.1 Diversion/Collection Ditch Data Sheet

**Title:** COLLECTION DITCH CD-9  
**Site:** SMT EAST  
**Company:** LIGONIER STONE & LIME  
**Permit Number:** 65210301

**Prepared By:** Earthtech, Inc.  
**Initials:** CGY  
**Telephone Number:** (724)439-1313  
**Date:** DECEMBER 2021  
**Sheet:** 1 of 2

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (ya)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Flow Velocity (ft/sec)</th>
<th>Q Available (CFS)</th>
<th>With Freeboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>End</td>
<td>Elevation</td>
<td>Section</td>
<td>Cum</td>
<td>Section</td>
<td>Cum.</td>
<td>Channel Bed Slope (%)</td>
<td>Channel Bottom Width (ft)</td>
<td>Side Slopes (H: V)</td>
<td>Flow</td>
<td>Top Flow Width (ft)</td>
<td>Flow Velocity (ft/sec)</td>
<td>Q Available (CFS)</td>
</tr>
<tr>
<td>0 + 00</td>
<td>1 + 80</td>
<td>1064.0</td>
<td>1.0</td>
<td>1.0</td>
<td>10</td>
<td>10.0%</td>
<td>85</td>
<td>3.2</td>
<td>3.2</td>
<td>1.7%</td>
<td>0.5</td>
<td>GRASS</td>
<td>0.070</td>
</tr>
</tbody>
</table>

**Ditch Profile**

![Ditch Profile Graph](image-url)
Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-9</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>3.2</td>
</tr>
<tr>
<td>End Station:</td>
<td>1 + 80</td>
<td>Drainage Acreage:</td>
<td>1.0</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,061.0</td>
<td>Watershed Slope:</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

**Given:**

- Flow Depth, $d$ (ft) = 0.4
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = GRASS
- $d_{rp}$ size (inches) = #N/A
- Manning's Coefficient = 0.070
- Channel Slope (s (ft/ft)) = 1.67%

**Flow Rate, $Q_{design}$ (cfs)**

$Q = (1.486/n) \times b \times r^{0.67} \times s^{0.5}$

$Q = 3.68 \text{ cfs}$

**Velocity, $V$ (fps)**

$V = Q/A$

$V = 1.35 \text{ fps}$

**Account for 40% Void Space in Rip Rap**

If $s \leq 10%$

- Rip Rap Thickness, $t$ (inches) = #N/A
- $A_{void} = 0.4b^{2}t$

$A_{void} = N/A \text{ sq.ft.}$

$A_{in-channel flow} = A - A_{void}$

$A_{in-channel flow} = #VALUE! \text{ sq.ft.}$

$A_{in-channel flow} = -b + \sqrt{b^{2} + 4 \times z \times A_{in-channel flow}} / 2 \times z$

$d_{in-channel flow} = #VALUE! \text{ ft}$

**Shear Stress Calculation**

Use $Sh$ to size rip rap if $s > 10%$

$Sh = 62.4 \times d_{in-channel flow} \times 5$

Allowable Shear Stress = #N/A psi

Calculated Shear Stress = 0.42 psi

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

$A = bd + zd^{2}$

$A = 2.72 \text{ sq.ft.}$

$A = 7.02 \text{ sq.ft.}$ WITH FREEBOARD

$P = b + 2d \sqrt{r^{2} + 1}$

$P = 7.79 \text{ feet}$ WITH FREEBOARD

$P = 10.02 \text{ feet}$ WITH FREEBOARD

**Top Width (feet)**

$T = b + 2d^{2}$

$T = 7.60 \text{ feet}$ WITH FREEBOARD

$T = 9.60 \text{ feet}$ WITH FREEBOARD

**Ditch Sizing Check**

Q CHECK = PASS

VELOCITY CHECK = PASS

SHEAR STRESS CHECK = USE VELOCITY

OVERALL CHECK = PASS
Graphical Peak Discharge

Project: SMT EAST
Location: CD-9

By: CGY
Checked:

Date: 01/04/22

Developed

1. Data:

   Drainage area: .................. A = 1.0000 Acres
   Runoff Curve Number: ........... CN = 85
   Time of Concentration: ......... Tc = 6.00 min
   Storm Type: ..................... = II
   Pond and swamp areas spread throughout watershed .......... = 0.00 percent of A
                 0.0000 Acres

2. Frequency: ....................... yr = 10


4. Initial abstraction, Ia: ............. = 0.3529

5. Compute Ia/P: ...................... = 0.0991

6. Unit peak discharge, qu ...... csm/in = 1000.000

7. Runoff, Q: ......................... in = 2.069

8. Pond & swamp adjustment factor, ... Fp = 1.00

Time of Concentration (SCS)

Project: SMT EAST
Location: CD-9

Curve Number : 85
Length of Flow : 408.00 ft
Average Land Slope : 10.30 %

Time of Concentration : 0.068 hrs, 4.1 mins
### 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm (yrs)</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Channel Lining (specify average rock size)</th>
<th>Manning's Coefficient (n)</th>
<th>Channel Bed Slope (%)</th>
<th>Channel Bottom Width (ft)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>With Freeboard</th>
<th>Q Available (CFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 + 00</td>
<td>1067.0</td>
<td>9.5</td>
<td>9.5</td>
<td>10</td>
<td>5.4</td>
<td>24.4</td>
<td>28.4</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 + 28</td>
<td>1061.0</td>
<td>9.5</td>
<td>9.5</td>
<td>10</td>
<td>5.4</td>
<td>24.4</td>
<td>28.4</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 + 58</td>
<td>1046.0</td>
<td>9.5</td>
<td>9.5</td>
<td>10</td>
<td>5.4</td>
<td>24.4</td>
<td>28.4</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ditch Profile**

**Elevation**

<table>
<thead>
<tr>
<th>Stations</th>
<th>0</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
<th>300</th>
<th>350</th>
<th>400</th>
<th>450</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,040</td>
<td>1,045</td>
<td>1,050</td>
<td>1,055</td>
<td>1,060</td>
<td>1,065</td>
<td>1,070</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Permit Number:** 65210301

**Date:** DECEMBER 2021

**Company:** LIGONIER STONE & LIME

**Prepared By:** Earthtech, Inc.

**Site:** SMT EAST

**Telephone Number:** (724)439-1313

**Initals:** CGY
**Trapezoidal/Triangle Section Ditch**

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>COLLECTION DITCH CD-10</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>25.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>25.4</td>
</tr>
<tr>
<td>End Station:</td>
<td>4 + 28</td>
<td>Drainage Acreage:</td>
<td>9.5</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,061.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

