NYRCR
City of Middletown
Preliminary Project Analysis

October 7, 2014
1. Culvert and Streambed Improvement

Academy Ave and Genung St.

- Piers Removal
- Remove Sediments
- Re-channelization

- Monhagen Brook
- Draper Brook

- Underground (Culvert)
- Daylight (Open Channel)
1. Culvert and Streambed Improvement Academy Ave and Genung St.

Actions

• Remove piers near the Monhagen/Draper Brooks junction
• Remove sediments and debris along the culvert
• Re-channelization of Monhagen Brook off of Genung St.

Preliminary Results

• Limited impacts/benefits downstream in terms of reduced WSE and floodplain extent
1. Culvert and Streambed Improvement Academy St. to south Genung St.

Sensitivity Analysis

• Increase the capacity of the culvert entrance on Fulton St.
  – Evaluate reduction of overland flow between Academy Ave and Genung St.

Preliminary Results

• Minimal change in overland flow
• No apparent impacts/benefits in terms of reduced WSE and floodplain extent
1. Culvert and Streambed Improvement
Exist Genung St. Culvert (Cross Section)

Monhagen_DUP Plan: 1) Existing 2) Improved Channel
RS = 6738

Legend
- WS 100-yr - Existing
- WS 100-yr - Improved Channel
- WS 2-yr - Existing
- WS 2-yr - Improved Channel
- Ground
- Bank Sta

- Reduced Manning’s n (i.e., lower resistance to flow)
- $\Delta WSE_{100-yr} \approx 0'$
- $\Delta WSE_{2-yr} = -1.5'$
- Proposed re-channelization
1. Culvert and Streambed Improvement (Water Profile)

Monhagen_DUP
Plan: 1) Improved Channel 2) Existing

Legend

<table>
<thead>
<tr>
<th>Legend Description</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>WS 100-yr - Improved Channel</td>
<td>Blue</td>
</tr>
<tr>
<td>WS 100-yr - Existing</td>
<td>Pink</td>
</tr>
<tr>
<td>WS 2-yr - Existing</td>
<td>Blue</td>
</tr>
<tr>
<td>WS 2-yr - Improved Channel</td>
<td>Pink</td>
</tr>
<tr>
<td>Ground</td>
<td>Pink</td>
</tr>
</tbody>
</table>

\[ \Delta WSE_{100-yr} \approx 0' \]

\[ \Delta WSE_{2-yr} = -1.5' \]
1. Culvert and Streambed Improvement Academy St. to south Genung St.

<table>
<thead>
<tr>
<th>Fulton St. Culvert Capacity Increase</th>
<th>2-year</th>
<th>10-year</th>
<th>25-year</th>
<th>50-year</th>
<th>100-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 % (Current)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>+ 10%</td>
<td>0.01</td>
<td>0.05</td>
<td>0.02</td>
<td>0.07</td>
<td>0.03</td>
</tr>
<tr>
<td>+ 20%</td>
<td>0.02</td>
<td>0.11</td>
<td>0.05</td>
<td>0.16</td>
<td>0.06</td>
</tr>
<tr>
<td>+ 50%</td>
<td>0.06</td>
<td>0.32</td>
<td>0.11</td>
<td>0.33</td>
<td>0.14</td>
</tr>
<tr>
<td>+ 75%</td>
<td>0.09</td>
<td>0.43</td>
<td>0.17</td>
<td>0.46</td>
<td>0.21</td>
</tr>
</tbody>
</table>
2. Culvert Evaluation
W Main St. and Monhagen Ave
2a. Culvert Evaluation
20’x8’ Concrete Box

**Actions**

- Increase culvert capacity to improve conveyance and avoid flooding upstream
  – A 20’x8’ concrete box is analyzed
- Dredging and channel improvement to accommodate the new structure

**Preliminary Results**

- Limited impacts/benefits in terms of reduced WSE and floodplain extent
2a. Culvert Evaluation
20’x8’ Concrete Box (Cross Section)
2a. Culvert Evaluation

20’x8’ Concrete Box (Cross Section)

Monhagen_DUP    Plan: Monhagen_Natural_DUP_culvert#1_20x8
RS = 11921    Culv Culvert #1 (Monhagen Ave, Parking Lot)

