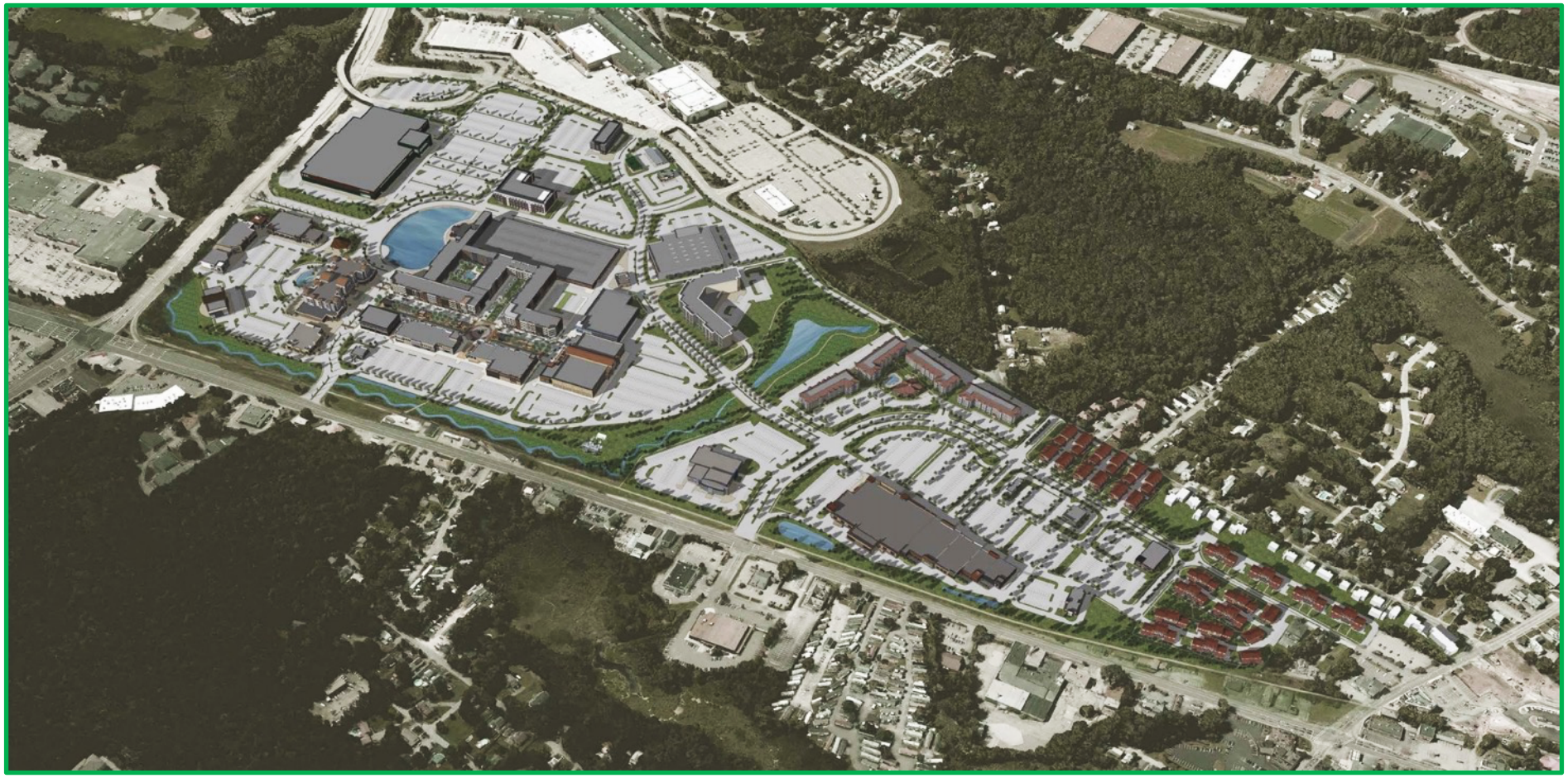


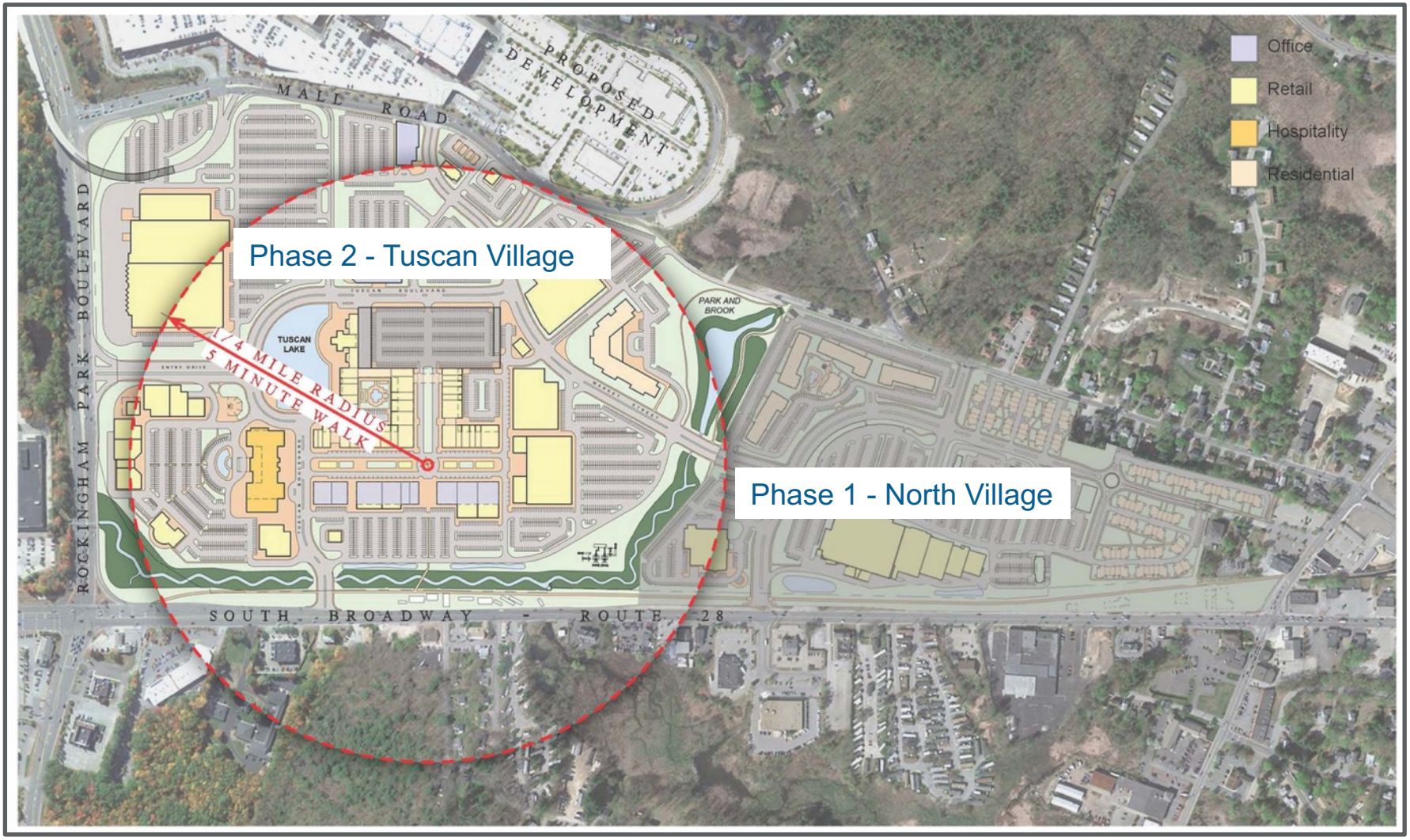
PRIVATE DEVELOPMENT - PUBLIC BENEFIT

Tuscan Village Floodplain Improvements in Salem, NH

Joseph M. Persechino, P.E.