**Given:**

- Flow Depth, \( d \) (ft) = 1.3
- Bottom Width (ft) = 6
- Side Slopes (H:1) = 2
- What size Rip Rap = GRASS
- \( d_b \) size (inches) = #N/A
- Manning’s Coefficient = 0.070
- Channel Slope, \( s \) (ft/ft) = 1.40%

**Flow Rate, \( Q_{design} \) (Cfs):**

\[
Q = (1.486/n) \cdot x \cdot x \cdot r^{0.6} \cdot x \cdot s^{0.5}
\]

\[
Q = 27.08 \text{ cf} \hat{s}
\]

**Velocity, \( V \) (fps):**

\[
V = Q/A
\]

\[
V = 2.42 \text{ fps}
\]

**Account for 40% Void Space in Rip Rap**

If \( s \leq 10\% \),

- Rip Rap Thickness, \( t \) (inches) = #N/A

\[
A_{void} = 0.4 \cdot b \\
A_{void} = \frac{N/A}{\text{sq ft}}
\]

\[
A_{in-channel-flow} = A - A_{void}
\]

\[
d_{in-channel-flow} = \frac{-b + \sqrt{b^2 + 4 \cdot z \cdot A_{in-channel-flow}}}{2 \cdot z}
\]

**Shear Stress Calculation**

Use \( Sh \) to size rip rap if \( s > 10\% \)

\[
Sh = 62.4 \times d_{in-channel-flow} \times s
\]

**Allowable Shear Stress = #N/A psf**

**Calculated Shear Stress = 1.14 psf**

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

\[
A = bd + zd^2
\]

\[
A = 11.18 \text{ sq ft}
\]

\[
A = 17.28 \text{ sq ft} \quad \text{WITH FREEBOARD}
\]

\[
P = b + 2d \cdot \sqrt{x + 1}
\]

\[
P = 11.81 \text{ feet} \quad \text{WITH FREEBOARD}
\]

\[
P = 14.05 \text{ feet} \quad \text{WITH FREEBOARD}
\]

**Top Width (feet):**

\[
T = b + 2z^2d
\]

\[
T = 11.20 \text{ feet} \quad \text{WITH FREEBOARD}
\]

\[
T = 13.20 \text{ feet} \quad \text{WITH FREEBOARD}
\]

**Ditch Sizing Check**

Q CHECK = PASS

VELOCITY CHECK = PASS

SHEAR STRESS CHECK = USE VELOCITY

OVERALL CHECK = PASS
<table>
<thead>
<tr>
<th>Given:</th>
<th>Cross Sectional Area, Wetted Perimeter &amp; Hydraulic Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Depth, d (ft) = 0.6</td>
<td>A = bd + zd^2</td>
</tr>
<tr>
<td>Bottom Width (ft) = 6</td>
<td>A = 4.32 sq ft</td>
</tr>
<tr>
<td>Side Slopes (H:1) = 2</td>
<td>A = 9.02 sq ft</td>
</tr>
<tr>
<td>What size Rip Rap = R-5</td>
<td>WITH FREEBOARD</td>
</tr>
<tr>
<td>d_{so} Size (inches) = 0</td>
<td>P = b + 2d SQRT(p^2 + 1)</td>
</tr>
<tr>
<td>Mannings Coefficient = 0.077</td>
<td>r = A/P</td>
</tr>
<tr>
<td>Channel Slope, s (ft/ft) = 50.00%</td>
<td>r = 0.50 feet</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flow Rate, Q_{des} (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q = (1.466/n) x s x r^{1/2}</td>
</tr>
<tr>
<td>Q = 36.87 cfs</td>
</tr>
<tr>
<td>Q = 108.11 cfs</td>
</tr>
<tr>
<td>WITH FREEBOARD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Velocity, V (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V = Q/A</td>
</tr>
<tr>
<td>V = 8.53 fps</td>
</tr>
<tr>
<td>V_{MAX} = 11.50 fps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Account for 40% Void Space in Rip Rap</th>
</tr>
</thead>
<tbody>
<tr>
<td>If s ≤ 10%</td>
</tr>
<tr>
<td>Rip Rap Thickness, t (inches) = 27</td>
</tr>
<tr>
<td>A_{void} = 0.4 x t</td>
</tr>
<tr>
<td>A_{void} = 5.40 sq ft</td>
</tr>
<tr>
<td>A_{in-channel flow} = A - A_{void}</td>
</tr>
<tr>
<td>A_{in-channel flow} = -1.06 sq ft</td>
</tr>
<tr>
<td>A_{in-channel flow} = \frac{-b + \sqrt{b^2 + 4 \times z \times A_{in-channel flow}}}{2 \times z}</td>
</tr>
<tr>
<td>d_{in-channel flow} = -0.19 ft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shear Stress Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Sh to size rip rap if s &gt; 10%</td>
</tr>
<tr>
<td>\text{Sh} = 62.4 \times d_{in-channel flow} \times s</td>
</tr>
<tr>
<td>Allowable Shear Stress = 3.00 \text{ psf}</td>
</tr>
<tr>
<td>Calculated Shear Stress = N/A \text{ psf}</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ditch Sizing Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q CHECK = PASS</td>
</tr>
<tr>
<td>VELOCITY CHECK = PASS</td>
</tr>
<tr>
<td>SHEAR STRESS CHECK = USE VELOCITY</td>
</tr>
<tr>
<td>OVERALL CHECK = PASS</td>
</tr>
</tbody>
</table>
Graphical Peak Discharge

Project: SMT EAST
Location: CD-10(1)

Developed

1. Data:

   Drainage area: .................. A = 9.5000 Acres

   Runoff Curve Number: .............. CN = 85

   Time of Concentration: ............ Tc = 10.90 min

   Storm Type: ....................... = II

   Pond and swamp areas spread throughout watershed .................. = 0.00 percent of A
                                                                  0.0000 Acres

2. Frequency ....................... yr = 10

3. Rainfall, P(24-hour) .......... in = 3.560

4. Initial abstraction, Ia ......... = 0.3529

5. Compute Ia/P .................... = 0.0991

6. Unit peak discharge, qu ........ csm/in = 827.741

7. Runoff, Q ....................... in = 2.069

8. Pond & swamp adjustment factor, Fp = 1.00

9. Peak Discharge, qp ............ cfs = 25.418
Graphical Peak Discharge

Project: SMT EAST
Location: CD-10(2)

By: CGY
Checked:

