# Hydrologic and Hydraulic Analysis Report

## Blind Brook Watershed Study

### City of Rye, New York

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# 6.3 Cost Estimate for Detention Ponds at SUNY-Purchase

## 6.3.1 Introduction

The cost estimate for the two proposed detention ponds at SUNY-Purchase has been performed using the following procedure. 2011 LiDAR data with 1/9 arc resolution (10 feet) was downloaded for the proposed pond area from the USGS National Viewer Website. The vertical elevation of the LiDAR data was converted from meters to feet. By using the *Spatial Analyst* tool, 1-foot interval contour has been created at the location of the proposed ponds. For Pond 1 and Pond 2 on the site of SUNY-Purchase campus, Figure 37 shows the location of two ponds, the maximum inundation areas and the close vicinity areas in three dimensional (3D) view of ArcScene Program.

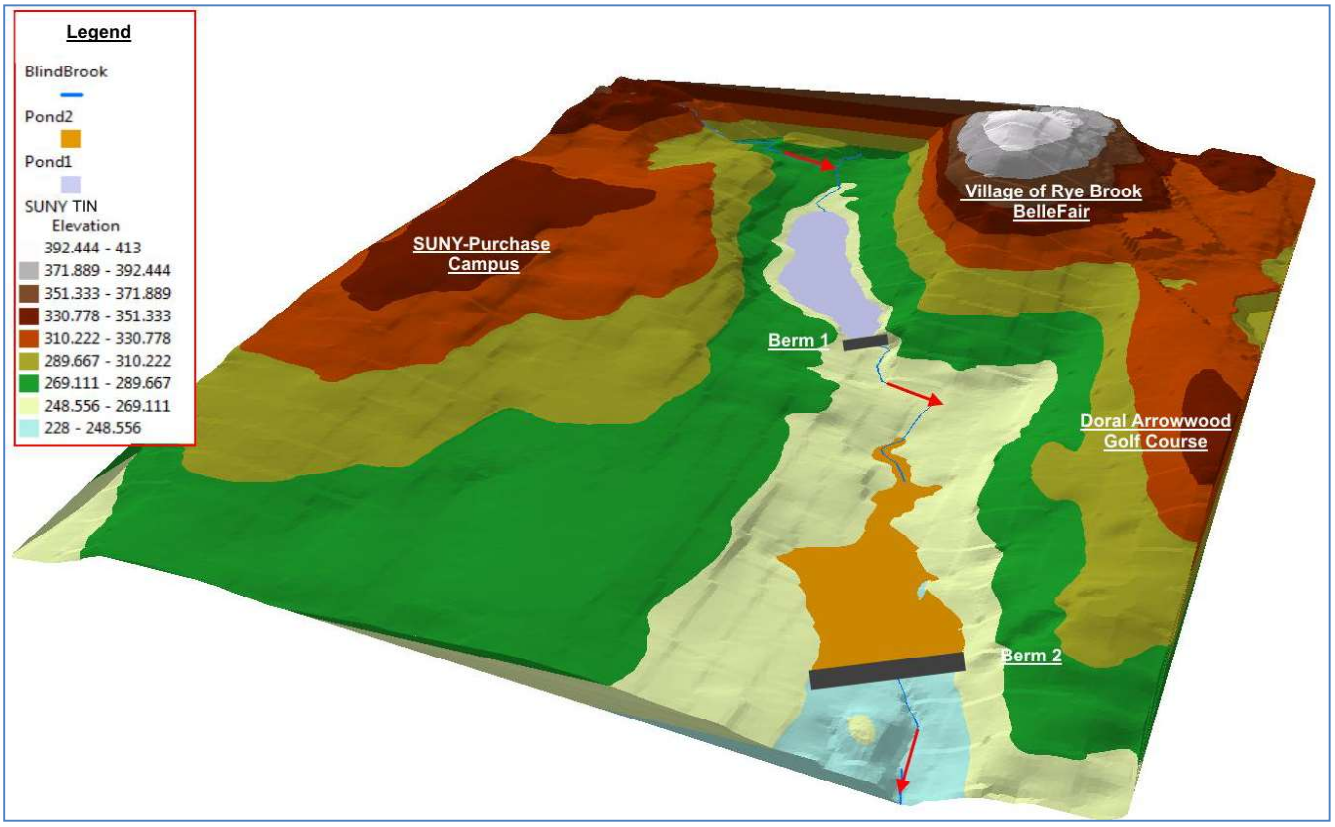


**Figure 37 - Location of Two Proposed Ponds in Vicinity of SUNY-Purchase**

Due the maximum height of the proposed earth berms for the two ponds, which are 8 feet (pond 1) and 13 feet (pond 2) respectively, Mechanically Stabilized Earth (MSE) Walls will be used to construct the berm. MSE Walls are cost-effective soil-retaining structures that can tolerate much larger settlements than reinforced concrete walls (NYSDOT Geotechnical Engineering Manual, Gem-16 Revision #2, 2007). By placing tensile reinforcing elements (inclusions) in the soil, the strength of the soil can be improved significantly such that the vertical face of the soil/reinforcement system is essentially self supporting. Use of a facing system to prevent soil raveling between the reinforcing

elements allows very steep slopes and vertical walls to be constructed safely. In some cases, the inclusions can also withstand bending from shear stresses, providing additional stability to the system.

MSE Walls offer significant technical and cost advantages over conventional reinforced concrete retaining structures at sites with poor foundation conditions. In such cases, the elimination of costs for foundation improvements such as piles and pile caps, that may be required to support of conventional structures, which result in cost savings of greater than 50 percent on completed projects. Some additional successful uses of MSE walls include:

- Temporary structures, which have been especially cost-effective for temporary detours necessary for highway reconstruction projects.
- Reinforced soil dikes, which have been used for containment structures for water and waste impoundments around oil and liquid natural gas storage tanks. (The use of reinforced soil containment dikes is economical and can also result in savings of land because a vertical face can be used, which reduces construction time). This is used for present study.
- Dams and seawalls, including increasing the height of existing dams.
- Bulk materials storage using sloped walls.