Station (ft)

Elevation (ft)

Legend
WS 100-yr
WS 2-yr
Ground
Ineff
Bank Sta

Reduced Manning’s n (i.e., lower resistance to flow)

(After)
2a. Culvert Evaluation
20’x8’ Concrete Box (Water Profile)

$\Delta WSE_{100\text{-yr}} = -0.8'$

$\Delta WSE_{2\text{-yr}} = -1.6'$
2b. Culvert Evaluation
Channel Bank Hardening

Actions

• Cover streambed and banks with smoother materials (e.g., concrete) to improve conveyance

Preliminary Results

• Positive impacts/benefits upstream in terms of reduced WSE and floodplain extent
  – Limited to approx. 350 ft upstream of the culvert
2b. Culvert Evaluation
Channel Bank Hardening (Cross Section)
2b. Culvert Evaluation
Channel Bank Hardening (Cross Section)

Reduced Manning’s n (i.e., lower resistance to flow)

Max $\Delta WSE_{100-yr} = -2.5'$
2b. Culvert Evaluation
Channel Bank Hardening (Water Profile)

Max $\Delta WSE_{100-yr} = -2.5'$
3. NJ Railroad Bridge Evaluation

**Actions**

- Widen the bridge opening to increase conveyance

**Preliminary Results**

- Significant impacts/benefits upstream in terms of reduced WSE and floodplain extent
3. NJ Railroad Bridge Evaluation (Cross Section)
3. NJ Railroad Bridge Evaluation (Cross Section)
3. NJ Railroad Bridge Evaluation (Water Profile)

\[ \Delta WSE_{100-yr} = -5' \]
3. NJ Railroad Bridge Evaluation (100-year Floodplain)
4. Maple Hill Park – Retention Area

Actions
• Draw down the WSE in existing pond prior to a storm event
  – Evaluate potential runoff volume storage
  – Investigate impacts/benefits downstream in terms of peak flow reduction

Preliminary Results
• Current storage is insufficient for capturing a 2-year (or larger) storm event
  – Maximum storage = 20% of 2-year Runoff Volume
• No apparent benefits/impacts in terms of peak flow reduction
4. Maple Hill Park – Retention Area
## 4. Maple Hill Park – Retention Area

<table>
<thead>
<tr>
<th></th>
<th>Drainage Area $^a$</th>
<th>(acres)</th>
<th>307</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Surface Area $^a$</td>
<td>(acres)</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Average Depth $^a$</td>
<td>(ft)</td>
<td>6</td>
</tr>
<tr>
<td><strong>Storage Volume</strong></td>
<td>($=\text{Area} \times \text{Depth}$)</td>
<td>(acre-ft)</td>
<td>5.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2-year</th>
<th>10-year</th>
<th>25-year</th>
<th>50-year</th>
<th>100-year</th>
<th>500-year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Peak Inflow</strong> $^b$</td>
<td>(cfs)</td>
<td>12.2</td>
<td>28.2</td>
<td>39.6</td>
<td>49.8</td>
<td>61.6</td>
</tr>
<tr>
<td><strong>24-hr Rainfall</strong> $^c$</td>
<td>(in)</td>
<td>3.5</td>
<td>5.5</td>
<td>5.8</td>
<td>6</td>
<td>7.5</td>
</tr>
<tr>
<td><strong>Runoff Depth</strong> $^c$</td>
<td>(in)</td>
<td>1</td>
<td>2.5</td>
<td>2.6</td>
<td>2.8</td>
<td>4</td>
</tr>
<tr>
<td><strong>Runoff Volume</strong> ($=\text{Drain. Area} \times \text{Depth}$)</td>
<td>(acre-ft)</td>
<td>25.6</td>
<td>64</td>
<td>66.5</td>
<td>71.6</td>
<td>102.3</td>
</tr>
</tbody>
</table>

$^a$ Estimated by using GIS  
$^b$ Source: USGS Streamstats  
$^c$ Source: USDA Urban Hydrology for Small Watersheds, TR-55
Flood Storage – Maple Hill Park Pond

Maximum Storage (Pond is empty prior the storm)
4. Maple Hill Park – Retention Area