David L. Azinheira, P.E., CFM

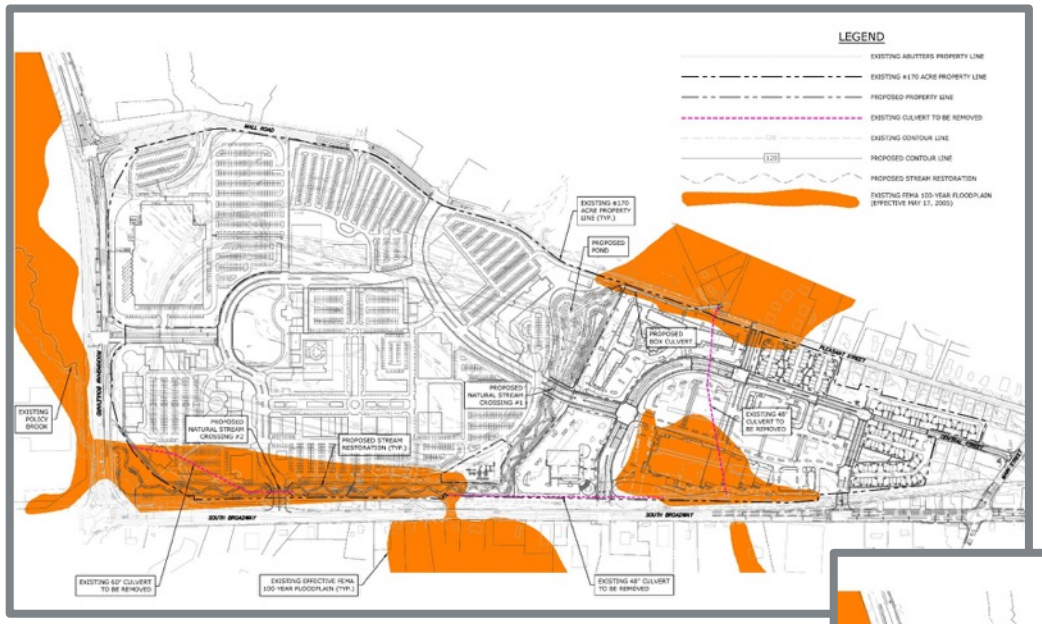
Tighe&Bond

Tuscan Village Masterplan

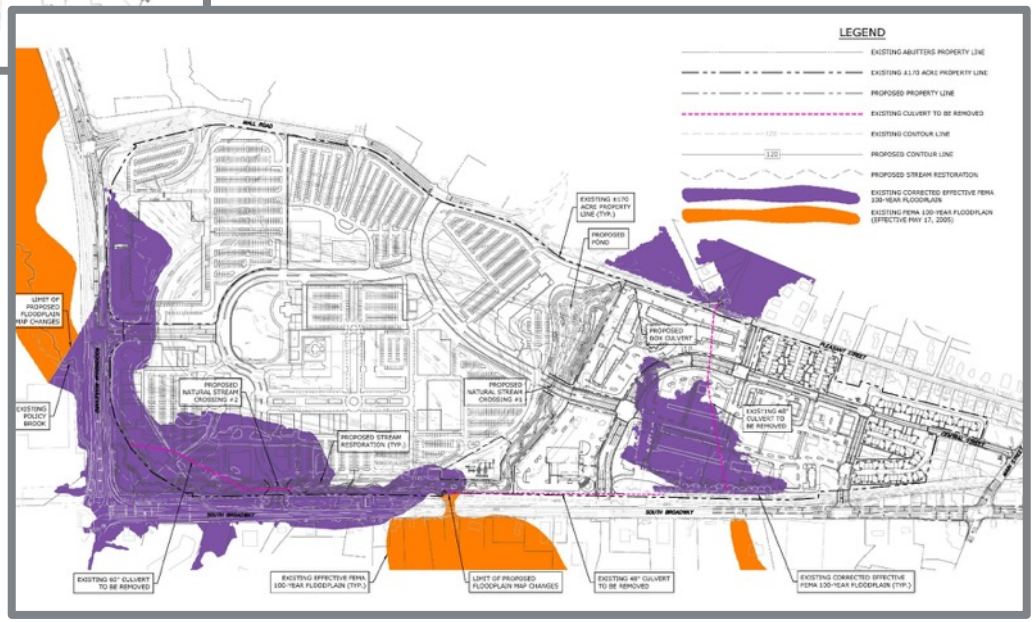


The Vision

The Problem - Existing Floodplain Limits