Date: 01/04/22

Developed

1. Data:

   Drainage area: .................. A = 1.1000 Acres

   Runoff Curve Number: .......... CN = 85

   Time of Concentration: .......... Tc = 10.90 min

   Storm Type: ..................... = II

   Pond and swamp areas spread throughout watershed .......... = 0.00 percent of A

       = 0.0000 Acres

2. Frequency: ..................... yr = 10

3. Rainfall, P(24-hour) .......... in = 3.560

4. Initial abstraction, Ia .......... = 0.3529

5. Compute Ia/P: .................. = 0.0991

6. Unit peak discharge, qu .......... csm/in = 827.741

7. Runoff, Q: ..................... in = 2.069

8. Pond & swap adjustment factor, Fp = 1.00

9. Peak Discharge, qp: ............ cfs = 2.943
Time of Concentration (SCS)

Project: SMT EAST
Location: CD-10

Curve Number : 85
Length of Flow : 1296.00 ft
Average Land Slope : 9.30 %
Time of Concentration : 0.181 hrs, 10.9 mins
### 12.1 Diversion/Collection Ditch Data Sheet

<table>
<thead>
<tr>
<th>Station</th>
<th>Drainage Area (acres)</th>
<th>Design Storm</th>
<th>Average Watershed Slope (%)</th>
<th>Curve Number</th>
<th>Peak Discharge Q (CFS)</th>
<th>Manning's Coefficient</th>
<th>Channel Bed Slope (ft)</th>
<th>Freeboard (ft)</th>
<th>Channel Freeboard (CFS)</th>
<th>Channel Manning's (ft)</th>
<th>Channel Bed Slope (H : V)</th>
<th>Flow Area (sq ft)</th>
<th>Flow Depth (ft)</th>
<th>Top Flow Width (ft)</th>
<th>Q Available (CFS)</th>
<th>Top Flow Velocity (ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1158.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1100.0</td>
<td>1.7</td>
<td>10</td>
<td>15.0%</td>
<td>75</td>
<td>1.8</td>
<td>5.8%</td>
<td>0.5</td>
<td>0.089</td>
<td>R-4</td>
<td>8.0</td>
<td>2 : 1</td>
<td>2.6</td>
<td>0.30</td>
<td>9.2</td>
<td>1.69</td>
</tr>
<tr>
<td>8</td>
<td>1115.0</td>
<td>2.2</td>
<td>10</td>
<td>10.0%</td>
<td>75</td>
<td>2.3</td>
<td>4.1%</td>
<td>0.5</td>
<td>0.072</td>
<td>R-4</td>
<td>8.0</td>
<td>2 : 1</td>
<td>3.5</td>
<td>0.40</td>
<td>9.6</td>
<td>2.11</td>
</tr>
<tr>
<td>16</td>
<td>1096.0</td>
<td>3.7</td>
<td>10</td>
<td>15.0%</td>
<td>75</td>
<td>3.9</td>
<td>8.0%</td>
<td>0.5</td>
<td>0.070</td>
<td>GRASS</td>
<td>8.0</td>
<td>2 : 1</td>
<td>4.5</td>
<td>0.50</td>
<td>10.0</td>
<td>1.91</td>
</tr>
<tr>
<td>18</td>
<td>1086.0</td>
<td>0.2</td>
<td>10</td>
<td>15.0%</td>
<td>75</td>
<td>0.2</td>
<td>8.2%</td>
<td>0.5</td>
<td>0.064</td>
<td>R-4</td>
<td>8.0</td>
<td>2 : 1</td>
<td>4.5</td>
<td>0.50</td>
<td>10.0</td>
<td>2.70</td>
</tr>
</tbody>
</table>

### Ditch Profile

![Ditch Profile Graph](image-url)
<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>DIVERSION DITCH DD-1</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>1.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>1</td>
<td>Peak Discharge (Cum):</td>
<td>1.8</td>
</tr>
<tr>
<td>End Station:</td>
<td>4 + 69</td>
<td>Drainage Acreage:</td>
<td>1.7</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,131.0</td>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

**Given:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Depth, d (ft)</td>
<td>0.3</td>
</tr>
<tr>
<td>Bottom Width (ft)</td>
<td>8</td>
</tr>
<tr>
<td>Side Slopes (H:1)</td>
<td>2</td>
</tr>
<tr>
<td>What size Rip Rap</td>
<td>R-4</td>
</tr>
<tr>
<td>d50 size (inches)</td>
<td>8</td>
</tr>
<tr>
<td>Manning’s Coefficient</td>
<td>0.089</td>
</tr>
<tr>
<td>Channel Slope, s (ft%)</td>
<td>5.76%</td>
</tr>
</tbody>
</table>

**Flow Rate, Q_{design} (cfs)**

\[
Q = (1.486/n) \times a \times r^2 \times s^{3/2} \\
Q = 4.37 \text{ cfs} \\
Q = 23.41 \text{ cfs} \text{ WITH FREEBOARD}
\]

**Velocity, V (fps)**

\[
V = Q/A \\
V = 1.69 \text{ fps} \\
V_{max} = 9.00 \text{ fps}
\]

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius**

\[
A = bd + zd^2 \\
A = 2.56 \text{ sq ft} \\
A = 7.88 \text{ sq ft} \text{ WITH FREEBOARD}
\]

\[
P = b + 2d \sqrt{r^2 + h} \\
P = 9.34 \text{ feet} \\
P = 11.58 \text{ feet} \text{ WITH FREEBOARD}
\]

**Top Width (feet)**

\[
T = b + 2z^*d \\
T = 9.20 \text{ feet} \\
T = 11.20 \text{ feet} \text{ WITH FREEBOARD}
\]

**Ditch Sizing Check**

\[
\text{Q \ CHECK} = \text{ PASS} \\
\text{VELOCITY \ CHECK} = \text{ PASS} \\
\text{SHEAR \ STRESS \ CHECK} = \text{ USE VELOCITY} \\
\text{OVERALL \ CHECK} = \text{ PASS}
\]

**Account for 40% Void Space in Rip Rap if s ≤ 10%**

\[
A_{void} = 0.4 \times d^1 \\
A_{void} = \text{N/A sq ft.}
\]

\[
A_{in-channel-flow} = A - A_{void} \\
A_{in-channel-flow} = \#VALUE! sq ft.
\]

\[
A_{in-channel-flow} = \frac{-b + \sqrt{b^2 + 4 \times z \times A_{in-channel-flow}}}{2 \times z} \\
d_{in-channel-flow} = \#VALUE! ft.
\]

**Shear Stress Calculation**

\[
Sh = 62.4 \times d_{in-channel-flow} \times s \\
\text{Allowable Shear Stress} = 2.00 \text{ psf} \\
\text{Calculated Shear Stress} = 1.08 \text{ psf}
\]
## Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>DIVERSION DITCH DD-1</th>
<th>Peak Disch &amp; Base Flow:</th>
<th>2.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>2</td>
<td>Peak Discharge (Cum):</td>
<td>4.1</td>
</tr>
<tr>
<td>End Station:</td>
<td>8</td>
<td>Drainage Acreage:</td>
<td>2.2</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,115.0</td>
<td>Watershed Slope:</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