Detailed information such as maximum wall height, wall length, maximum inundation area, maximum pond storage volumes of proposed Pond 1 and Pond 2 on the SUNY property are listed in Table 36 below. As it should be noted, both ponds will be dry ponds under normal base flow condition. Pond will only store water for storm events greater than 2-years.

**Table 36 - Detailed Information about Pond 1 and 2 on SUNY-Purchase**

| | Wall Features | | Pond Features | | | |
|---|---|---|---|---|---|---|
| | Wall Length (feet) | Maximum Wall Height (feet) | Lowest Ground Elevation in Pond (feet) | Maximum Water Surface Elevation in Pond (feet) | Maximum Inundation Area (acre) | Maximum Pond Storage (acre-feet) |
| Pond 1 | 280 | 8 | 258 | 266 | 15.50 | 53.18 |
| Pond 2 | 820 | 13 | 236 | 249 | 15.07 | 65.62 |

### 6.3.2 Construction Cost Estimate of Pond 1

Pond 1 will be constructed at an upstream location in close vicinity to the SUNY-Purchase campus. The location of the MSE wall and the maximum inundation area are shown in the Figure 38. As it can be seen from this figure, Pond 1 is located in between SUNY-Purchase and Village of Rye Brook - BelleFair. On the west side of the maximum inundation boundary of the pond, there is a support facility which houses central air conditioner fan units for an office complex, this facility requires flood protection from the inundation. A 3 foot high, 300 foot long proposed flood wall will be constructed to protect the facility.

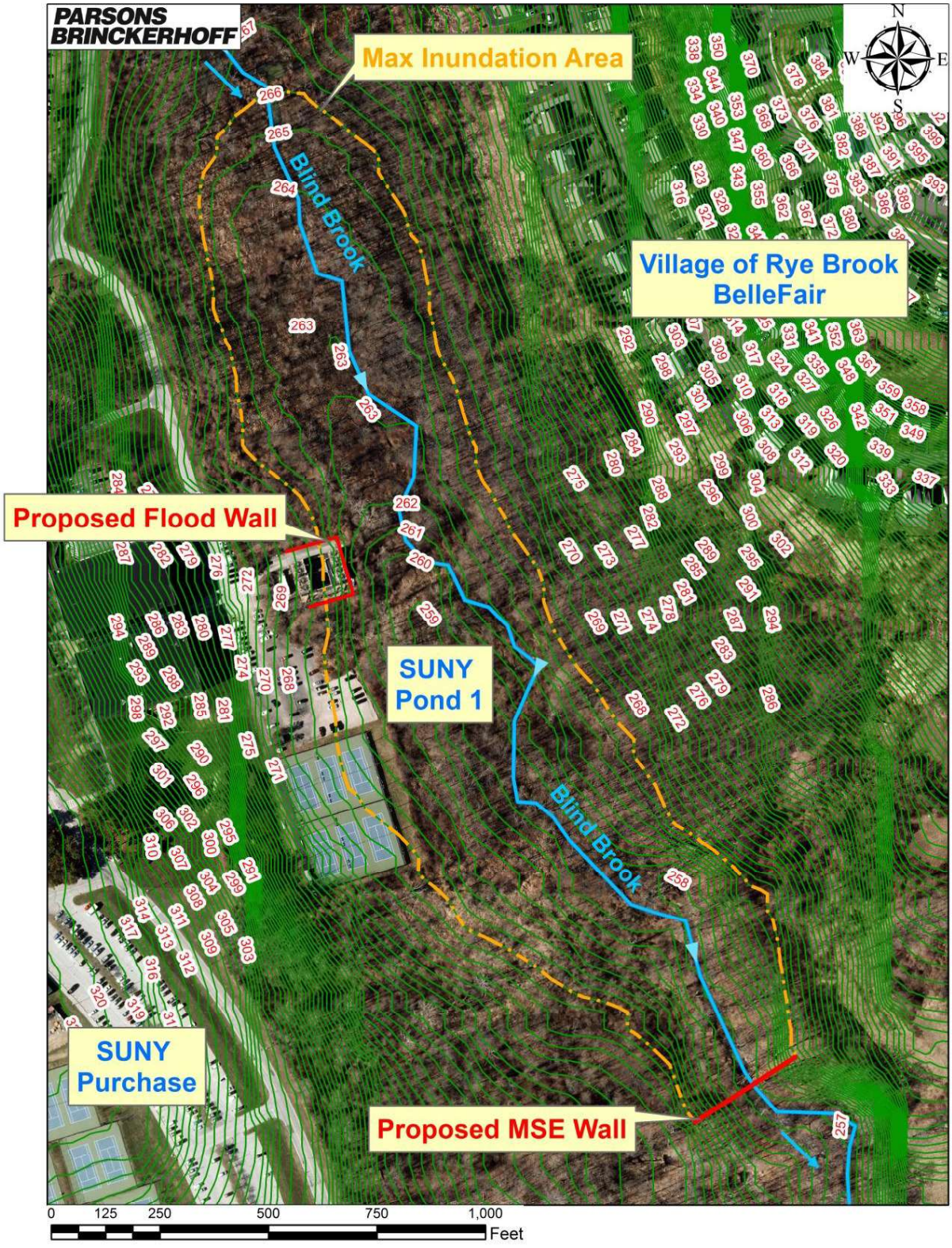


**Figure 38 - Proposed Detention Pond 1 (Upstream) in SUNY-Purchase**

Using the conic volume computational method, the elevation area and storage volume table for Pond 1 was developed and is provided in Table 37, as well as the graphical representation in Figure 39.