OVERALL EFFECTIVE EXISTING FLOODPLAIN



OVERALL CORRECTED EFFECTIVE EXISTING FLOODPLAIN

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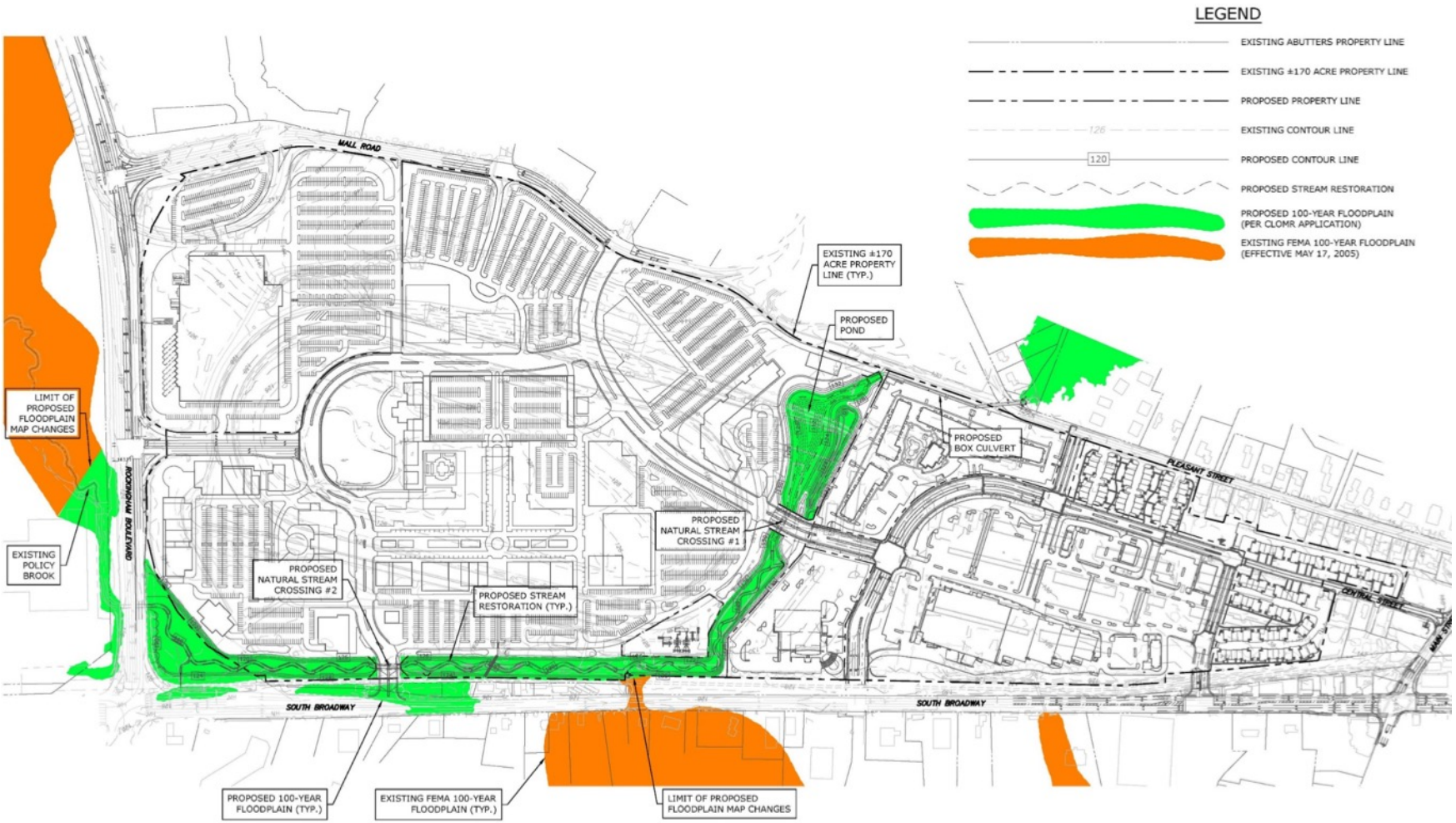
The Solution – Propose New Floodplain Limits