Source: “Urban Hydrology for Small Watersheds, TR-55” United States Department of Agriculture

2-year Storm

<table>
<thead>
<tr>
<th>Storage Volume $V_s$ (acre-ft)</th>
<th>Runoff Volume $V_r$ (acre-ft)</th>
<th>$V_s/V_r$</th>
<th>Peak Inflow $q_i$ (cfs)</th>
<th>Peak Outflow $q_o$ (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>141</td>
<td>0.2</td>
<td>12.2</td>
<td>9</td>
</tr>
</tbody>
</table>
5. Fancher Davidge Park Retention Area

Actions
• Create a flood retention area north of Fancher Davidge Park
  – Evaluate potential runoff volume storage
  – Investigate impacts/benefits downstream in terms of peak flow reduction

Preliminary Results
• Current storage is sufficient for capturing a 100-year storm event
  – Storage Volume > 100-year Runoff Volume
• Positive impacts in terms of peak flow reduction
5. Fancher Davidge Park Retention Area
5. Fancher Davidge Park Retention Area

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Area</td>
<td>(acres)</td>
<td>704</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Area</td>
<td>(acres)</td>
<td>46.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Depth</td>
<td>(ft)</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Volume</td>
<td>(acre-ft)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>277.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2-year</th>
<th>10-year</th>
<th>25-year</th>
<th>50-year</th>
<th>100-year</th>
<th>500-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Inflow</td>
<td>(cfs)</td>
<td>24.1</td>
<td>55.1</td>
<td>77.4</td>
<td>97.4</td>
<td>120</td>
</tr>
<tr>
<td>24-hr Rainfall</td>
<td>(in)</td>
<td>3.5</td>
<td>5.5</td>
<td>5.75</td>
<td>6.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Runoff Depth</td>
<td>(in)</td>
<td>1.0</td>
<td>2.5</td>
<td>2.6</td>
<td>2.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Runoff Volume</td>
<td>(acre-ft)</td>
<td>58.7</td>
<td>146.7</td>
<td>152.5</td>
<td>164.3</td>
<td>234.7</td>
</tr>
</tbody>
</table>

*a Estimated by using GIS
*b Source: USGS Streamstats
*c Source: USDA Urban Hydrology for Small Watersheds, TR-55
5. Fancher Davidge Park Retention Area

Source: “Urban Hydrology for Small Watersheds, TR-55” United States Department of Agriculture

<table>
<thead>
<tr>
<th>500-year Storm</th>
<th>Storage Volume $V_s$ (acre-ft)</th>
<th>Runoff Volume $V_r$ (acre-ft)</th>
<th>$V_s/V_r$</th>
<th>Peak Inflow $q_i$ (cfs)</th>
<th>Peak Outflow $q_o$ (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>277.8</td>
<td>234.7</td>
<td>1.18</td>
<td>120</td>
<td>~ 0</td>
</tr>
</tbody>
</table>
6. Brewster Drive Emergency Road

Actions
• Evaluate the capacity of the culvert at the emergency road crossing to Brewster Drive
  – Determine whether structure size or channel should be modified to improve local flooding

Preliminary Results
• Culvert conveys a 100-year (or smaller) storm
  – 100-year flow appears close to capacity
  – Several hydraulic assumptions made
    ▪ More detailed assessment recommended
6. Brewster Drive Emergency Road
6. Brewster Drive Emergency Road

**100-yr Storm Event**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Peak Flow ($Q_{p100}$)</td>
<td>201 ft³/s</td>
</tr>
<tr>
<td>Max. Design Flow ($Q_d$)</td>
<td>215.7 ft³/s</td>
</tr>
</tbody>
</table>

- $Q_{p100} < Q_{d100}$: **YES**

**Box culvert can convey peak flow**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of Discharge to Width</td>
<td>22.3 ft³/ft</td>
</tr>
<tr>
<td>Inlet control head loss ($H_e$)</td>
<td>0.1 ft</td>
</tr>
<tr>
<td>HW/Rise</td>
<td>1.0</td>
</tr>
<tr>
<td>Upstream Water Depth ($HW_{100}$)</td>
<td>3.8 ft</td>
</tr>
<tr>
<td>Allowable HW ($HW_a$)</td>
<td>4 ft</td>
</tr>
</tbody>
</table>