**Table 37 - Elevation-Area-Volume Computation for SUNY Pond 1**

| Elevation | Area | ΔV | Total Volume |
|---|---|---|---|
| (ft) | (acre) | (ac-ft) | (ac-ft) |
| 258 | 0.31 | 0.00 | 0.00 |
| 259 | 1.76 | 0.94 | 0.94 |
| 260 | 3.05 | 2.38 | 3.31 |
| 261 | 4.21 | 3.62 | 6.93 |
| 262 | 5.47 | 4.83 | 11.76 |
| 263 | 7.25 | 6.34 | 18.10 |
| 264 | 10.63 | 8.89 | 26.98 |
| 265 | 13.17 | 11.88 | 38.86 |
| 266 | 15.50 | 14.32 | 53.18 |

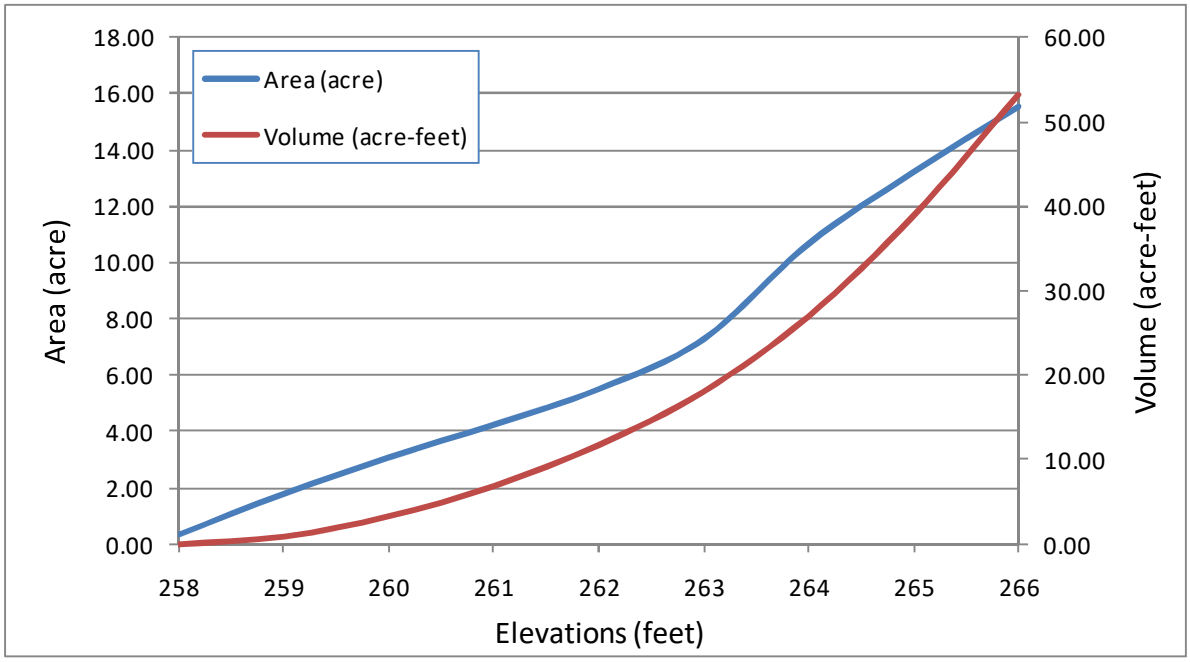


**Figure 39 - Elevation-Area & Elevation-Storage Curves for Proposed Detention Pond 1**

It should be noted that the height of the MSE Wall is not a constant. The height of the wall will gradually decrease from 8 feet in the vicinity of the main channel to zero on the outer edge of the floodplain. By assuming a 1:1 side slope of the MSE Wall, the face area can be computed based on the cross section plot of the ground surface and the top of the wall elevation of 266 feet. The front surface area of the wall is computed to be 2,084 square feet, or 193.71 square meters. In close vicinity to the main channel, there will be a

3 feet high by 20 feet wide opening in the wall to allow the low flow of Blind Brook to pass downstream.