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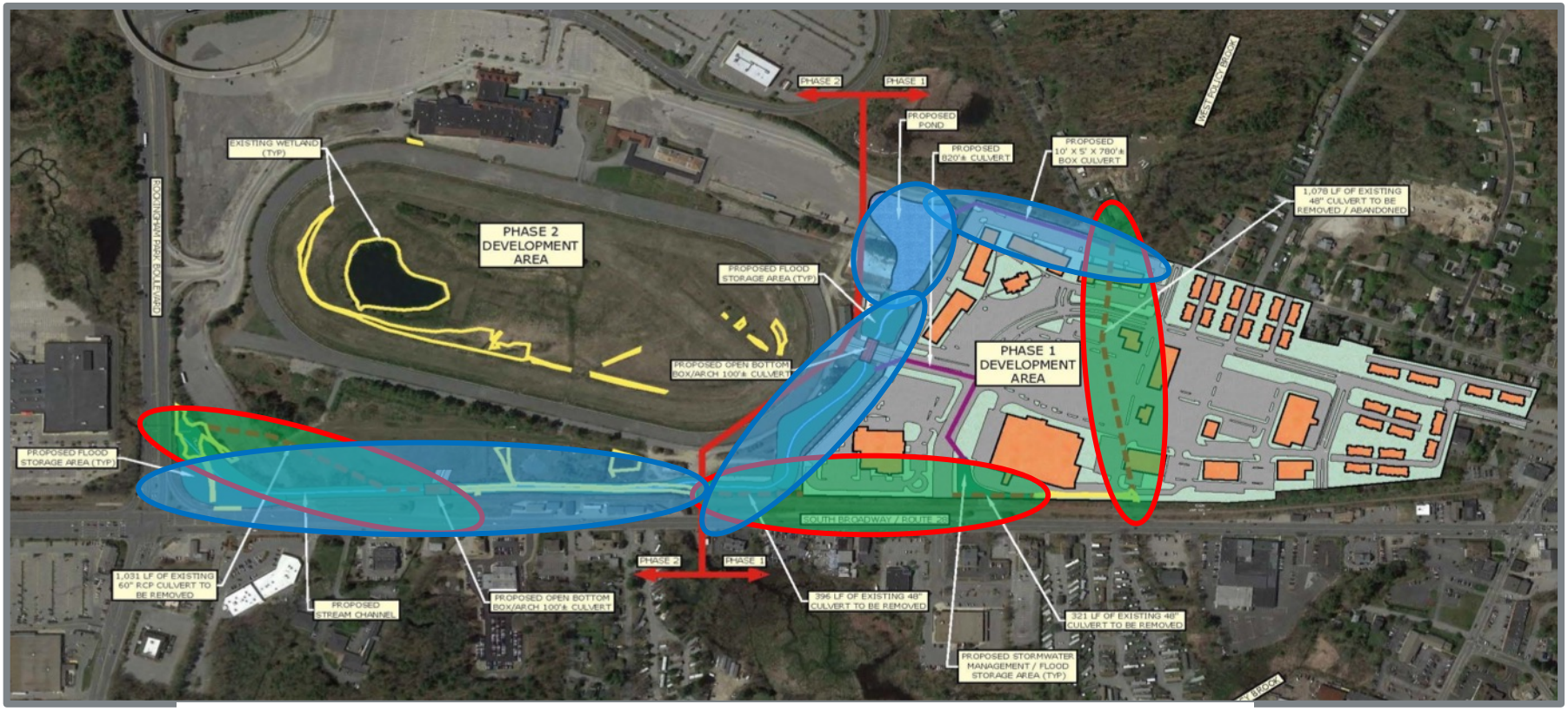
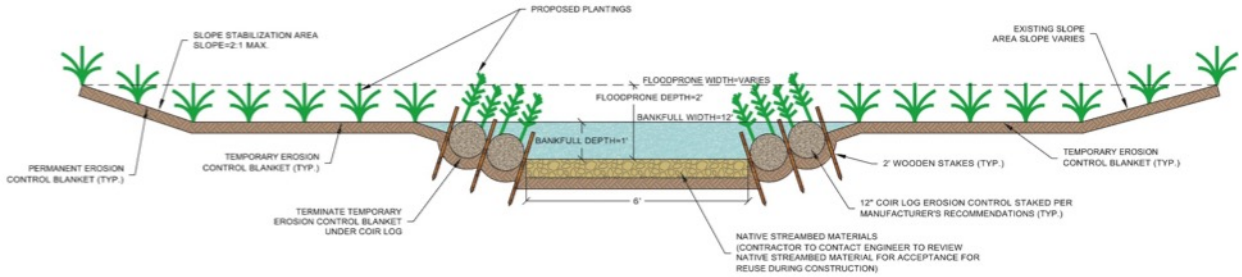
Conceptual Stream Restoration and Floodplain Improvement Plan