### Given:
- Flow Depth, d (ft) = 0.4
- Bottom Width (ft) = 8
- Side Slopes (H:1) = 2
- What size Rip Rap = R:4
- $d_{50}$ size (inches) = 6
- Manning’s Coefficient = 0.072
- Channel Slope, s (ft/ft) = 4.15%

### Cross Sectional Area, Wetted Perimeter & Hydraulic Radius

**A = bd + zd^2**
- $A = 3.52$ sq ft
- $A = 8.82$ sq ft WITH FREEBOARD

**P = b + 2d SQRT(z^2 + f)**
- $P = 9.79$ feet
- $P = 12.02$ feet WITH FREEBOARD

**r = A/P**
- $r = 0.36$ feet
- $r = 0.73$ feet WITH FREEBOARD

### Velocity, V (fps)

$V = Q/A$
- $V = 2.11$ fps
- $V_{MAX} = 9.00$ fps WITH FREEBOARD

### Ditch Sizing Check

**Q CHECK = PASS**
**VELOCITY CHECK = PASS**
**SHEAR STRESS CHECK = USE VELOCITY**
**OVERALL CHECK = PASS**

### Flow Rate, $Q_{design}$ (cfs)

$Q = (1.486ln) \times a \times r^{0.7} \times h^{0.6}$
- $Q = 7.44$ cfs
- $Q = 30.07$ cfs WITH FREEBOARD

### Use V to size rip rap if s < 10%, grouted, or $d_{50} < 6$

$V = Q/A$
- $V = 2.11$ fps
- $V_{MAX} = 9.00$ fps WITH FREEBOARD

### Account for 40% Void Space in Rip Rap

- If s > 10%:
  - $A_{void} = 0.4b^2 t$
  - $A_{void} = N/A$ sq ft.

### Shear Stress Calculation

Use $Sh$ to size rip rap if s > 10%

$Sh = 62.4 \times d_{50}$

- Allowable Shear Stress = 2.00 psf
- Calculated Shear Stress = 1.03 psf

### Top Width (feet)

$T = b + 2z^2d$
- $T = 9.60$ feet
- $T = 11.60$ feet WITH FREEBOARD
### Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Channel Name:</th>
<th>DIVERSION DITCH DD-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section Number:</td>
<td>3</td>
</tr>
<tr>
<td>End Station:</td>
<td>16 + 34</td>
</tr>
<tr>
<td>End Elevation:</td>
<td>1,096.0</td>
</tr>
<tr>
<td>Peak Disch &amp; Base Flow:</td>
<td>3.9</td>
</tr>
<tr>
<td>Peak Discharge (Cum):</td>
<td>8.0</td>
</tr>
<tr>
<td>Drainage Acreage:</td>
<td>3.7</td>
</tr>
<tr>
<td>Watershed Slope:</td>
<td>15.0%</td>
</tr>
</tbody>
</table>

**Given:**
- Flow Depth, d (ft) = 0.5
- Bottom Width (ft) = 8
- Side Slopes (H:1) = 2
- What size Rip Rap = GRASS
- d_{50} size (inches) = #N/A
- Manning's Coefficient = 0.070
- Channel Slope, s (ft/ft) = 2.44%

**Flow Rate, Q_{desig} (cfs):**

\[ Q = (1.485/n) \times a \times r^{0.5} \times s^{0.5} \]

\[ Q = 6.60 \text{ cfs} \]

**Velocity, V (fps):**

\[ V = \frac{Q}{A} \]

\[ V = 1.91 \text{ fps} \]

\[ V_{max} = 3.50 \text{ fps} \]

**Cross Sectional Area, Wetted Perimeter & Hydraulic Radius:**

\[ A = bd + zd^2 \]

\[ A = 4.50 \text{ sq ft} \]

\[ A = 10.00 \text{ sq ft} \]

\[ P = b + 2d \sqrt{d^2 + 1} \]

\[ P = 10.24 \text{ feet} \]

\[ P = 12.47 \text{ feet} \]

**Top Width (feet):**

\[ T = b + 2z \]

\[ T = 10.00 \text{ feet} \]

\[ T = 12.00 \text{ feet} \]

**Ditch Sizing Check:**

Q CHECK = PASS

VELOCITY CHECK = PASS

SHEAR STRESS CHECK = USE VELOCITY

OVERALL CHECK = PASS

**Account for 40% Void Space in Rip Rap:**

if \( s \leq 10\% \), grouted, or \( d_{50} \text{size} \leq 0 \\

\[ A_{void} = \frac{0.4}{b'} \]

\[ A_{void} = \text{N/A sq ft} \]

**Shear Stress Calculation:**

Use Sh to size rip rap if \( s > 10\% \)

\[ Sh = 62.4 \times d_{50} \times \text{channel flow} \times s \]

Allowable Shear Stress = #N/A psf

Calculated Shear Stress = 0.76 psf
Trapezoidal/Triangle Section Ditch

<table>
<thead>
<tr>
<th>Given:</th>
<th>Cross Sectional Area, Wetted Perimeter &amp; Hydraulic Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Depth, d (ft) = 0.5</td>
<td>A = bd + zd^2</td>
</tr>
<tr>
<td>Bottom Width (ft) = 8</td>
<td>A = 4.60 sq ft, WITH FREEBOARD</td>
</tr>
<tr>
<td>Side Slopes (H:1) = 2</td>
<td>P = b + 2d SQRT(z^2 + 1)</td>
</tr>
<tr>
<td>What size Rip Rap = R-4</td>
<td>r = 0.44 feet, WITH FREEBOARD</td>
</tr>
<tr>
<td>d_r of size (inches) = 6</td>
<td>T = b + 2<em>z</em>d</td>
</tr>
<tr>
<td>Mannings Coefficient = 0.064</td>
<td>T = 10.00 feet, WITH FREEBOARD</td>
</tr>
<tr>
<td>Channel Slope, s (ft/ft) = 4.03%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Top Width (feet)</td>
</tr>
<tr>
<td></td>
<td>T = 12.00 feet, WITH FREEBOARD</td>
</tr>
</tbody>
</table>

Flow Rate, Q_{design} (cfs)

Q = (1.456/n) x a x r^{2/3} x s^{1/2}
Q = 12.17 cfs, Q = 40.44 cfs WITH FREEBOARD

Velocity, V (fps)

V = Q/A
V = 2.70 fps, V_{MAX} = 9.00 fps

Account for 40% Void Space in Rip Rap if s ≥ 10%

A_{void} = 0.4*b*t
A_{void} = N/A sq ft

A_{total} = A_{void} + A_{channel flow}

A_{total} = #VALUE! sq ft

d_{in-channel flow} = \frac{b + \sqrt{b^2 + 4 * z * A_{in-channel flow}}}{2 * z}
d_{in-channel flow} = #VALUE! ft