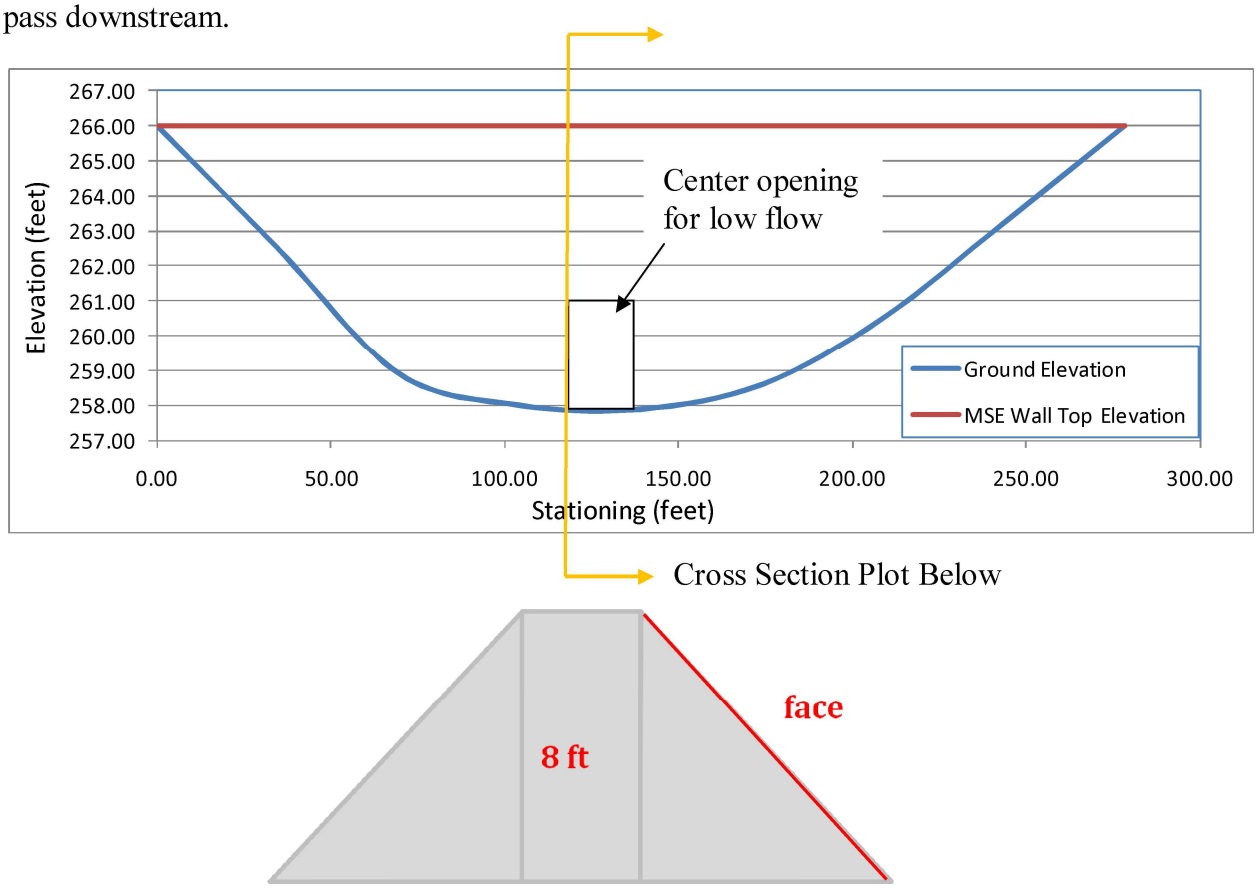


**Figure 40 - Face View of the MSE Wall and Cross Section of Proposed Detention Pond 1**

**Table 38 - Computation of the Face Area of MSE Wall of Pond 1**

| X | $Z_{ground}$ | $Z_{wall}$ | ΔArea | Face Area |
|---|---|---|---|---|
| ft | ft | ft | $ft^2$ | $ft^2$ |
| 0.00 | 266.00 | 266 | 0.00 | 0 |
| 34.81 | 262.49 | 266 | 86.42 | 86 |
| 69.62 | 258.92 | 266 | 260.76 | 347 |
| 104.43 | 258.01 | 266 | 371.07 | 718 |
| 139.24 | 257.90 | 266 | 396.18 | 1,114 |
| 174.05 | 258.60 | 266 | 381.57 | 1,496 |
| 208.87 | 260.51 | 266 | 317.14 | 1,813 |
| 243.68 | 263.24 | 266 | 203.01 | 2,016 |
| 278.49 | 266.00 | 266 | 67.90 | 2,084 |

In NYSDOT's Geotechnical Manual (2007), site specific costs of a MSE Wall is a function of many factors, including cut-fill requirements, wall/slope size and type, in-situ soil type, available backfill materials, facing finish, and if the wall is a temporary or a permanent application. It has been found that MSE Walls with precast concrete facings are usually less expensive than reinforced concrete retaining walls for heights greater than about 3 m (10 ft) and average foundation conditions. Modular Block Walls (MBW) is competitive with concrete walls at heights of less than 4.5 m (15 ft).

In general, the use of MSE walls results in savings on the order of 25 to 50 percent and possibly more in comparison with a conventional reinforced concrete retaining structure, especially when the latter is supported on a deep foundation system (poor foundation condition). A substantial savings is obtained by the elimination of the deep foundations, which is usually possible because reinforced soil structures can accommodate relatively large amounts of total and differential settlements. Other cost saving features included ease and speed of construction. A comparison of wall material and erection costs for several reinforced soil retaining walls and other retaining wall systems, based on a survey of state and federal transportation agencies, is shown in Figure 41. Typical total costs for MSE Walls range from $200 to $400 per square meters, or $19 to $37 per square feet of face area, generally as function of height, size of project and cost of select fill.