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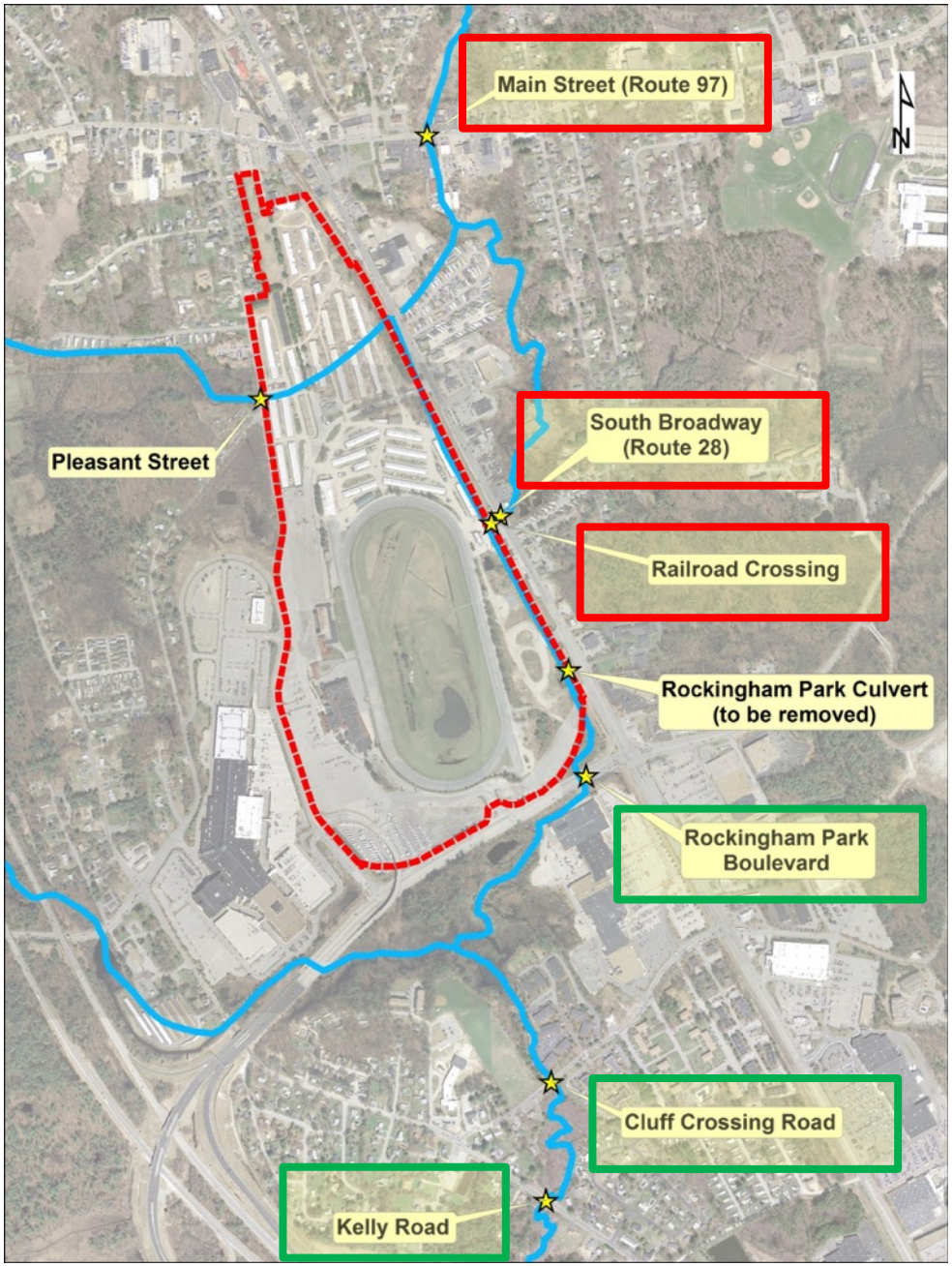
Modeling Approach

