352 Turnpike Road
Southborough, MA 01772
508.480.9900

April 30, 2024

Town of Methuen
Community Development Board
41 Pleasant Street
Searles Building, Room 217
Methuen, MA 01844

Attn: Nancy P. Hudson

**Re: Methuen Credit Union - Proposed Bank Canopy Addition and Drive-Thru Improvements**
**Drainage Memo**
**248 Broadway (RTE 28), Methuen, MA**

Dear Ms. Hudson,

This letter is written to summarize our assessment of the calculated stormwater drainage conditions that are anticipated to occur as a result of the proposed addition to the existing drive-thru canopy of a Methuen Credit Union and associated site improvements located at 248 Broadway (RTE 28). The project proposes a 130± square-foot addition to the existing drive-thru canopy to accommodate an additional drive-thru aisle with associated site improvements, inclusive of the reconfiguration of the parking area to accommodate the additional drive-thru lane, as indicated on the enclosed Site Plan Documents. This letter provides a comparative analysis of the calculated pre- and post-development site runoff conditions generated on the project site. In support of this analysis, please find attached the following documents:

- One (1) 11”x17” copy of the “Existing Conditions Drainage Area Map”, dated April 30, 2024;
- One (1) 11”x17” copy of the “Proposed Conditions Drainage Area Map”, dated April 30, 2024;
- One (1) copy of the “Pre Conditions” HydroCAD report, dated April 30, 2024; and
- One (1) copy of the “Post Conditions” HydroCAD report, dated April 30, 2024.

## Existing Conditions

The subject site is a 0.2± acre parcel of land, denoted as Block 120, Lot 11 on the City of Methuen Assessor’s Map 612. The site is located on the west side of Broadway (RTE 28) and is located within the Central Business District (CBD), the Metheun Center Smart Overlay District (MCSOD), and within the Historic Overlay District. The site is bordered by an apartment complex to the north, a retail plaza to the south, an assisted living facility to the west, and a bank, across Broadway, to the east. The site currently contains a Methuen Credit Union, which is intended to remain.

The study area has been generally defined through a review of the topography and stormwater infrastructure compiled as part of the project survey. A topographic review of the subject parcel indicates that majority of the stormwater runoff generated within the study area generally flows towards an existing catch basin in the northwest portion of the existing pavement. The existing catch basin routes the stormwater to the existing drainage network on the existing site. It appears a portion of the adjacent parcel north of the site drains towards the existing closed drainage system on-site and has been included as part of the study area. A portion at the southwest of the site flows southeast toward the southeastern abutting property and is collected by the existing drainage network on the site. There is a portion at the northeastern side of the property that flows northeast into Broadway. The existing drainage infrastructure has been identified as Design Point #1, denoted DP #1. Broadway (RTE 28) has been identified as Design Point #2, denoted DP#2. Soils within the analyzed area

have been classified by the Natural Resource Conservation Service (NRCS) as Udorthents, smoothed, which is classified as Hydrologic Soil Group 'A' (HSG 'A').

Accordingly, the pre- and post-development stormwater models have been arranged to assess the anticipated stormwater conditions at these Design Point locations. The analysis area consists of two subcatchments, denoted EX-#1 and EX-#2. Subcatchment EX-#1 is made up of 4,720± square feet of impervious pavement area, 2,728± square feet of roof, 131± square feet of gravel area, and 1,844± square feet of landscaped area. Subcatchment EX-#2 is made up of 123± square feet of impervious pavement area and 389± square feet of landscaped area.

**Proposed Site Conditions**

The project proposes a canopy addition of approximately 130± square feet, a concrete island with a proposed pneumatic tube system, an additional drive-thru lane, and associated site improvements to accommodate same. The proposed condition results in a slight net decrease in impervious area. Under the proposed condition, the analysis area consists of two subcatchments, denoted PR-#1 and PR-#2. The Design Points associated with the post-development model is the same as that included as part of the pre-development model. Subcatchment PR-#1 is made up of 4,699± square feet of impervious pavement area, 2,728± square feet of roof, 131± square feet of gravel area, and 1,865± square feet of landscaped area. Subcatchment PR-#2 is made up of 123± square feet of impervious pavement area and 389± square feet of landscaped area.

As further detailed in this narrative and attached watershed calculations, the proposed reduction in impervious surface is calculated to result in no net increase in stormwater runoff from the site for all storms analyzed.

**Methodology**

HydroCAD© modeling software was used to assess both the pre- and post-development hydrologic conditions. HydroCAD© input and output data is enclosed.

The proposed stormwater management design is calculated to reduce or maintain the peak stormwater runoff rates from the proposed facility for DP#1 and DP#2 for the 2-, 10-, 25-, and 100-year design storm events utilizing the SCS TR-20 method.

A minimum time of concentration (Tc) of six (6) minutes has been assumed and input as direct entries for both the pre- and post-development analysis for the area of analysis.

The following rainfall data is used in the calculations, which are based upon the Extreme Precipitation Tables as prepared by Cornell University's NRCC Atlas of Precipitation Extremes for the North Eastern United States and Canada:

**Table 1 – RAINFALL DATA**

| | 2-Year | 10-Year | 25-Year | 100-Year |
|---|---|---|---|---|
| Rainfall (inches) | 3.09 | 4.72 | 6.01 | 8.67 |

**Summary**

In summary, the proposed project is calculated to not result in a "net increase" in stormwater peak runoff rates from the subject site when compared to pre-development conditions for the 2-, 10-, 25-, and 100-storm

frequencies for flows directed to DP#1 and DP#2, as anticipated due to the decrease in impervious area. The proposed site improvements have been designed such that runoff is collected and conveyed a manner which mimics existing hydrology.