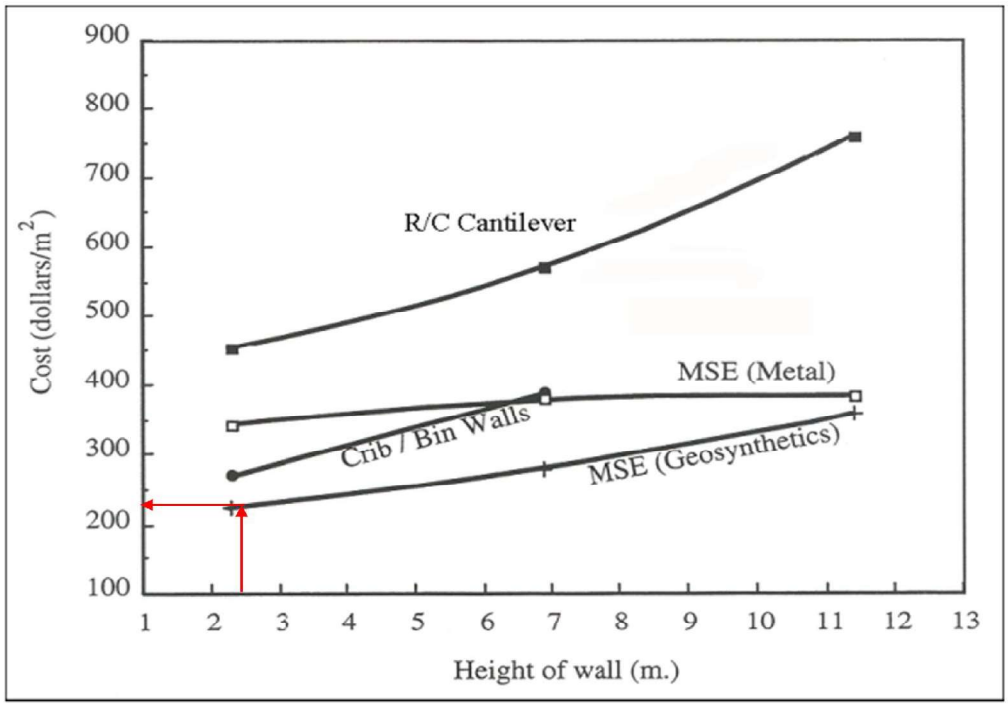


**Figure 41 - Cost Estimate Based on Height of MSE Wall for Pond 1**

From the figure above, the unit cost based on the height of the wall is 235 dollars per square meters, or 22 dollars per square feet. The cost of constructing the MSE wall will be: $22 / $ft^2$ x 2,084 $ft^2$ = $45,848. The total cost was computed in the following table. The total cost for constructing detention Pond 1 would be approximately $143,000.

**Table 39 - Cost Estimate for Detention Pond 1 in SUNY-Purchase**

| Item | Description | Unit | Quantity | Unit Cost | Cost |
|---|---|---|---|---|---|
| 1 | Mobilization | LS | 1 | 10,000 | 10,000 |
| 2 | Clearing and Grubbing | AC | 0.5 | 7,800 | 3,900 |
| 3 | MSE Wall | LS | 1 | 45,848 | 45,848 |
| 4 | Soil Erosion and Sediment Control | LS | 1 | 20,000 | 20,000 |
| 5 | Flood Wall | SF | 900 | 44 | 39,285 |
| | | | | Total | 119,033 |
| | | | | Contingencey 20% | 23,807 |
| | | | | **Total** | **142,840** |

### 6.3.3 Construction Cost Estimate of Pond 2

Pond 2 will be constructed approximately 0.76 mile downstream of Pond 1 on the main stem of Blind Brook. The location of the MSE Wall and the maximum inundation area is shown in the Figure 42. As it can be seen from the figure, Pond 2 is located in between SUNY-Purchase and Doral Arrowwood Golf Course, in the Village of Rye Brook. The main channel of Blind Brook is also the property boundary line for the two properties mentioned above.