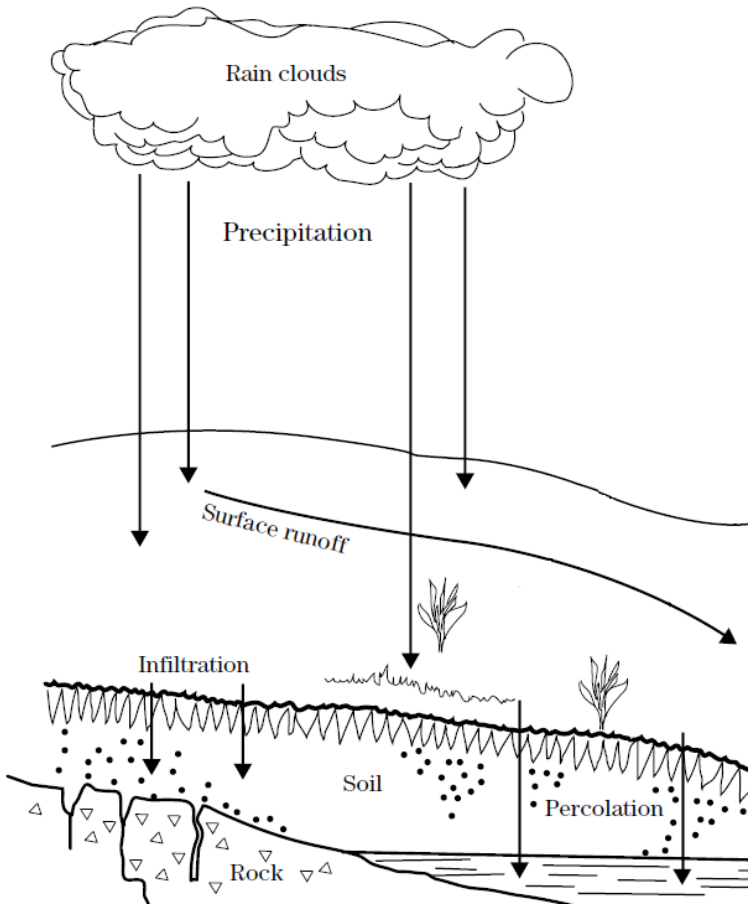
- **Onsite Model Components**
  - Culvert “A” and “B” / Pleasant Street
  - Policy Brook
  - Rockingham Park Culvert
- **Near site Model Component**
  - Sediment Blocking Downstream Culvert

Modeling Approach

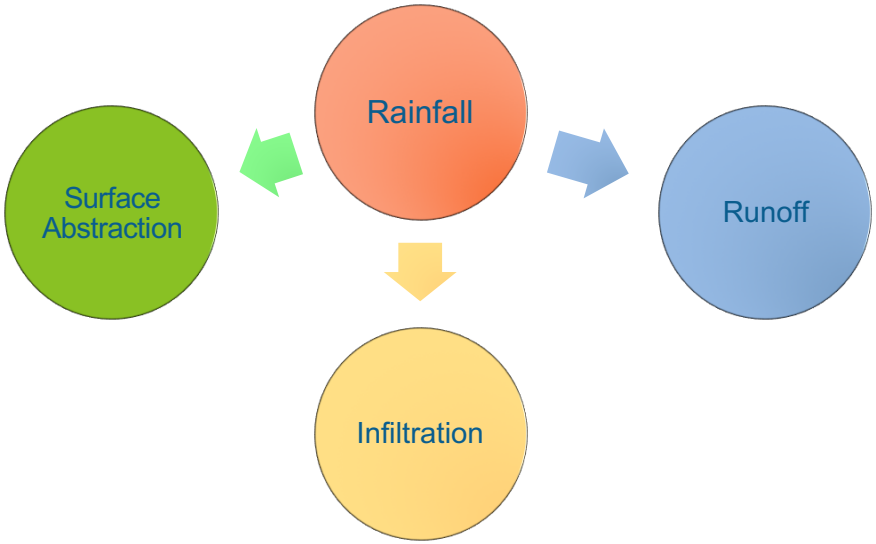
- **Offsite Model Components**
  - Upstream of Site
    - Main Street (Route 97)
    - South Broadway (Route 28)
    - Railroad Crossing
  - Downstream of Site
    - Rockingham Park Boulevard
    - Cluff Crossing Road
    - Kelly Road