The pre-development versus post-development peak discharge rates comparisons are contained within Table 2 and Table 3 in cubic feet per second (cfs):

**Table 2 – SUMMARY COMPARISON OF CALCULATED STORMWATER RUNOFF RATES DP#1**
*Runoff rates by Storm Event (cubic feet per second) to (DP#1)*

| | 2-Year | 10-Year | 25-Year | 100-Year |
|---|---|---|---|---|
| Pre-Development | 0.43 | 0.79 | 1.07 | 1.65 |
| Post-Development | 0.43 | 0.79 | 1.07 | 1.65 |
| Difference | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 3 – SUMMARY COMPARISON OF CALCULATED STORMWATER RUNOFF RATES DP#2**
*Runoff rates by Storm Event (cubic feet per second) to (DP#2)*

| | 2-Year | 10-Year | 25-Year | 100-Year |
|---|---|---|---|---|
| Pre-Development | 0.00 | 0.01 | 0.02 | 0.04 |
| Post-Development | 0.00 | 0.01 | 0.02 | 0.04 |
| Difference | 0.00 | 0.00 | 0.00 | 0.00 |

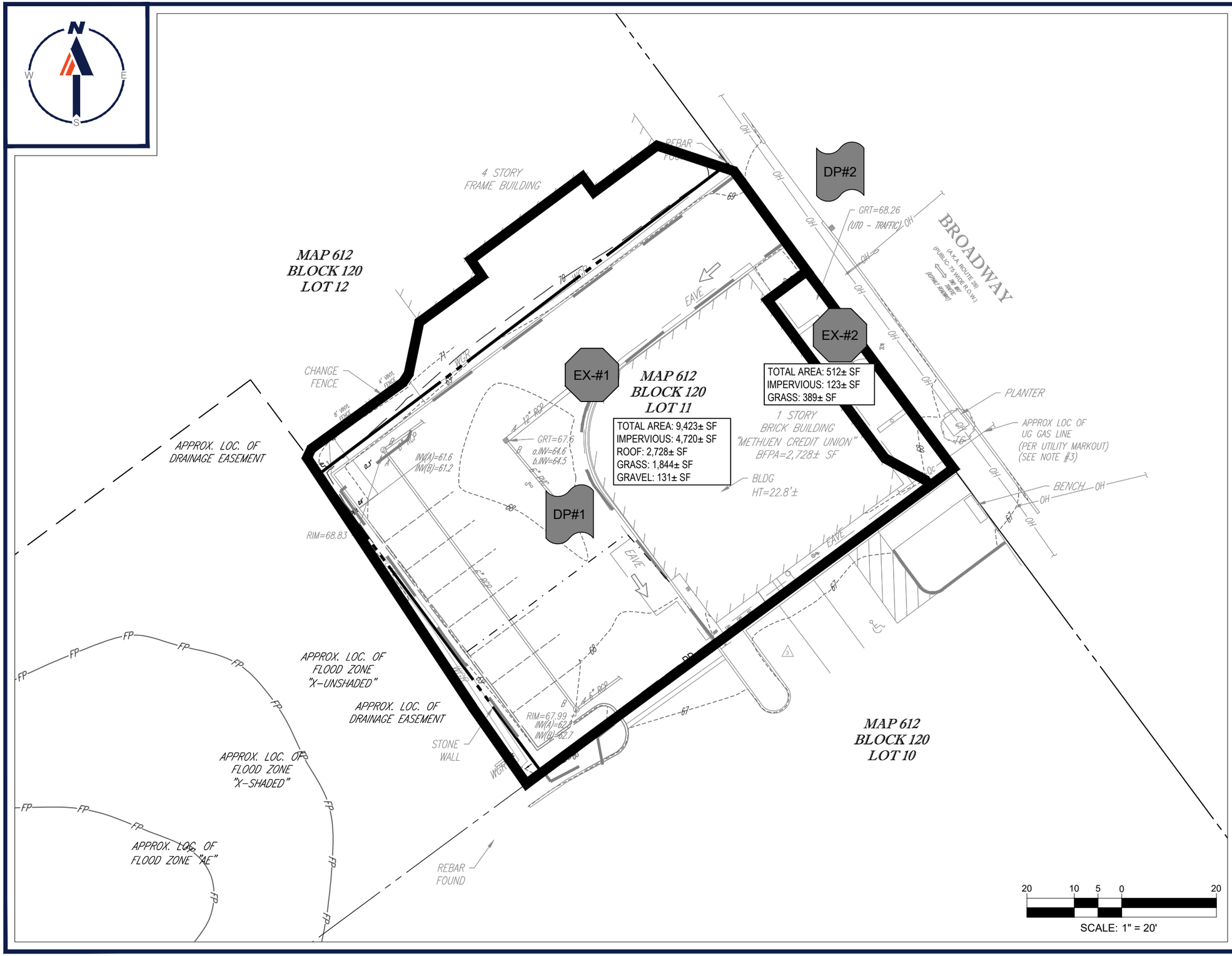
We trust the above is sufficient for your needs at this time. Should you have any questions or require additional information, please do not hesitate to contact us at (508) 480-9900.

