Culvert Calculations Report

Ameresco Sturbridge Site Proposed Solar Array Sturbridge, MA

Official: June 4, 2018





Harrisburg, PA Prepared By: Craig A. Wilson, P.E. for Stephen M. Loss, P.E.



INTRODUCTION

The purpose of this submittal is to provide watershed and hydraulic calculations for two proposed culverts for the Ameresco – Sturbridge solar array site. The site is located between Charleton Road (MA Route 20) and Interstate 84 in Sturbridge, Massachusetts. The project will consist of the installation of a 36" CMP culvert and a 13'x3' concrete box culvert for two separate stream crossings.

Culv-1

Culv-1 is a proposed 36" CMP. At a 1.0% pipe slope the pipe has a carrying capacity of 26 cfs. The watershed for Culv-1, as calculated by Streamstats, has a 100-year surface runoff of 13.6 cfs. Therefore, the proposed culvert is adequate to carry the flow.

<u>SD-1</u>

SD-1 is a proposed 13'x3' concrete box culvert with a natural stream bottom. At a 0.5% slope, the culvert has a carrying capacity of 549 cfs. The watershed for SD-1, as calculated by StreamStats, has a 100-year surface runoff of 487 cfs. Therefore, the proposed culvert is adequate to carry the flow.

Culvert Calculations Ameresco - Sturbridge Sturgridge, MA



CULV-1 CALCULATIONS

StreamStats Report - Structure Culv 1



Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|----------------|---|--------|--------------|
| DRNAREA | Area that drains to a point on a stream | 0.0365 | square miles |
| ELEV | Mean Basin Elevation | 647 | feet |
| LC06STOR | Percentage of water bodies and wetlands determined from the NLCD 2006 | 15.34 | percent |

Peak-Flow Statistics Parameters [Peak Statewide 2016 5156] Parameter Code Parameter Name Value Units Min Limit Max Limit DRNAREA 0.0365 0.16 512 Drainage Area square miles ELEV Mean Basin Elevation 647 feet 80.6 1948 LC06STOR Percent Storage from NLCD2006 15.34 0 32.3 percent Peak-Flow Statistics Disclaimers [Peak Statewide 2016 5156] One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156] Statistic Value Unit 2 Year Peak Flood 2.64 ft^3/s 5 Year Peak Flood ft^3/s 4.67 10 Year Peak Flood 6.4 ft^3/s 25 Year Peak Flood 9 ft^3/s 50 Year Peak Flood 11.2 ft^3/s 100 Year Peak Flood ft^3/s 13.6 200 Year Peak Flood 16.3 ft^3/s 500 Year Peak Flood 20.2 ft^3/s

Peak-Flow Statistics Citations

| The open channel flow calculator | | | | | |
|----------------------------------|---------------------------|-----------------|------------------------------|-----------|--|
| Select Channel Type: Circle ✓ | FT | z1 Trapezoid | z1 z2 Iy | | |
| Velocity(V)&Discharge(Q) V | Select unit system: F | eet(ft) V | | | |
| Channel slope: .005 | Water depth(y): 2. | 99 ft | Radius (r) ft | 1.5 | |
| Flow velocity 3.7047 ft/s | LeftSlope (Z1): to 1 (H.' | | RightSlope (| Z2): | |
| Flow discharge 26.1785 ft^3/s | Input n value .024 | or select r | | | |
| Calculate! | Status: Calculation f | inished | Reset | | |
| Wetted perimeter 9.08 | Flow area 7.07 ft^2 | | Top width(T)0.35 ft | | |
| Specific energy 3.2 | Froude number 0.14 | | Flow status Subcritical flow | | |
| Critical depth 1.66 ft | Critical slope 0.015 | 51 ft/ft | Velocity hea | d 0.21 ft | |

Copyright 2000 Dr. Xing Fang, Department of Civil Engineering, Lamar University.

Culvert Calculations Ameresco - Sturbridge Sturgridge, MA



SD-1 CALCULATIONS





Basin Characteristics

| Parameter Code | Parameter Description | Value | Unit |
|----------------|---|-------|--------------|
| DRNAREA | Area that drains to a point on a stream | 4.14 | square miles |
| ELEV | Mean Basin Elevation | 687 | feet |
| LC06STOR | Percentage of water bodies and wetlands determined from the NLCD 2006 | 18.2 | percent |

| Peak-Flow Statistics Parameters [Peak Statewide 2016 5156] | | | | | |
|---|-------------------------------|-------|--------------|-----------|-----------|
| Parameter Code | Parameter Name | Value | Units | Min Limit | Max Limit |
| DRNAREA | Drainage Area | 4.14 | square miles | 0.16 | 512 |
| ELEV | Mean Basin Elevation | 687 | feet | 80.6 | 1948 |
| LC06STOR | Percent Storage from NLCD2006 | 18.2 | percent | 0 | 32.3 |
| Peak-Flow Statistics Flow Report [Peak Statewide 2016 5156] | | | | | |

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

| Statistic | Value | Unit | PII | Plu | SEp |
|---------------------|-------|--------|------|------|------|
| 2 Year Peak Flood | 110 | ft^3/s | 56 | 216 | 42.3 |
| 5 Year Peak Flood | 185 | ft^3/s | 92.6 | 368 | 43.4 |
| 10 Year Peak Flood | 245 | ft^3/s | 120 | 500 | 44.7 |
| 25 Year Peak Flood | 334 | ft^3/s | 158 | 705 | 47.1 |
| 50 Year Peak Flood | 408 | ft^3/s | 187 | 890 | 49.4 |
| 100 Year Peak Flood | 487 | ft^3/s | 216 | 1100 | 51.8 |
| 200 Year Peak Flood | 573 | ft^3/s | 247 | 1330 | 54.1 |
| 500 Year Peak Flood | 698 | ft^3/s | 287 | 1700 | 57.6 |

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

| The open channel flow calculator | | | | | |
|-------------------------------------|------------------------------|--------------|---------------------------------|--------|--|
| Select Channel Type: Rectangle ✓ | Feetangle | z2 pezoid | z1 z2 | | |
| Velocity(V)&Discharge(Q) 🗸 | elect unit system: Feet(ft) | \checkmark | | | |
| Channel slope: .005 ft/ft | Water depth(y): 2.99 | ft | Bottom W(b) ft | 13 | |
| Flow velocity 14.1211 ft/s | LeftSlope (Z1): 0 to 1 (H:' | | RightSlope (Z2): 0 to 1 (H:V | | |
| Flow discharge 548.8866 ft^3/s | Input n value 012 | or select r | | | |
| Calculate! | Status: Calculation finished | | Reset | | |
| Wetted perimeter 18.98 | Flow area 38.87 ft^2 | | Top width(T)13 ft | | |
| Specific energy 6.09 ft | Froude number 1.44 | | Flow status Supercritical flow | | |
| Critical depth 3.81 ft | Critical slope 0.0025 | ft/ft | Velocity head | 3.1 ft | |

Copyright 2000 Dr. Xing Fang, Department of Civil Engineering, Lamar University.