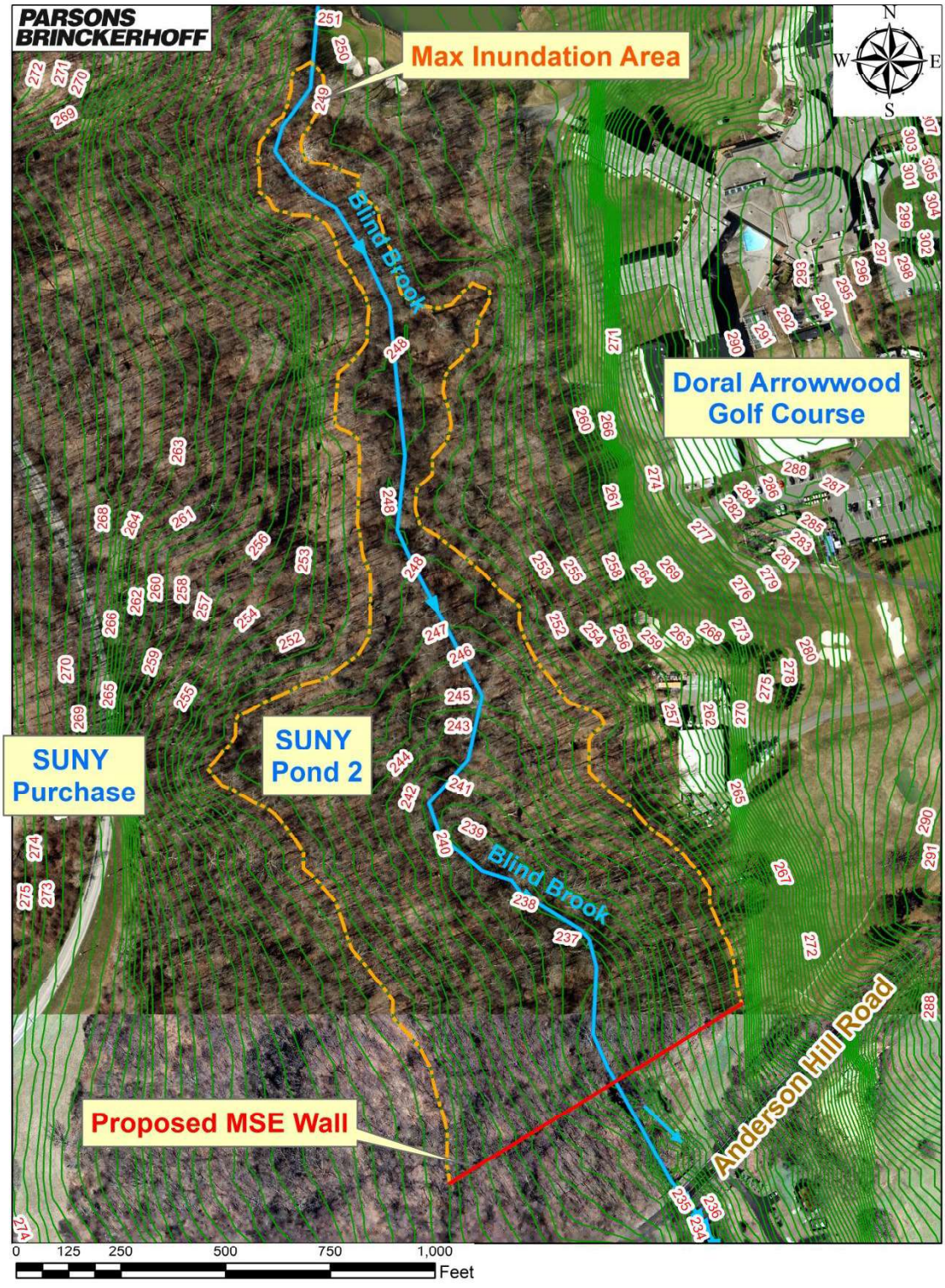


**Figure 42 - Proposed Detention Pond 2 (Downstream) in SUNY-Purchase**

Using the conic volume computational method, the elevation area and storage table for Detention Pond 2 was developed and provided in Table 40 below, as well as the graphical representation in Figure 43.

**Table 40 - Elevation-Area-Volume Computation for SUNY Pond 2**

| Elevation | Area | ΔV | Total Volume |
|---|---|---|---|
| (ft) | (acre) | (ac-ft) | (ac-ft) |
| 236 | 0.20 | 0.00 | 0.00 |
| 237 | 0.56 | 0.36 | 0.36 |
| 238 | 0.94 | 0.74 | 1.11 |
| 239 | 1.61 | 1.26 | 2.36 |
| 240 | 2.28 | 1.93 | 4.30 |
| 241 | 2.97 | 2.62 | 6.92 |
| 242 | 3.73 | 3.34 | 10.26 |
| 243 | 4.59 | 4.15 | 14.41 |
| 244 | 5.49 | 5.03 | 19.44 |
| 245 | 6.49 | 5.98 | 25.42 |
| 246 | 7.75 | 7.11 | 32.53 |
| 247 | 9.05 | 8.39 | 40.92 |
| 248 | 12.70 | 10.83 | 51.75 |
| 249 | 15.07 | 13.87 | 65.62 |

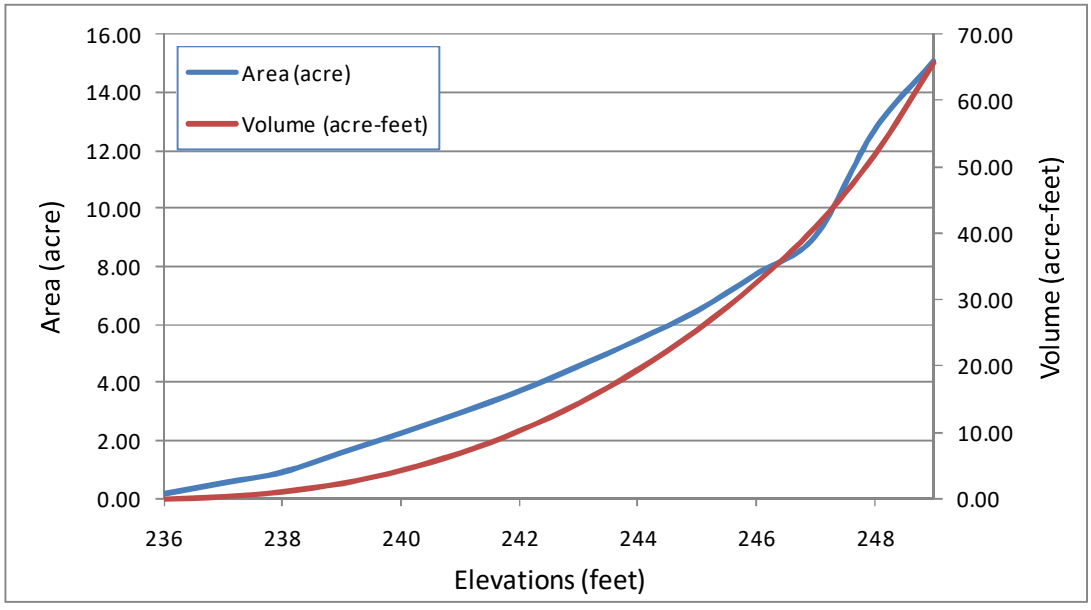


**Figure 43 - Elevation-Area and Elevation-Storage Curves for Proposed Detention Pond 2**

It should be noted that the height of the MSE Wall is not a constant. The height of the wall will gradually decrease from 13 feet in close vicinity of the main channel to zero on the outer edge of the floodplain. At station 410 feet measured from the center line of the main channel, the wall will taper into the existing ground.