Sincerely,

**BOHLER**

Kate Engler

Erica K. Rochefort




## LEGEND

- DP# — DESIGN POINT
- EX-# — EXISTING SUBCATCHMENT
- A — SOIL RATING
- SUBCATCHMENT BOUNDARY
- LIMIT OF WORK

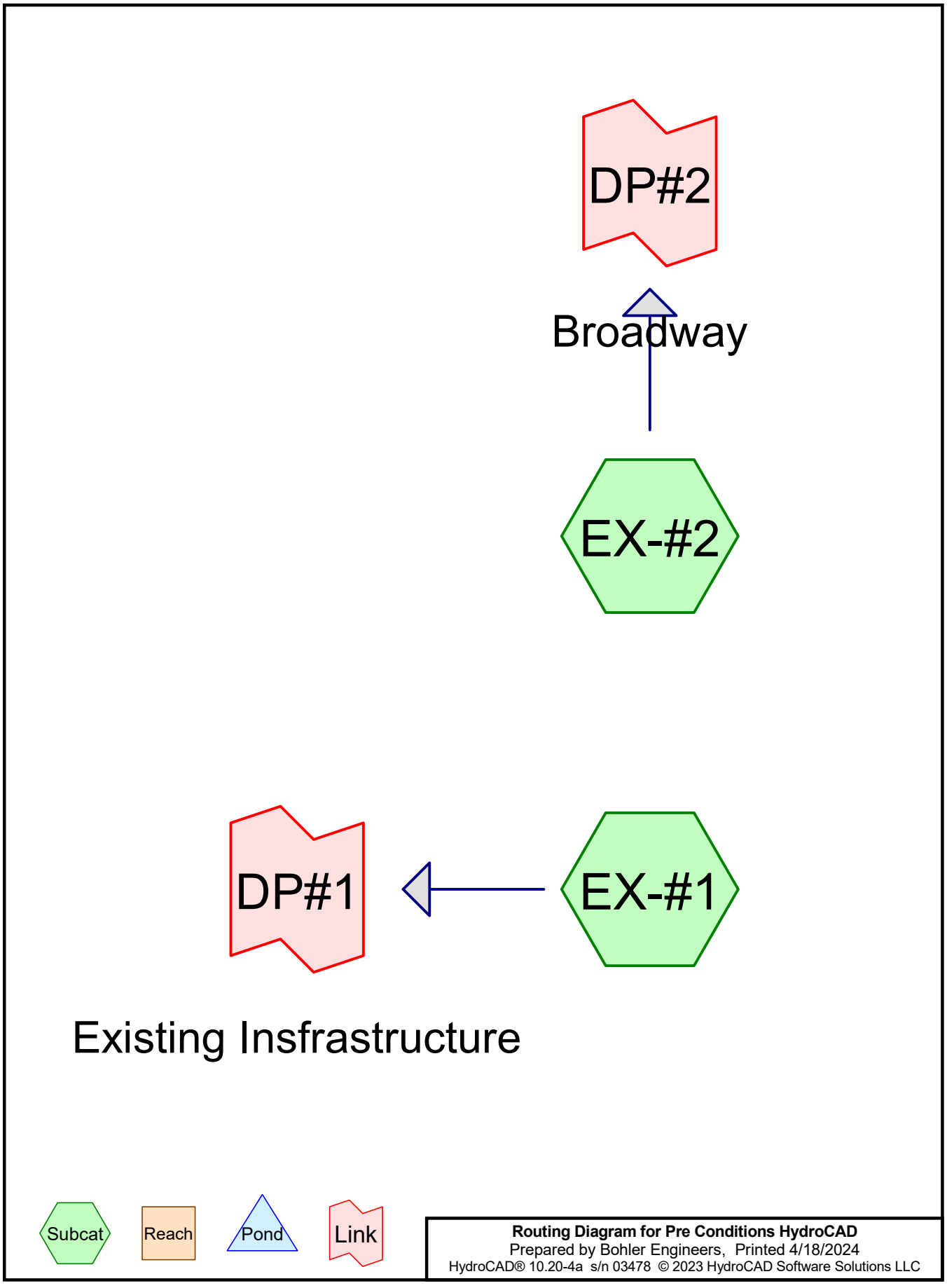
# EXISTING CONDITIONS DRAINAGE AREA MAP

248 BROADWAY (RTE 28)
METHUEN, MASSACHUSETTS

PREPARED BY

BOHLER

SCALE:1"=20' DATE: 04/30/2024




**Routing Diagram for Pre Conditions HydroCAD**
Prepared by Bohler Engineers, Printed 4/18/2024

## Rainfall Events Listing

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 2-Year | Type III 24-hr | | Default | 24.00 | 1 | 3.09 | 2 |
| 2 | 10-Year | Type III 24-hr | | Default | 24.00 | 1 | 4.72 | 2 |
| 3 | 25-Year | Type III 24-hr | | Default | 24.00 | 1 | 6.01 | 2 |
| 4 | 100-Year | Type III 24-hr | | Default | 24.00 | 1 | 8.67 | 2 |

## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 0.051 | 39 | >75% Grass cover, Good, HSG A (EX-#1, EX-#2) |
| 0.003 | 76 | Gravel roads, HSG A (EX-#1) |
| 0.111 | 98 | Paved parking, HSG A (EX-#1, EX-#2) |
| 0.063 | 98 | Roofs, HSG A (EX-#1) |
| **0.228** | **84** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.228 | HSG A | EX-#1, EX-#2 |
| 0.000 | HSG B | |
| 0.000 | HSG C | |
| 0.000 | HSG D | |
| 0.000 | Other | |
| **0.228** | | **TOTAL AREA** |

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment EX-#1:** Runoff Area=9,423 sf 79.04% Impervious Runoff Depth=1.74"
Tc=6.0 min CN=86 Runoff=0.43 cfs 0.031 af

**Subcatchment EX-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=0.17"
Tc=6.0 min CN=53 Runoff=0.00 cfs 0.000 af

**Link DP#1: Existing Insfrastructure** Inflow=0.43 cfs 0.031 af
Primary=0.43 cfs 0.031 af

**Link DP#2: Broadway** Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.032 af Average Runoff Depth = 1.66"**
**23.79% Pervious = 0.054 ac 76.21% Impervious = 0.174 ac**

## Summary for Subcatchment EX-#1:

Runoff = 0.43 cfs @ 12.09 hrs, Volume= 0.031 af, Depth= 1.74"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.09"

| Area (sf) | CN | Description |
|---|---|---|
| 4,720 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,844 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,975 | | 20.96% Pervious Area |
| 7,448 | | 79.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment EX-#2:

Runoff = 0.00 cfs @ 12.41 hrs, Volume= 0.000 af, Depth= 0.17"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.09"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 79.04% Impervious, Inflow Depth = 1.74" for 2-Year event
Inflow = 0.43 cfs @ 12.09 hrs, Volume= 0.031 af
Primary = 0.43 cfs @ 12.09 hrs, Volume= 0.031 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 0.17" for 2-Year event
Inflow = 0.00 cfs @ 12.41 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 12.41 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment EX-#1:** Runoff Area=9,423 sf 79.04% Impervious Runoff Depth=3.21"
Tc=6.0 min CN=86 Runoff=0.79 cfs 0.058 af

**Subcatchment EX-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=0.73"
Tc=6.0 min CN=53 Runoff=0.01 cfs 0.001 af

**Link DP#1: Existing Insfrastructure** Inflow=0.79 cfs 0.058 af
Primary=0.79 cfs 0.058 af

**Link DP#2: Broadway** Inflow=0.01 cfs 0.001 af
Primary=0.01 cfs 0.001 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.059 af Average Runoff Depth = 3.08"**
**23.79% Pervious = 0.054 ac 76.21% Impervious = 0.174 ac**