Shear Stress Calculation

Use Sh to size rip rap if s > 10%

Sh = 62.4 \times d_{in-channel flow} \times S

Allowable Shear Stress = 2.00 psf
Calculated Shear Stress = 1.26 psf

Ditch Sizing Check

Q CHECK = PASS
VELOCITY CHECK = PASS
SHEAR STRESS CHECK = USE VELOCITY
OVERALL CHECK = PASS
Graphical Peak Discharge

Project: SMT EAST  
By: CGY  
Location: DD-1(1)  
Checked:  
Date: 01/04/22

Developed

1. Data:

   Drainage area: .................. A = 1.7000 Acres
   Runoff Curve Number: ............. CN = 75
   Time of Concentration: ............ Tc = 29.60 min
   Storm Type: ...................... = II
   Pond and swamp areas spread throughout watershed: ............... = 0.00 percent of A 
                                                                    0.0000 Acres

2. Frequency: ....................... yr = 10


4. Initial abstraction, Ia: ........... = 0.6667

5. Compute Ia/P: ..................... = 0.1873

6. Unit peak discharge, qu: ......... csm/in = 498.813

7. Runoff, Q: ........................ in = 1.344

8. Pond & swamp adjustment factor, .. Fp = 1.00

9. Peak Discharge, qp: ............... cfs = 1.781
Graphical Peak Discharge

Project: SMT EAST
Location: DD-1(2)

By: CGY
Checked: 

Date: 01/04/22
Date:

Developed

1. Data:

   Drainage area: .................. A = 2.2000 Acres

   Runoff Curve Number: ............ CN = 75

   Time of Concentration: .......... Tc = 29.60 min

   Storm Type: ....................... = II

   Pond and swamp areas spread throughout watershed ............ = 0.00 percent of A
   0.0000 Acres

2. Frequency ......................... yr = 10

3. Rainfall, P(24-hour) .......... in = 3.560

4. Initial abstraction, Ia .......... = 0.6667

5. Compute Ia/P ..................... = 0.1873

6. Unit peak discharge, qu .......... csm/in = 498.813

7. Runoff, Q  ......................... in = 1.344

8. Pond & swap adjustment factor, Fp = 1.00

9. Peak Discharge, qp ............ cfs = 2.305
Graphical Peak Discharge

Project: SMT EAST
Location: DD-1(3)

By: CGY
Checked:

Date: 01/04/22

Developed

1. Data:

Drainage area: \[ A = 3.7000 \text{ Acres} \]

Runoff Curve Number: \[ CN = 75 \]

Time of Concentration: \[ T_c = 29.60 \text{ min} \]

Storm Type: \[ = II \]

Pond and swamp areas spread throughout watershed: \[ = 0.00 \text{ percent of A} \]

0.0000 Acres

2. Frequency: \[ \text{yr} = 10 \]

3. Rainfall, \( P(24\text{-hour}) \): \[ \text{in} = 3.560 \]

4. Initial abstraction, \( I_a \): \[ = 0.6667 \]

5. Compute \( I_a/P \): \[ = 0.1873 \]

6. Unit peak discharge, \( q_u \): \[ \text{csm/in} = 498.813 \]

7. Runoff, \( Q \): \[ \text{in} = 1.344 \]

8. Pond & swamp adjustment factor, \( F_p \): \[ = 1.00 \]

9. Peak Discharge, \( q_p \): \[ \text{cfs} = 3.877 \]
Developed

1. Data:
   Drainage area: ................. A = 0.2000 Acres
   Runoff Curve Number: ......... CN = 75
   Time of Concentration: ....... Tc = 29.60 min
   Storm Type: .................... = II
   Pond and swamp areas spread throughout watershed ........... = 0.00 percent of A
                                        0.0000 Acres

2. Frequency ..................... yr = 10

3. Rainfall, P(24-hour) .......... in = 3.560

4. Initial abstraction, Ia .......... = 0.6667

5. Compute Ia/P .................... = 0.1873

6. Unit peak discharge, qu .......... csm/in = 498.813

7. Runoff, Q ....................... in = 1.344

8. Pond & swamp adjustment factor, Fp .......... = 1.00

9. Peak Discharge, qp .............. cfs = 0.210
Project: SMT EAST
Location: DD-1

Curve Number : 75
Length of Flow : 1890.00 ft
Average Land Slope : 4.30 %
Time of Concentration : 0.494 hrs, 29.6 mins
## STANDARD E&S WORKSHEET #1
Compost Filter Socks

**PROJECT NAME:** LIGONIER STONE & LIME COMPANY - SMT EAST  
**LOCATION:** DERRY TOWNSHIP, WESTMORELAND COUNTY  
**PREPARED BY:** CGY  
**CHECKED BY:** BV  
**DATE:** JANUARY 2021, REV. DECEMBER 2021

### 2" X 2" WOODEN STAKES PLACED 10' O.C.

**BLOWN/PLACED FILTER MEDIA**  
**DISTURBED AREA**  
**COMPOST FILTER SOCK**  
**UNDISTURBED AREA**

<table>
<thead>
<tr>
<th>SOCK NO.</th>
<th>Dia. (In.)</th>
<th>LOCATION</th>
<th>SLOPE PERCENT</th>
<th>SLOPE LENGTH ABOVE BARRIER (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFS-1</td>
<td>12</td>
<td>BELOW CD-4</td>
<td>7</td>
<td>140</td>
</tr>
<tr>
<td>CFS-2</td>
<td>18</td>
<td>BELOW SP-1</td>
<td>8</td>
<td>240</td>
</tr>
<tr>
<td>CFS-3</td>
<td>12</td>
<td>BELOW SP-3</td>
<td>5</td>
<td>200</td>
</tr>
<tr>
<td>CFS-4</td>
<td>12</td>
<td>BELOW SP-3</td>
<td>5</td>
<td>180</td>
</tr>
<tr>
<td>CFS-5</td>
<td>12</td>
<td>BELOW PROCESS PONDS</td>
<td>6</td>
<td>140</td>
</tr>
<tr>
<td>CFS-6</td>
<td>18</td>
<td>BELOW SLURRY PIPE CROSSING</td>
<td>11</td>
<td>200</td>
</tr>
<tr>
<td>CFS-7</td>
<td>18</td>
<td>BELOW Haul ROAD</td>
<td>11</td>
<td>180</td>
</tr>
<tr>
<td>CFS-8</td>
<td>12</td>
<td>BELOW Haul ROAD</td>
<td>8</td>
<td>160</td>
</tr>
<tr>
<td>CFS-9</td>
<td>18</td>
<td>BELOW SP-2</td>
<td>8</td>
<td>220</td>
</tr>
<tr>
<td>CFS-10</td>
<td>18</td>
<td>BELOW SP-2</td>
<td>8</td>
<td>230</td>
</tr>
<tr>
<td>CFS-11</td>
<td>12</td>
<td>BELOW Haul ROAD CROSSING</td>
<td>8</td>
<td>160</td>
</tr>
</tbody>
</table>
Design Parameters