- $HW_{100} < HW_a$: **YES**

**Upstream water is below culvert rise**

**Culvert Max. Design Flow (100-year)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-Sectional Area</td>
<td>36 ft²</td>
</tr>
<tr>
<td>Wetted Perimeter</td>
<td>26 ft</td>
</tr>
<tr>
<td>Hydraulic Radius</td>
<td>1.4 ft</td>
</tr>
<tr>
<td>Max. Design Flow ($Q_d$)</td>
<td>215.7 ft³/s</td>
</tr>
</tbody>
</table>

**Span ≈ 9’**

**Length ≈ 10’**

**Rise ≈ 4’**

**Headwater Depth for Concrete Box Culverts With Inlet Control**

- **Span ≈ 9’**
- **Rise ≈ 4’**
7. Channel Improvement South of W Main St.

**Actions**

- Remove sediments and debris along the streambed
- Re-channelization of Monhagen Brook
  - Creation of a bench along the right overbank

**Preliminary Results**

- Limited impacts/benefits upstream in terms of reduced WSE and floodplain extent
  - Limited to the area just downstream of the W Main St. Bridge
7. Channel Improvement South of W Main St.
7. Channel Improvement South of W Main St. Proposed Re-channelization (Cross Section)
7. Channel Improvement South of W Main St. Proposed Re-channelization (Cross Section)

Reduced Manning’s n (i.e., lower resistance to flow)

(After)
7. Channel Improvement South of W Main St. Downstream of Bridge (Cross Section)

\[ \Delta WSE_{100-yr} = -2.1' \]
7. Channel Improvement South of W Main St. (Water Profile)

ΔWSE_{2-yr} = -2.1'
8. Egerton Ave Retention Area

Actions

• Create flood retention areas east of Egerton Ave (next to former hospital facility)
  – Evaluate potential runoff volume storage
  – Investigate impacts/benefits downstream in terms of peak flow reduction

Preliminary Results

• Drainage area >> proposed retention areas
  ➢ Significant basin depth would be required to store runoff volume of small storm (e.g., 2-year)
8. Egerton Ave Retention Area
# 8. Egerton Ave Retention Area

## Peak Inflow
- **2-year:** 46.7 cfs
- **10-year:** 55.1 cfs
- **25-year:** 77.4 cfs
- **50-year:** 97.4 cfs
- **100-year:** 120 cfs
- **500-year:** 189 cfs

## 24-hr Rainfall
- **Area 1:** 3.5 in
- **Area 2:** 5.5 in
- **Area 3:** 5.75 in
- **Area 1+2+3:** 6.0 in

## Runoff Depth
- **Area 1:** 1.0 in
- **Area 2:** 2.5 in
- **Area 3:** 2.6 in
- **Area 1+2+3:** 2.8 in

## Runoff Volume
- **Area 1:** 1.0 in
- **Area 2:** 2.5 in
- **Area 3:** 2.6 in
- **Area 1+2+3:** 2.8 in

## Runoff Volume Calculation
- **Area:** 1530 acres
- **Runoff Volume:** 58.7 acre-ft

## Depth Required to Store 2-Yr Runoff Volume

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 1+2+3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(acres)</td>
<td>1530</td>
<td>1530</td>
<td>1530</td>
<td>1530</td>
</tr>
<tr>
<td>Surface Area</td>
<td>2.8</td>
<td>5.7</td>
<td>5.3</td>
<td>13.8</td>
</tr>
<tr>
<td>(acres)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (Area/Runoff Vol.)</th>
<th>Area 1</th>
<th>Area 2</th>
<th>Area 3</th>
<th>Area 1+2+3</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ft)</td>
<td>45.5</td>
<td>22.5</td>
<td>24.1</td>
<td>9.2</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Note</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Estimated by using GIS</td>
<td>b Source: USGS Streamstats</td>
</tr>
<tr>
<td>b Source: USDA Urban Hydrology for Small Watersheds, TR-55</td>
<td></td>
</tr>
</tbody>
</table>
Thank You for Your Attention

Questions?