## Summary for Subcatchment EX-#1:

Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af, Depth= 3.21"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.72"

| Area (sf) | CN | Description |
|---|---|---|
| 4,720 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,844 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,975 | | 20.96% Pervious Area |
| 7,448 | | 79.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment EX-#2:

Runoff = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af, Depth= 0.73"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.72"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 79.04% Impervious, Inflow Depth = 3.21" for 10-Year event
Inflow = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af
Primary = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 0.73" for 10-Year event
Inflow = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af
Primary = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment EX-#1:** Runoff Area=9,423 sf 79.04% Impervious Runoff Depth=4.42"
Tc=6.0 min CN=86 Runoff=1.07 cfs 0.080 af

**Subcatchment EX-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=1.37"
Tc=6.0 min CN=53 Runoff=0.02 cfs 0.001 af

**Link DP#1: Existing Insfrastructure** Inflow=1.07 cfs 0.080 af
Primary=1.07 cfs 0.080 af

**Link DP#2: Broadway** Inflow=0.02 cfs 0.001 af
Primary=0.02 cfs 0.001 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.081 af Average Runoff Depth = 4.26"**
**23.79% Pervious = 0.054 ac 76.21% Impervious = 0.174 ac**

## Summary for Subcatchment EX-#1:

Runoff = 1.07 cfs @ 12.09 hrs, Volume= 0.080 af, Depth= 4.42"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.01"

| Area (sf) | CN | Description |
|---|---|---|
| 4,720 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,844 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,975 | | 20.96% Pervious Area |
| 7,448 | | 79.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment EX-#2:

Runoff = 0.02 cfs @ 12.11 hrs, Volume= 0.001 af, Depth= 1.37"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.01"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 79.04% Impervious, Inflow Depth = 4.42" for 25-Year event
Inflow = 1.07 cfs @ 12.09 hrs, Volume= 0.080 af
Primary = 1.07 cfs @ 12.09 hrs, Volume= 0.080 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 1.37" for 25-Year event
Inflow = 0.02 cfs @ 12.11 hrs, Volume= 0.001 af
Primary = 0.02 cfs @ 12.11 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment EX-#1:** Runoff Area=9,423 sf 79.04% Impervious Runoff Depth=6.98"
Tc=6.0 min CN=86 Runoff=1.65 cfs 0.126 af

**Subcatchment EX-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=3.02"
Tc=6.0 min CN=53 Runoff=0.04 cfs 0.003 af

**Link DP#1: Existing Insfrastructure** Inflow=1.65 cfs 0.126 af
Primary=1.65 cfs 0.126 af

**Link DP#2: Broadway** Inflow=0.04 cfs 0.003 af
Primary=0.04 cfs 0.003 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.129 af Average Runoff Depth = 6.78"**
**23.79% Pervious = 0.054 ac 76.21% Impervious = 0.174 ac**

## Summary for Subcatchment EX-#1:

Runoff = 1.65 cfs @ 12.09 hrs, Volume= 0.126 af, Depth= 6.98"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.67"

| Area (sf) | CN | Description |
|---|---|---|
| 4,720 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,844 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,975 | | 20.96% Pervious Area |
| 7,448 | | 79.04% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment EX-#2:

Runoff = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af, Depth= 3.02"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.67"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

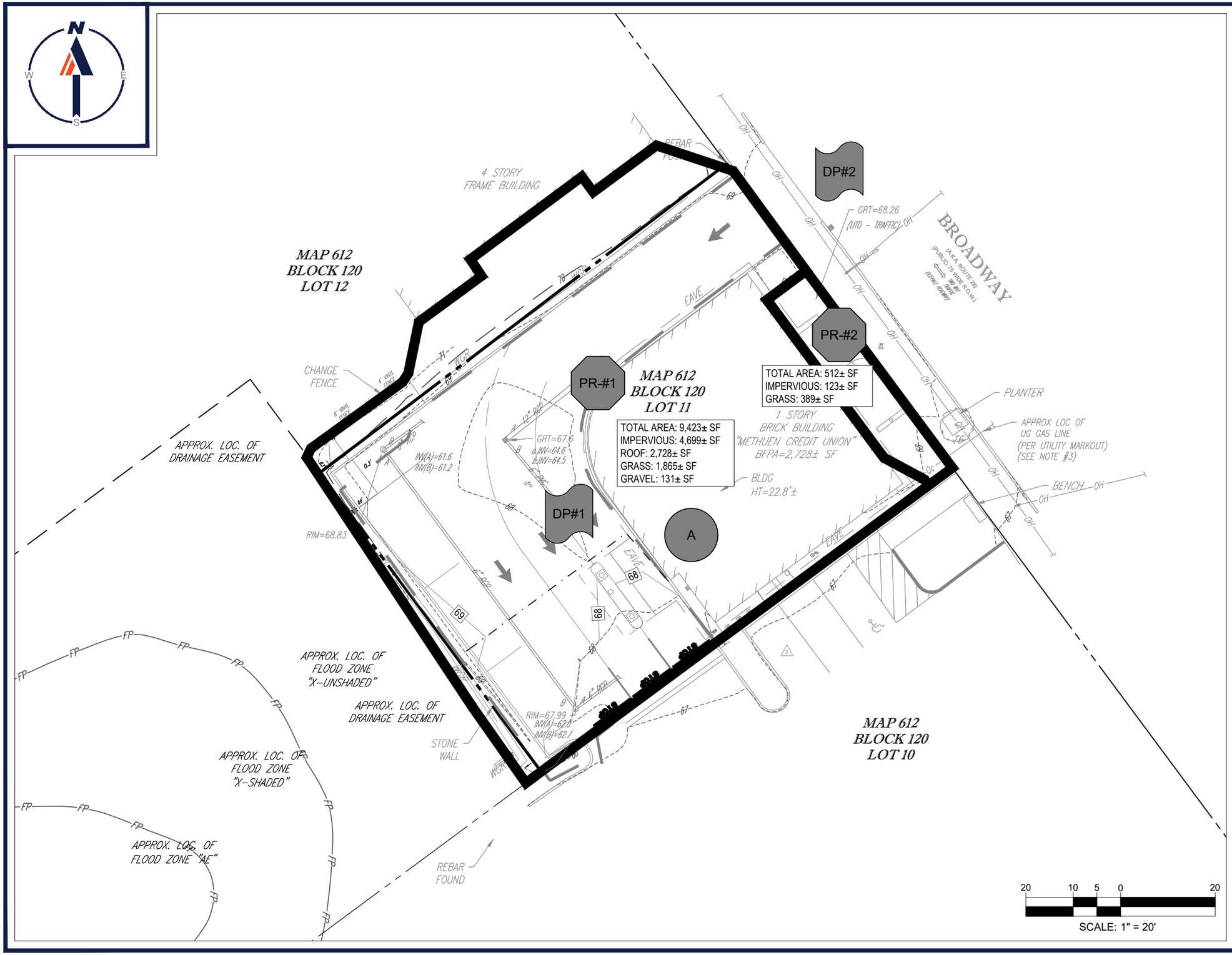
Inflow Area = 0.216 ac, 79.04% Impervious, Inflow Depth = 6.98" for 100-Year event
Inflow = 1.65 cfs @ 12.09 hrs, Volume= 0.126 af
Primary = 1.65 cfs @ 12.09 hrs, Volume= 0.126 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 3.02" for 100-Year event
Inflow = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af
Primary = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs




## LEGEND

- DP# — DESIGN POINT
- PR-# — PROPOSED SUBCATCHMENT
- A — SOIL RATING
- SUBCATCHMENT BOUNDARY
- LIMIT OF WORK

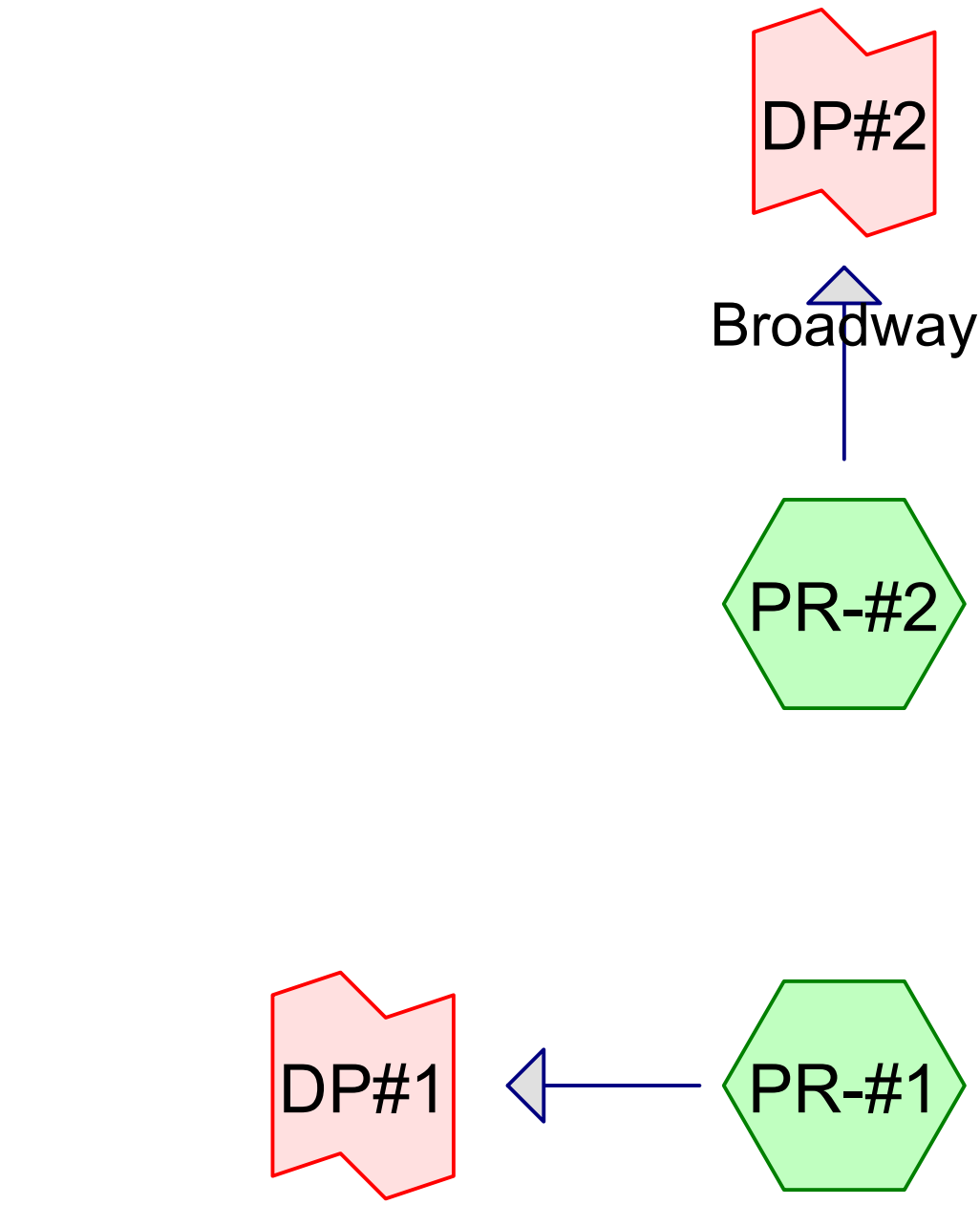
# PROPOSED CONDITIONS DRAINAGE AREA MAP

248 BROADWAY (RTE 28)
METHUEN, MASSACHUSETTS

PREPARED BY

BOHLER

SCALE:1"=20' DATE: 04/30/2024




Existing Insfrastructure

Subcat Reach Pond Link

**Routing Diagram for Post Conditions HydroCAD**
Prepared by Bohler Engineers, Printed 4/18/2024

## Rainfall Events Listing

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 2-Year | Type III 24-hr | | Default | 24.00 | 1 | 3.09 | 2 |
| 2 | 10-Year | Type III 24-hr | | Default | 24.00 | 1 | 4.72 | 2 |
| 3 | 25-Year | Type III 24-hr | | Default | 24.00 | 1 | 6.01 | 2 |
| 4 | 100-Year | Type III 24-hr | | Default | 24.00 | 1 | 8.67 | 2 |

## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 0.052 | 39 | >75% Grass cover, Good, HSG A (PR-#1, PR-#2) |
| 0.003 | 76 | Gravel roads, HSG A (PR-#1) |
| 0.111 | 98 | Paved parking, HSG A (PR-#1, PR-#2) |
| 0.063 | 98 | Roofs, HSG A (PR-#1) |
| **0.228** | **84** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.228 | HSG A | PR-#1, PR-#2 |
| 0.000 | HSG B | |
| 0.000 | HSG C | |
| 0.000 | HSG D | |
| 0.000 | Other | |
| **0.228** | | **TOTAL AREA** |

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment PR-#1:** Runoff Area=9,423 sf 78.82% Impervious Runoff Depth=1.74"
Tc=6.0 min CN=86 Runoff=0.43 cfs 0.031 af

**Subcatchment PR-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=0.17"
Tc=6.0 min CN=53 Runoff=0.00 cfs 0.000 af

**Link DP#1: Existing Insfrastructure** Inflow=0.43 cfs 0.031 af
Primary=0.43 cfs 0.031 af

**Link DP#2: Broadway** Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.032 af Average Runoff Depth = 1.66"**
**24.01% Pervious = 0.055 ac 75.99% Impervious = 0.173 ac**

## Summary for Subcatchment PR-#1:

Runoff = 0.43 cfs @ 12.09 hrs, Volume= 0.031 af, Depth= 1.74"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.09"

| Area (sf) | CN | Description |
|---|---|---|
| 4,699 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,865 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,996 | | 21.18% Pervious Area |
| 7,427 | | 78.82% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment PR-#2:

Runoff = 0.00 cfs @ 12.41 hrs, Volume= 0.000 af, Depth= 0.17"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.09"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 78.82% Impervious, Inflow Depth = 1.74" for 2-Year event
Inflow = 0.43 cfs @ 12.09 hrs, Volume= 0.031 af
Primary = 0.43 cfs @ 12.09 hrs, Volume= 0.031 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 0.17" for 2-Year event
Inflow = 0.00 cfs @ 12.41 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 12.41 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment PR-#1:** Runoff Area=9,423 sf 78.82% Impervious Runoff Depth=3.21"
Tc=6.0 min CN=86 Runoff=0.79 cfs 0.058 af

**Subcatchment PR-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=0.73"
Tc=6.0 min CN=53 Runoff=0.01 cfs 0.001 af

**Link DP#1: Existing Insfrastructure** Inflow=0.79 cfs 0.058 af
Primary=0.79 cfs 0.058 af

**Link DP#2: Broadway** Inflow=0.01 cfs 0.001 af
Primary=0.01 cfs 0.001 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.059 af Average Runoff Depth = 3.08"**
**24.01% Pervious = 0.055 ac 75.99% Impervious = 0.173 ac**

## Summary for Subcatchment PR-#1:

Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af, Depth= 3.21"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.72"

| Area (sf) | CN | Description |
|---|---|---|
| 4,699 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,865 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,996 | | 21.18% Pervious Area |
| 7,427 | | 78.82% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment PR-#2:

Runoff = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af, Depth= 0.73"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.72"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 78.82% Impervious, Inflow Depth = 3.21" for 10-Year event
Inflow = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af
Primary = 0.79 cfs @ 12.09 hrs, Volume= 0.058 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 0.73" for 10-Year event
Inflow = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af
Primary = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment PR-#1:** Runoff Area=9,423 sf 78.82% Impervious Runoff Depth=4.42"
Tc=6.0 min CN=86 Runoff=1.07 cfs 0.080 af

**Subcatchment PR-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=1.37"
Tc=6.0 min CN=53 Runoff=0.02 cfs 0.001 af

**Link DP#1: Existing Insfrastructure** Inflow=1.07 cfs 0.080 af
Primary=1.07 cfs 0.080 af

**Link DP#2: Broadway** Inflow=0.02 cfs 0.001 af
Primary=0.02 cfs 0.001 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.081 af Average Runoff Depth = 4.26"**
**24.01% Pervious = 0.055 ac 75.99% Impervious = 0.173 ac**

## Summary for Subcatchment PR-#1:

Runoff = 1.07 cfs @ 12.09 hrs, Volume= 0.080 af, Depth= 4.42"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.01"

| Area (sf) | CN | Description |
|---|---|---|
| 4,699 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,865 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,996 | | 21.18% Pervious Area |
| 7,427 | | 78.82% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment PR-#2:

Runoff = 0.02 cfs @ 12.11 hrs, Volume= 0.001 af, Depth= 1.37"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.01"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 78.82% Impervious, Inflow Depth = 4.42" for 25-Year event
Inflow = 1.07 cfs @ 12.09 hrs, Volume= 0.080 af
Primary = 1.07 cfs @ 12.09 hrs, Volume= 0.080 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 1.37" for 25-Year event
Inflow = 0.02 cfs @ 12.11 hrs, Volume= 0.001 af
Primary = 0.02 cfs @ 12.11 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment PR-#1:** Runoff Area=9,423 sf 78.82% Impervious Runoff Depth=6.98"
Tc=6.0 min CN=86 Runoff=1.65 cfs 0.126 af

**Subcatchment PR-#2:** Runoff Area=512 sf 24.02% Impervious Runoff Depth=3.02"
Tc=6.0 min CN=53 Runoff=0.04 cfs 0.003 af

**Link DP#1: Existing Insfrastructure** Inflow=1.65 cfs 0.126 af
Primary=1.65 cfs 0.126 af

**Link DP#2: Broadway** Inflow=0.04 cfs 0.003 af
Primary=0.04 cfs 0.003 af

**Total Runoff Area = 0.228 ac Runoff Volume = 0.129 af Average Runoff Depth = 6.78"**
**24.01% Pervious = 0.055 ac 75.99% Impervious = 0.173 ac**

## Summary for Subcatchment PR-#1:

Runoff = 1.65 cfs @ 12.09 hrs, Volume= 0.126 af, Depth= 6.98"
Routed to Link DP#1 : Existing Insfrastructure

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.67"

| Area (sf) | CN | Description |
|---|---|---|
| 4,699 | 98 | Paved parking, HSG A |
| 2,728 | 98 | Roofs, HSG A |
| 1,865 | 39 | >75% Grass cover, Good, HSG A |
| 131 | 76 | Gravel roads, HSG A |
| 9,423 | 86 | Weighted Average |
| 1,996 | | 21.18% Pervious Area |
| 7,427 | | 78.82% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Subcatchment PR-#2:

Runoff = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af, Depth= 3.02"
Routed to Link DP#2 : Broadway

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.67"

| Area (sf) | CN | Description |
|---|---|---|
| 123 | 98 | Paved parking, HSG A |
| 389 | 39 | >75% Grass cover, Good, HSG A |
| 512 | 53 | Weighted Average |
| 389 | | 75.98% Pervious Area |
| 123 | | 24.02% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 6.0 | | | | | **Direct Entry,** |

## Summary for Link DP#1: Existing Insfrastructure

Inflow Area = 0.216 ac, 78.82% Impervious, Inflow Depth = 6.98" for 100-Year event
Inflow = 1.65 cfs @ 12.09 hrs, Volume= 0.126 af
Primary = 1.65 cfs @ 12.09 hrs, Volume= 0.126 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

## Summary for Link DP#2: Broadway

Inflow Area = 0.012 ac, 24.02% Impervious, Inflow Depth = 3.02" for 100-Year event
Inflow = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af
Primary = 0.04 cfs @ 12.10 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

# Custom Soil Resource Report for Essex County, Massachusetts, Northern Part


November 10, 2023

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

**Preface**.....2
**How Soil Surveys Are Made**.....5
**Soil Map**.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Essex County, Massachusetts, Northern Part.....13
651—Udorthents, smoothed.....13
**References**.....15

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report
## Soil Map


Map Scale: 1:381 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 5 10 20 30

Feet: 0 15 30 60 90

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

## MAP LEGEND

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

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

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

**Water Features**
- Streams and Canals

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

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 19, Sep 10, 2023

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 651 | Udorthents, smoothed | 0.3 | 100.0% |
| **Totals for Area of Interest** | | **0.3** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# Essex County, Massachusetts, Northern Part

## 651—Udorthents, smoothed

### Map Unit Setting

*National map unit symbol:* vjwk
*Elevation:* 0 to 3,000 feet
*Mean annual precipitation:* 45 to 54 inches
*Mean annual air temperature:* 43 to 54 degrees F
*Frost-free period:* 145 to 240 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Udorthents and similar soils:* 80 percent
*Minor components:* 20 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Udorthents

#### Setting

*Parent material:* Excavated and filled land loamy and/or excavated and filled land sandy and gravelly

#### Typical profile

*H1 - 0 to 6 inches:* variable
*H2 - 6 to 60 inches:* variable

#### Properties and qualities

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to very high (0.06 to 20.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6s
*Hydrologic Soil Group:* A
*Hydric soil rating:* Unranked

### Minor Components

#### Urban land

*Percent of map unit:* 10 percent
*Hydric soil rating:* Unranked

#### Beaches

*Percent of map unit:* 8 percent
*Hydric soil rating:* Unranked

#### Dumps

*Percent of map unit:* 2 percent
*Hydric soil rating:* Unranked

# Extreme Precipitation Tables

## Northeast Regional Climate Center

***Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.***

| Metadata for Point | |
|---|---|
| **Smoothing** | Yes |
| **State** | |
| **Location** | |
| **Latitude** | 42.726 degrees North |
| **Longitude** | 71.186 degrees West |
| **Elevation** | 20 feet |
| **Date/Time** | Tue Dec 12 2023 12:03:14 GMT-0500 (Eastern Standard Time) |

## Extreme Precipitation Estimates

| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1yr** | 0.27 | 0.42 | 0.52 | 0.68 | 0.85 | 1.07 | **1yr** | 0.73 | 1.01 | 1.24 | 1.58 | 2.01 | 2.57 | 2.78 | **1yr** | 2.28 | 2.68 | 3.12 | 3.80 | 4.43 | **1yr** |
| **2yr** | 0.33 | 0.51 | 0.64 | 0.84 | 1.06 | 1.34 | **2yr** | 0.91 | 1.22 | 1.55 | 1.95 | 2.45 | 3.09 | 3.42 | **2yr** | 2.74 | 3.29 | 3.81 | 4.52 | 5.15 | **2yr** |
| **5yr** | 0.39 | 0.61 | 0.77 | 1.03 | 1.32 | 1.68 | **5yr** | 1.14 | 1.53 | 1.96 | 2.47 | 3.12 | 3.93 | 4.37 | **5yr** | 3.48 | 4.20 | 4.83 | 5.72 | 6.48 | **5yr** |
| **10yr** | 0.44 | 0.70 | 0.88 | 1.20 | 1.55 | 2.00 | **10yr** | 1.34 | 1.81 | 2.34 | 2.97 | 3.75 | 4.72 | 5.27 | **10yr** | 4.18 | 5.07 | 5.79 | 6.85 | 7.72 | **10yr** |
| **25yr** | 0.52 | 0.83 | 1.06 | 1.46 | 1.94 | 2.52 | **25yr** | 1.67 | 2.27 | 2.96 | 3.77 | 4.78 | 6.01 | 6.75 | **25yr** | 5.32 | 6.49 | 7.35 | 8.69 | 9.74 | **25yr** |
| **50yr** | 0.59 | 0.94 | 1.21 | 1.70 | 2.29 | 3.02 | **50yr** | 1.98 | 2.70 | 3.56 | 4.55 | 5.76 | 7.22 | 8.15 | **50yr** | 6.39 | 7.83 | 8.82 | 10.41 | 11.61 | **50yr** |
| **100yr** | 0.68 | 1.09 | 1.41 | 1.99 | 2.72 | 3.60 | **100yr** | 2.34 | 3.20 | 4.25 | 5.45 | 6.90 | 8.67 | 9.83 | **100yr** | 7.67 | 9.45 | 10.58 | 12.48 | 13.85 | **100yr** |
| **200yr** | 0.77 | 1.25 | 1.62 | 2.33 | 3.22 | 4.30 | **200yr** | 2.78 | 3.80 | 5.10 | 6.55 | 8.30 | 10.42 | 11.87 | **200yr** | 9.22 | 11.42 | 12.69 | 14.97 | 16.52 | **200yr** |
| **500yr** | 0.92 | 1.52 | 1.98 | 2.88 | 4.03 | 5.43 | **500yr** | 3.48 | 4.78 | 6.47 | 8.34 | 10.59 | 13.30 | 15.24 | **500yr** | 11.77 | 14.66 | 16.15 | 19.04 | 20.88 | **500yr** |