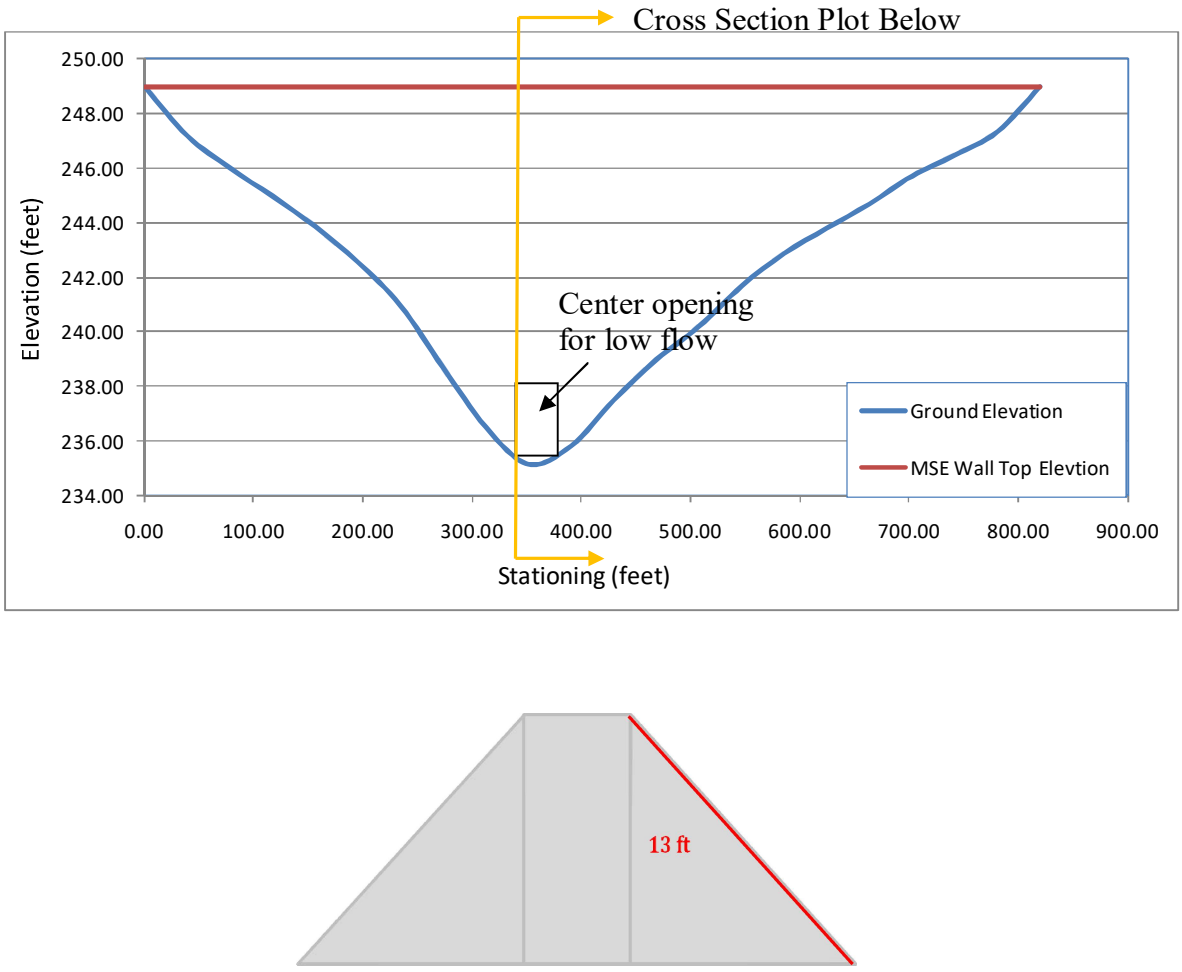


**Figure 44 - Face View of the MSE Wall & Cross Section of Proposed Detention Pond 2**

By assuming a 1:1 side slope of the MSE wall, the face area of wall is computed based on the cross section plot and the top of the wall elevation of 249 feet. The front surface area of the wall was computed to be 7,683 square feet, or 714 square meters. In close vicinity to the main channel, there will be a 3 feet high by 20 feet wide opening in the wall to allow the low flow of Blind Brook to pass downstream.

**Table 41 - Computation of the Face Area of MSE Wall of Pond 2**

| X | $Z_{ground}$ | $Z_{wall}$ | ΔArea | Face Area |
|---|---|---|---|---|
| ft | ft | ft | $ft^2$ | $ft^2$ |
| 0.00 | 249.00 | 249 | 0.00 | 0 |
| 39.04 | 247.20 | 249 | 49.81 | 50 |
| 78.08 | 246.01 | 249 | 132.22 | 182 |
| 117.12 | 244.98 | 249 | 193.37 | 375 |
| 156.16 | 243.86 | 249 | 252.94 | 628 |
| 195.20 | 242.56 | 249 | 319.81 | 948 |
| 234.24 | 240.95 | 249 | 399.97 | 1,348 |
| 273.28 | 238.68 | 249 | 507.14 | 1,855 |
| 312.32 | 236.49 | 249 | 630.23 | 2,485 |
| 351.36 | 235.12 | 249 | 728.30 | 3,214 |
| 390.40 | 235.80 | 249 | 747.51 | 3,961 |
| 429.44 | 237.47 | 249 | 682.70 | 4,644 |
| 468.48 | 238.96 | 249 | 595.35 | 5,239 |
| 507.52 | 240.18 | 249 | 520.49 | 5,760 |
| 546.56 | 241.67 | 249 | 445.81 | 6,206 |
| 585.60 | 242.88 | 249 | 371.44 | 6,577 |
| 624.63 | 243.80 | 249 | 312.57 | 6,890 |
| 663.67 | 244.69 | 249 | 262.49 | 7,152 |
| 702.71 | 245.72 | 249 | 209.48 | 7,362 |
| 741.75 | 246.48 | 249 | 160.14 | 7,522 |
| 780.79 | 247.35 | 249 | 115.29 | 7,637 |
| 819.83 | 249.00 | 249 | 45.69 | 7,683 |

Based on NYSDOT Geotechnical Manual (2007), from the same figure used to complete the cost of Pond 1, the unit cost of Pond 2 with 13 feet wall height is 250 dollars per square meters, or 23 dollars per square feet. The cost of constructing the MSE Wall will be: \$23 / $ft^2$ x 7,683 $ft^2$ = \$178,508. The total cost was computed in the following table. The total cost for constructing detention Pond 2 would be approximately \$368,000.