Section
Shape: Circular
Material: HDPE
Diameter: 12.00 in
Manning's n: 0.0120
Number of Barrels: 1

Inlet
Inlet Type: Mitered to Slope
Ke: 0.70

Inverts
Inlet Invert Elevation: 1042.000 ft
Outlet Invert Elevation: 1041.000 ft
Length: 100.000 ft
Slope: 1.00 %

Culvert Calculation
Discharge: 5.6608 cfs
Headwater Elevation: 1045.500 ft
Tailwater Elevation: 0.000 ft
Downstream Velocity: 7.37 ft/s
Downstream Flow Depth: 0.945 ft
Flow Control Type: Outlet Control, Gradually Varied Flow
Culvert-2 Design

Design Parameters

Section
Shape: Circular
Material: HDPE
Diameter: 18.00 in
Manning's n: 0.0120
Number of Barrels: 2

Inlet
Inlet Type: Mitered to Slope
Ke: 0.70

Inverts
Inlet Invert Elevation: 1042.500 ft
Outlet Invert Elevation: 1041.000 ft
Length: 150.000 ft
Slope: 1.00 %

Culvert Calculation
Discharge: 25.2570 cfs
Headwater Elevation: 1046.000 ft
Tailwater Elevation: 0.000 ft
Downstream Velocity: 7.59 ft/s
Downstream Flow Depth: 1.338 ft
Flow Control Type: Inlet Control, Submerged
Graphical Peak Discharge

Project: SMT EAST
Location: CULV-2

By: CGY
Checked: 
Date: 12/06/21

Developed

1. Data:

   Drainage area: ..................... A = 7.5000 Acres
   Runoff Curve Number: .......... CN = 85
   Time of Concentration: ......... Tc = 6.00 min
   Storm Type: ...................... = II
   Pond and swamp areas spread throughout watershed: .......... = 0.00 percent of A
   0.0000 Acres

2. Frequency: ...................... yr = 10


4. Initial abstraction, Ia......... = 0.3529

5. Compute Ia/P: .................... = 0.0991

6. Unit peak discharge, Qu...... csm/in = 1000.000

7. Runoff, Q: ...................... in = 2.069

8. Pond & swamp adjustment factor, Fp = 1.00

9. Peak Discharge, qp........... cfs = 24.243
Design Parameters

Section
Shape: Circular
Material: HDPE
Diameter: 24.00 in
Manning's n: 0.0120
Number of Barrels: 2

Inlet
Inlet Type: Mitered to Slope
Ke: 0.70

Inverts
Inlet Invert Elevation: 1033.700 ft
Outlet Invert Elevation: 1033.000 ft
Length: 70.000 ft
Slope: 1.00 %

Culvert Calculation
Discharge: 48.7394 cfs
Headwater Elevation: 1038.000 ft
Tailwater Elevation: 0.000 ft
Downstream Velocity: 8.89 ft/s
Downstream Flow Depth: 1.629 ft
Flow Control Type: Inlet Control, Submerged
Design Parameters

**Section**
- **Shape:** Circular
- **Material:** HDPE
- **Diameter:** 18.00 in
- **Manning's n:** 0.0120
- **Number of Barrels:** 2

**Inlet**
- **Inlet Type:** Mitered to Slope
- **Ke:** 0.70

**Inverts**
- **Inlet Invert Elevation:** 1097.500 ft
- **Outlet Invert Elevation:** 1097.000 ft
- **Length:** 50.000 ft
- **Slope:** 1.00 %

**Culvert Calculation**
- **Discharge:** 30.1281 cfs
- **Headwater Elevation:** 1102.000 ft
- **Tailwater Elevation:** 0.000 ft
- **Downstream Velocity:** 8.75 ft/s
- **Downstream Flow Depth:** 1.407 ft
- **Flow Control Type:** Inlet Control, Submerged
Culvert-5 Design

Design Parameters

Section
Shape: Circular
Material: HDPE
Diameter: 18.00 in
Manning's n: 0.0120
Number of Barrels: 1

Inlet
Inlet Type: Mitered to Slope
Ke: 0.70

Inverts
Inlet Invert Elevation: 1110.000 ft
Outlet Invert Elevation: 1109.000 ft
Length: 100.000 ft
Slope: 1.00 %

Culvert Calculation
Discharge: 13.8997 cfs
Headwater Elevation: 1114.000 ft
Tailwater Elevation: 0.000 ft
Downstream Velocity: 8.18 ft/s
Downstream Flow Depth: 1.379 ft
Flow Control Type: Inlet Control, Submerged
Culvert-6 Design

Design Parameters

Section
Shape: Circular
Material: HDPE
Diameter: 18.00 in
Manning's n: 0.0120
Number of Barrels: 1

Inlet
Inlet Type: Mitered to Slope
Ke: 0.70

Inverts
Inlet Invert Elevation: 1097.000 ft
Outlet Invert Elevation: 1096.500 ft
Length: 50.000 ft
Slope: 1.00 %

Culvert Calculation
Discharge: 11.2141 cfs
Headwater Elevation: 1100.000 ft
Tailwater Elevation: 0.000 ft
Downstream Velocity: 7.34 ft/s
Downstream Flow Depth: 1.210 ft
Flow Control Type: Inlet Control, Submerged
### SECTION A-A

<table>
<thead>
<tr>
<th>OUTLET NO.</th>
<th>PIPE DIA (IN) Pd</th>
<th>RIPRAP</th>
<th>APRON</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SIZE THICK. LENGTH</td>
<td>Initial Width</td>
<td>Terminal Width</td>
</tr>
<tr>
<td></td>
<td>R in (IN) Ft (FT)  Alw (FT)</td>
<td>Atw (FT)</td>
<td></td>
</tr>
<tr>
<td>CULV-1</td>
<td>12</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>CULV-2</td>
<td>18 (2X)</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>CULV-3</td>
<td>24 (2X)</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>CULV-4</td>
<td>18 (2X)</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>CULV-5</td>
<td>18</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>CULV-6</td>
<td>18</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>SP-2 PRINCIPAL SPILLWAY</td>
<td>18</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>SP-2 DEWATERING PIPE</td>
<td>6</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>SP-3 DEWATERING PIPE</td>
<td>4</td>
<td>4</td>
<td>18</td>
</tr>
</tbody>
</table>

**NOTES:**

ALL APRONS SHALL BE CONSTRUCTED TO THE DIMENSIONS SHOWN. TERMINAL WIDTHS SHALL BE ADJUSTED AS NECESSARY TO MATCH RECEIVING CHANNELS.