## Lower Confidence Limits

| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1yr** | 0.24 | 0.37 | 0.45 | 0.60 | 0.74 | 0.87 | **1yr** | 0.64 | 0.86 | 1.11 | 1.37 | 1.66 | 2.37 | 2.57 | **1yr** | 2.10 | 2.48 | 2.81 | 3.39 | 4.04 | **1yr** |
| **2yr** | 0.32 | 0.49 | 0.61 | 0.82 | 1.01 | 1.21 | **2yr** | 0.87 | 1.18 | 1.38 | 1.82 | 2.33 | 3.00 | 3.32 | **2yr** | 2.65 | 3.19 | 3.70 | 4.39 | 5.02 | **2yr** |
| **5yr** | 0.37 | 0.57 | 0.71 | 0.97 | 1.23 | 1.45 | **5yr** | 1.06 | 1.42 | 1.64 | 2.12 | 2.71 | 3.69 | 4.05 | **5yr** | 3.26 | 3.90 | 4.52 | 5.34 | 6.07 | **5yr** |
| **10yr** | 0.41 | 0.63 | 0.78 | 1.09 | 1.41 | 1.65 | **10yr** | 1.22 | 1.62 | 1.86 | 2.39 | 3.04 | 4.29 | 4.67 | **10yr** | 3.79 | 4.50 | 5.24 | 6.17 | 6.99 | **10yr** |
| **25yr** | 0.47 | 0.72 | 0.89 | 1.28 | 1.68 | 1.95 | **25yr** | 1.45 | 1.91 | 2.20 | 2.79 | 3.54 | 5.23 | 5.64 | **25yr** | 4.62 | 5.43 | 6.37 | 7.49 | 8.38 | **25yr** |
| **50yr** | 0.52 | 0.80 | 0.99 | 1.42 | 1.92 | 2.22 | **50yr** | 1.65 | 2.17 | 2.49 | 3.14 | 3.98 | 6.06 | 6.50 | **50yr** | 5.36 | 6.25 | 7.42 | 8.67 | 9.60 | **50yr** |
| **100yr** | 0.59 | 0.89 | 1.11 | 1.61 | 2.20 | 2.53 | **100yr** | 1.90 | 2.47 | 2.83 | 3.54 | 4.47 | 6.76 | 7.48 | **100yr** | 5.98 | 7.20 | 8.64 | 10.05 | 11.00 | **100yr** |
| **200yr** | 0.66 | 0.99 | 1.25 | 1.81 | 2.53 | 2.87 | **200yr** | 2.18 | 2.81 | 3.20 | 3.98 | 5.03 | 7.78 | 8.64 | **200yr** | 6.89 | 8.31 | 10.06 | 11.62 | 12.56 | **200yr** |
| **500yr** | 0.77 | 1.14 | 1.47 | 2.14 | 3.04 | 3.40 | **500yr** | 2.62 | 3.32 | 3.77 | 4.67 | 5.90 | 9.34 | 10.43 | **500yr** | 8.26 | 10.03 | 12.33 | 14.08 | 14.98 | **500yr** |

## Upper Confidence Limits

| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1yr** | 0.30 | 0.46 | 0.57 | 0.76 | 0.94 | 1.10 | **1yr** | 0.81 | 1.07 | 1.26 | 1.67 | 2.13 | 2.76 | 2.96 | **1yr** | 2.44 | 2.85 | 3.37 | 4.06 | 4.78 | **1yr** |
| **2yr** | 0.34 | 0.53 | 0.65 | 0.89 | 1.09 | 1.30 | **2yr** | 0.94 | 1.27 | 1.49 | 1.95 | 2.49 | 3.20 | 3.55 | **2yr** | 2.83 | 3.42 | 3.93 | 4.66 | 5.33 | **2yr** |
| **5yr** | 0.43 | 0.66 | 0.82 | 1.12 | 1.43 | 1.68 | **5yr** | 1.23 | 1.64 | 1.93 | 2.50 | 3.17 | 4.18 | 4.69 | **5yr** | 3.70 | 4.51 | 5.15 | 6.12 | 6.91 | **5yr** |
| **10yr** | 0.52 | 0.79 | 0.98 | 1.37 | 1.77 | 2.05 | **10yr** | 1.53 | 2.01 | 2.36 | 3.02 | 3.81 | 5.16 | 5.81 | **10yr** | 4.56 | 5.59 | 6.32 | 7.52 | 8.45 | **10yr** |
| **25yr** | 0.66 | 1.01 | 1.26 | 1.80 | 2.36 | 2.68 | **25yr** | 2.04 | 2.62 | 3.09 | 3.88 | 4.84 | 6.81 | 7.73 | **25yr** | 6.03 | 7.44 | 8.31 | 9.91 | 11.08 | **25yr** |
| **50yr** | 0.80 | 1.22 | 1.51 | 2.17 | 2.93 | 3.29 | **50yr** | 2.53 | 3.22 | 3.78 | 4.69 | 5.82 | 8.41 | 9.62 | **50yr** | 7.45 | 9.25 | 10.20 | 12.21 | 13.60 | **50yr** |
| **100yr** | 0.97 | 1.47 | 1.84 | 2.66 | 3.65 | 4.03 | **100yr** | 3.15 | 3.94 | 4.64 | 5.69 | 7.00 | 10.76 | 11.97 | **100yr** | 9.52 | 11.51 | 12.54 | 15.06 | 16.73 | **100yr** |
| **200yr** | 1.17 | 1.77 | 2.24 | 3.24 | 4.52 | 4.95 | **200yr** | 3.90 | 4.84 | 5.70 | 6.88 | 8.41 | 13.38 | 14.91 | **200yr** | 11.84 | 14.33 | 15.40 | 18.55 | 20.59 | **200yr** |
| **500yr** | 1.52 | 2.26 | 2.91 | 4.23 | 6.02 | 6.50 | **500yr** | 5.19 | 6.36 | 7.49 | 8.87 | 10.74 | 17.86 | 19.95 | **500yr** | 15.81 | 19.18 | 20.21 | 24.47 | 27.15 | **500yr** |