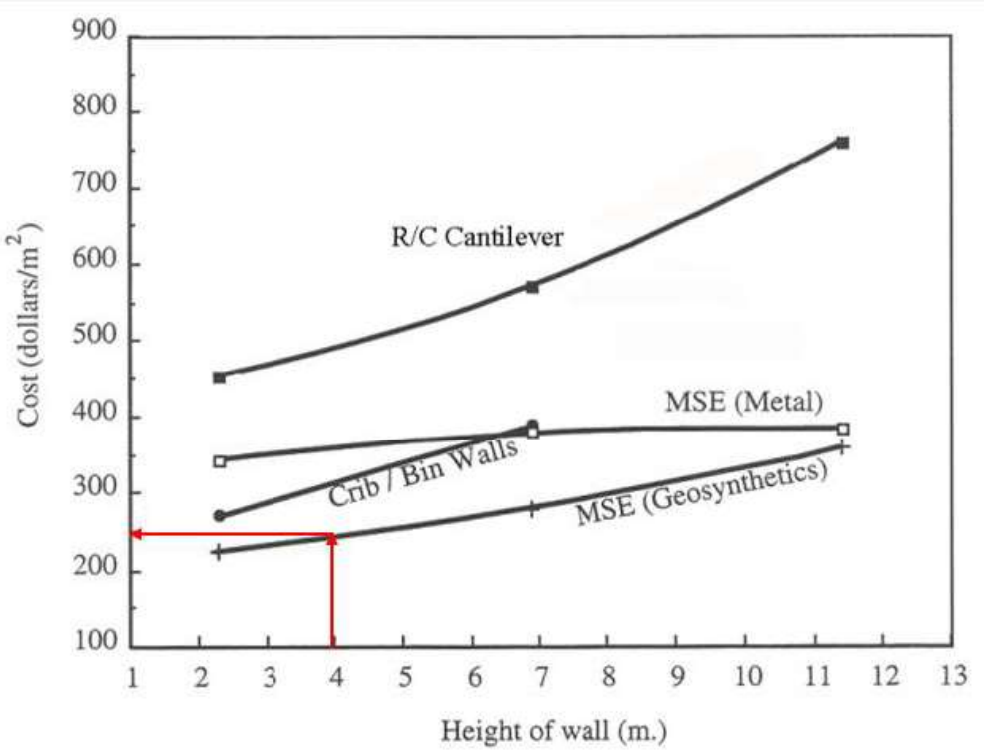


**Figure 45 - Cost Estimate Based on Height of MSE Wall of Pond 2**

**Table 42 - Cost Estimate for Pond 2 in SUNY-Purchase**

| Item | Description | Unit | Quantity | Unit Cost | Cost |
|---|---|---|---|---|---|
| 1 | Mobilization | LS | 1 | 40,000 | 40,000 |
| 2 | Clearing and Grubbing | AC | 1 | 7,800 | 7,800 |
| 3 | MSE Wall | LS | 1 | 178,508 | 178,508 |
| 4 | Soil Erosion and Sediment Control | LS | 1 | 80,000 | 80,000 |
| | | | | Total | 306,308 |
| | | | | Contingencey 20% | 61,262 |
| | | | | **Total** | **367,570** |

### 6.3.4 Construction Cost Summary for SUNY-Purchase Ponds

By using the *Weighted Average Item Price Report By Item Region and Quarter (US Customary Contract Let, July 2012 – June 2013)* from the Office of Engineering, Design Quality Assurance Bureau, New York State Department of Transportation (NYSDOT) website, the total cost for constructing the two detention ponds on the SUNY-Purchase will be approximately $143,000 + $368,000 = $511,000. The major construction work includes building two MSE Walls with maximum height ranging from 8 feet to 13 feet, and the length of 280 feet and 820 feet respectively. For Pond 1, construction of the 300 ft long, 3 ft high flood wall along the a support facility located on the SUNY Purchase campus is needed to protect the property from being flood during larger storm events.

## 6.4 Summary Table of Cost and Water Surface Elevation Reduction

Based on the hydraulic analysis in the previous chapters and the cost estimate in this chapter, the cost and water surface elevation reduction comparison table is listed below. The water surface elevation reduction refers to the comparison between proposed improvements of the ponds vs. the existing condition with gate and gauge at the dam, but assume no operation of the gate (gate is closed). Additional water surface elevation reductions would be realized if relocation of the gauge at Bowman Avenue Dam is considered. No cost estimate has been developed for this alternative yet.

**Table 43 - Cost and Water Surface Elevation Reductions of Two Proposed Options**

| Return Periods | Locations | SUNY Detention Ponds | | Resize Upper Pond | |
|---|---|---|---|---|---|
| | | Cost | Water Surface Elevation Reduction | Cost | Water Surface Elevation Reduction |
| 2-Year Storm | D/S I-287 | 0.51 Million Dollars | -0.10 | 6.1 ~ 6.6 Million Dollars | -0.14 |
| | Purchase St | | -0.09 | | -0.14 |
| | Mendota Avenue | | -0.09 | | -0.13 |
| | Highland Road | | -0.09 | | -0.13 |
| | U/S I-95 | | -0.07 | | -0.10 |
| 10-Year Storm | D/S I-287 | | -0.91 | | -0.47 |
| | Purchase St | | -1.60 | | -0.80 |
| | Mendota Avenue | | -1.36 | | -0.74 |
| | Highland Road | | -1.40 | | -0.75 |
| | U/S I-95 | | -1.70 | | -1.00 |
| 50-Year Storm | D/S I-287 | | -0.52 | | -0.33 |
| | Purchase St | | -0.90 | | -0.64 |
| | Mendota Avenue | | -1.42 | | -1.23 |
| | Highland Road | | -1.43 | | -1.23 |
| | U/S I-95 | | -1.51 | | -1.30 |
| 100-Year Storm | D/S I-287 | | -0.36 | | -0.10 |
| | Purchase St | | -0.72 | | -0.32 |
| | Mendota Avenue | | -1.22 | | -0.60 |
| | Highland Road | | -1.22 | | -0.60 |
| | U/S I-95 | | -1.31 | | -0.63 |