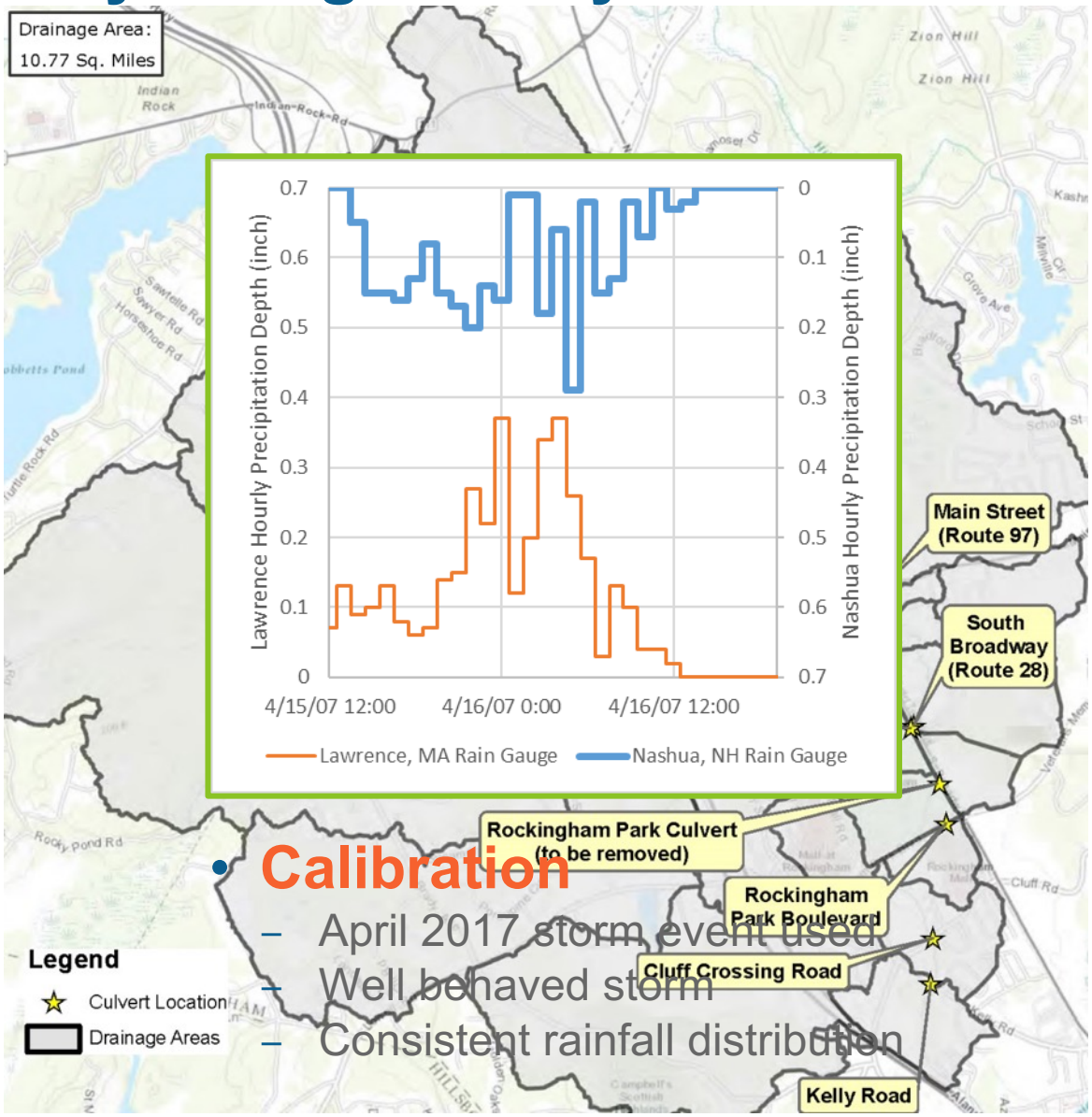
Hydrology - Overview



- **Science of hydrologic cycle (water)**
- **What is the flow of water?**
  - 2-percent-annual chance flood (50-year frequency storm)