ALL APRONS SHALL BE INSPECTED AT LEAST WEEKLY AND AFTER EACH RUNOFF EVENT. DISPLACED RIPRAP WITHIN THE APRON SHALL BE REPLACED IMMEDIATELY.

EXTEND RIPRAP ON BACK SIDE OF APRON TO AT LEAST 1/2 DEPTH OF PIPE ON BOTH SIDES TO PREVENT SCOUR AROUND THE PIPE.

**STANDARD CONSTRUCTION DETAIL #9-2**

RIPRAP APRON AT PIPE OUTLET
NO FLARED ENDWALL

NOT TO SCALE
TYPICAL DITCH NOTES:
- The ditches shall be constructed to the design specifications in Module 12. The minimum ditch size is reflected in the Module 12.
- Vegetative ditches shall be seeded and mulched with hay-straw after completion. This will achieve vegetation as soon as possible.
- Any areas of significant erosion within the ditch will be repaired with R-4 rip rap. The rip rap will be placed in a way that the ditch size will not be decreased.
- Vegetative ditches shall have R-4 rip rap placed at abrupt changes in direction to dissipate energy.

TYPICAL GRASS-LINED DITCH
N.T.S.

*Sidecast material compacted as necessary.

TYPICAL ROCK-LINED DITCH
N.T.S.
* MOUNTABLE BERM USED TO PROVIDE PROPER COVER FOR PIPE

NOTES:
REMOVE TOPSOIL PRIOR TO INSTALLATION OF ROCK CONSTRUCTION ENTRANCE. EXTEND ROCK OVER FULL WIDTH OF ENTRANCE.
RUNOFF SHALL BE DIVERTED FROM ROADWAY TO A SUITABLE SEDIMENT REMOVAL BMP PRIOR TO ENTERING ROCK CONSTRUCTION ENTRANCE.
MOUNTABLE BERM SHALL BE INSTALLED WHEREVER OPTIONAL CULVERT PIPE IS USED AND PROPER PIPE COVER AS SPECIFIED BY MANUFACTURER IS NOT OTHERWISE PROVIDED. PIPE SHALL BE SIZED APPROPRIATELY FOR SIZE OF DITCH BEING CROSSED.
MAINTENANCE: ROCK CONSTRUCTION ENTRANCE THICKNESS SHALL BE CONSTANTLY MAINTAINED TO THE SPECIFIED DIMENSIONS BY ADDING ROCK. A STOCKPILE SHALL BE MAINTAINED ON SITE FOR THIS PURPOSE. ALL SEDIMENT DEPOSITED ON PAVED ROADWAYS SHALL BE REMOVED AND RETURNED TO THE CONSTRUCTION SITE IMMEDIATELY. IF EXCESSIVE AMOUNTS OF SEDIMENT ARE BEING DEPOSITED ON ROADWAY, EXTEND LENGTH OF ROCK CONSTRUCTION ENTRANCE BY 50 FOOT INCREMENTS UNTIL CONDITION IS ALLEVIATED OR INSTALL WASH RACK. WASHING THE ROADWAY OR SWEEPING THE DEPOSITS INTO ROADWAY DITCHES, SEWERS, CULVERTS, OR OTHER DRAINAGE COURSES IS NOT ACCEPTABLE.

STANDARD CONSTRUCTION DETAIL #3-1
ROCK CONSTRUCTION ENTRANCE

NOT TO SCALE
TYPICAL CUT SECTION

TYPICAL FILL SECTION

TYPICAL CUT/FILL SECTION

TYPICAL HAUL ROAD CROSS SECTIONS

NOT TO SCALE
EXISTING FARM POND FLOW ANALYSIS
Summary for Subcatchment 1S: DRAINAGE TO EXISTING POND PRE

Runoff = 57.05 cfs @ 12.17 hrs, Volume = 4.274 af, Depth > 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span = 5.00-20.00 hrs, dt = 0.01 hrs
Type II 24-hr 10-YR Rainfall = 3.56"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>42.300</td>
<td>75</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.6</td>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td>Direct Entry,</td>
</tr>
</tbody>
</table>

Subcatchment 1S: DRAINAGE TO EXISTING POND PRE

Hydrograph

Type II 24-hr
10-YR Rainfall = 3.56"
Runoff Area = 42.300 ac
Runoff Volume = 4.274 af
Runoff Depth > 1.21"
Tc = 22.6 min
CN = 75
Summary for Subcatchment 3S: DRAINAGE TO EXISTING POND POST

Runoff = 23.20 cfs @ 12.17 hrs, Volume= 1.738 af, Depth> 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=3.56"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>* 17.200</td>
<td>75</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry,</td>
</tr>
</tbody>
</table>

Subcatchment 3S: DRAINAGE TO EXISTING POND POST

Type II 24-hr
10-YR Rainfall=3.56"
Runoff Area=17.200 ac
Runoff Volume=1.738 af
Runoff Depth>1.21"
Tc=22.6 min
CN=75
EXISTING POND

Summary for Subcatchment 4S: DD-1

Runoff = 8.82 cfs @ 12.26 hrs, Volume= 0.786 af, Depth= 1.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=3.56"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.800</td>
<td>75</td>
<td>100.00% Pervious Area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc (min)</th>
<th>Length (feet)</th>
<th>Slope (ft/ft)</th>
<th>Velocity (ft/sec)</th>
<th>Capacity (cfs)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Direct Entry,</td>
</tr>
</tbody>
</table>

Subcatchment 4S: DD-1

Type II 24-hr 10-YR Rainfall=3.56"
Runoff Area=7.800 ac
Runoff Volume=0.786 af
Runoff Depth>1.21"
Tc=29.6 min
CN=75

Hydrograph

Flow (cfs)

Time (hours)
**Summary for Subcatchment 5S: SP-2 DRAINAGE AREA**

Runoff = 59.19 cfs @ 12.22 hrs, Volume= 4.993 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=3.56"

<table>
<thead>
<tr>
<th>Area (ac)</th>
<th>CN</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.500</td>
<td>85</td>
<td>100.00% Pervious Area</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tc</th>
<th>Length</th>
<th>Slope</th>
<th>Velocity</th>
<th>Capacity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.0</td>
<td>Direct Entry,</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subcatchment 5S: SP-2 DRAINAGE AREA**

- Type II 24-hr
- 10-YR Rainfall=3.56"
- Runoff Area=31.500 ac
- Runoff Volume=4.993 af
- Runoff Depth>1.90"
- Tc=28.0 min
- CN=85
Summary for Pond 6P: SP-2

Inflow Area = 31,500 ac, 0.00% Impervious, Inflow Depth > 1.90" for 10-YR event
Inflow = 59.19 cfs @ 12.22 hrs, Volume= 4,993 af
Outflow = 1.47 cfs @ 19.59 hrs, Volume= 0.788 af, Atten= 98%, Lag= 441.9 min
Primary = 1.16 cfs @ 19.59 hrs, Volume= 0.721 af
Secondary = 0.31 cfs @ 19.59 hrs, Volume= 0.067 af
Tertiary = 0.00 cfs @ 5.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dI= 0.01 hrs
Starting Elev= 1,089.00' Surf.Area= 0 sf Storage= 71,680 cf
Peak Elev= 1,096.26' @ 19.59 hrs Surf.Area= 0 sf Storage= 254,911 cf (183,231 cf above start)
Flood Elev= 1,098.00' Surf.Area= 0 sf Storage= 310,120 cf (238,440 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 185.9 min (981.7 - 795.8)

<table>
<thead>
<tr>
<th>#1</th>
<th>Invert</th>
<th>Avail.Storage</th>
<th>Storage Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,085.00'</td>
<td>379,329 cf</td>
<td>Custom Stage Data Listed below</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Elevation (feet)</th>
<th>Cum.Store (cubic-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,085.00</td>
<td>0</td>
</tr>
<tr>
<td>1,085.50</td>
<td>7,920</td>
</tr>
<tr>
<td>1,086.00</td>
<td>16,129</td>
</tr>
<tr>
<td>1,086.50</td>
<td>24,631</td>
</tr>
<tr>
<td>1,087.00</td>
<td>33,431</td>
</tr>
<tr>
<td>1,087.50</td>
<td>42,532</td>
</tr>
<tr>
<td>1,088.00</td>
<td>51,938</td>
</tr>
<tr>
<td>1,088.50</td>
<td>61,653</td>
</tr>
<tr>
<td>1,089.00</td>
<td>71,680</td>
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<tr>
<td>1,090.00</td>
<td>92,690</td>
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<td>103,680</td>
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<td>1,091.00</td>
<td>114,998</td>
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<tr>
<td>1,091.50</td>
<td>126,648</td>
</tr>
<tr>
<td>1,092.00</td>
<td>138,635</td>
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<tr>
<td>1,092.50</td>
<td>150,962</td>
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<td>1,093.00</td>
<td>163,632</td>
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<td>1,093.50</td>
<td>176,651</td>
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<td>1,094.00</td>
<td>190,022</td>
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<td>1,094.50</td>
<td>203,748</td>
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<td>1,095.00</td>
<td>217,834</td>
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<td>232,283</td>
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<td>1,096.00</td>
<td>247,100</td>
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<td>1,096.50</td>
<td>262,288</td>
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<td>1,097.00</td>
<td>277,852</td>
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<tr>
<td>1,097.50</td>
<td>293,794</td>
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<tr>
<td>1,098.00</td>
<td>310,120</td>
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<tr>
<td>1,098.50</td>
<td>326,832</td>
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<tr>
<td>1,099.00</td>
<td>343,935</td>
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<tr>
<td>1,099.50</td>
<td>361,433</td>
</tr>
<tr>
<td>1,100.00</td>
<td>379,329</td>
</tr>
</tbody>
</table>
**EXISTING POND**

Prepared by Earthtech, Inc.

Type II 24-hr 10-YR Rainfall=3.56"  
Printed 1/4/2022

HydroCAD® 10.00-26 s/n 09668 © 2020 HydroCAD Software Solutions LLC

**Outlet Devices**

<table>
<thead>
<tr>
<th>Device</th>
<th>Routing</th>
<th>Invert</th>
<th>44.0' long x 20.0' breadth EMERGENCY SPILLWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>Tertiary</td>
<td>1,097.00'</td>
<td>Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device</th>
<th>Routing</th>
<th>Invert</th>
<th>18.0&quot; Round PRINCIPAL SPILLWAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2</td>
<td>Secondary</td>
<td>1,096.00'</td>
<td>L=70.0' CPP, mitered to conform to fill, Ke=0.700</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inlet / Outlet Invert= 1,096.00&quot; / 1,094.60&quot;, S= 0.0200 &quot; Cc= 0.900</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device</th>
<th>Routing</th>
<th>Invert</th>
<th>18.0&quot; Round DEWATERING PIPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3</td>
<td>Primary</td>
<td>1,089.00'</td>
<td>L=300.0' CPP, mitered to conform to fill, Ke=0.700</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inlet / Outlet Invert= 1,089.00&quot; / 1,085.00&quot;, S= 0.0133 &quot; Cc= 0.900</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.77 sf</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device</th>
<th>Routing</th>
<th>Invert</th>
<th>1.4&quot; Vert. ORIFICES X 2.00 columns</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4</td>
<td>Device 3</td>
<td>1,089.00'</td>
<td>X 5 rows with 12.0&quot; cc spacing C= 0.600</td>
</tr>
</tbody>
</table>

**Primary OutFlow** Max=1.16 cfs @ 19.59 hrs HW=1,096.26' (Free Discharge)

**Secondary OutFlow** Max=0.31 cfs @ 19.59 hrs HW=1,096.26' (Free Discharge)

**Tertiary OutFlow** Max=0.00 cfs @ 5.00 hrs HW=1,089.00' (Free Discharge)

---

**Pond 6P: SP-2**

- **Inflow Area=31.500 ac**  
- **Peak Elev=1,096.26'**  
- **Storage=254,911 cf**
Summary for Link 2L: EXISTING POND PRE

Inflow Area = 42.300 ac, 0.00% Impervious, Inflow Depth > 1.21" for 10-YR event
Inflow  = 57.05 cfs @ 12.17 hrs, Volume= 4.274 af
Primary = 57.05 cfs @ 12.17 hrs, Volume= 4.274 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs

Link 2L: EXISTING POND PRE

[Graph showing hydrograph with inflow and primary flow]
Summary for Link 7L: EXISTING POND POST

Inflow Area = 56.500 ac, 0.00% Impervious, Inflow Depth > 0.70" for 10-YR event
Inflow = 31.77 cfs @ 12.18 hrs, Volume= 3.312 af
Primary = 31.77 cfs @ 12.18 hrs, Volume= 3.312 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.01 hrs
Time of Concentration (SCS)

Project: SMT EAST
Location: EXISTING POND
Present

Curve Number : 75
Length of Flow : 1484.00 ft
Average Land Slope : 5.00 %

Time of Concentration : 0.377 hrs, 22.6 mins