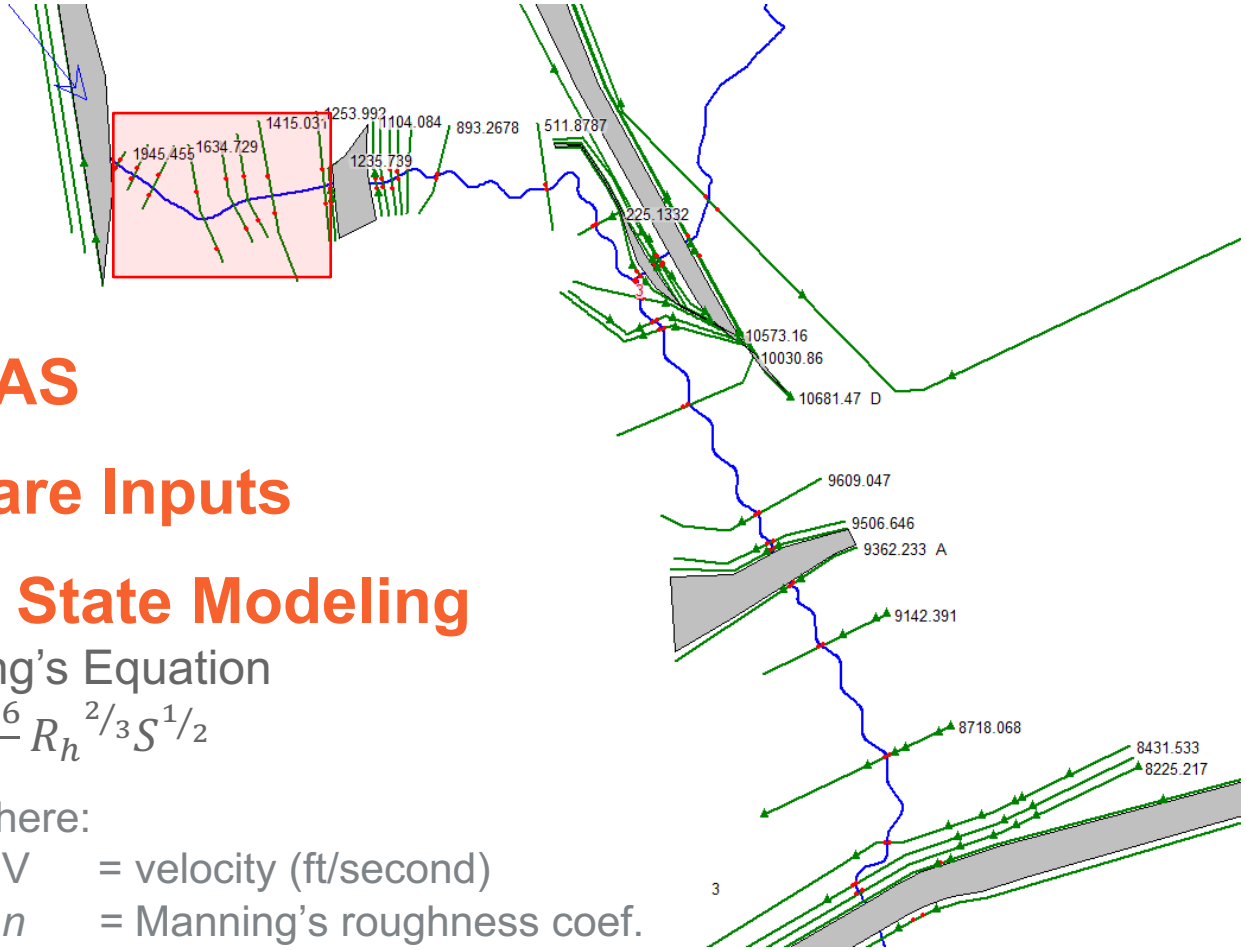
Hydrologic Analysis



- **Calibration**
  - April 2017 storm event used
  - Well behaved storm
  - Consistent rainfall distribution

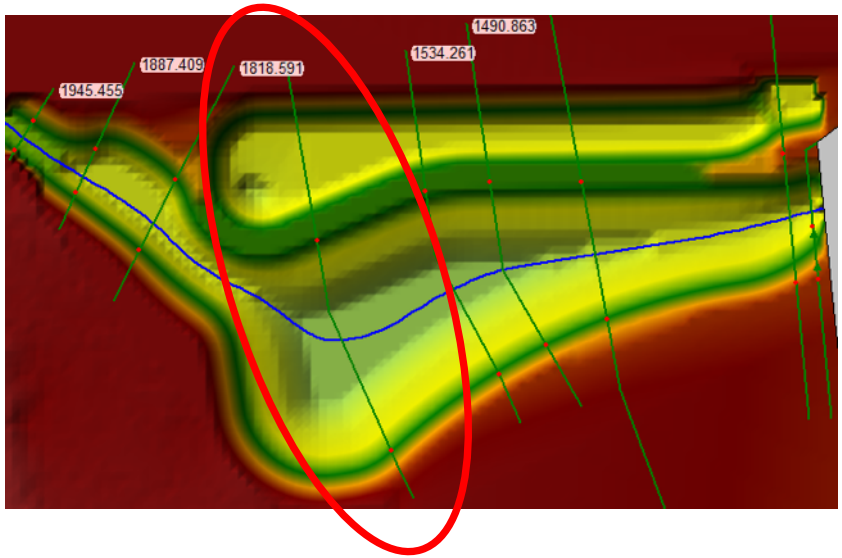
- **HEC-HMS**
- **Drainage Area**
  - 10.8 Square Miles
  - 17 Sub-catchments
- **Approach**
  - Infiltration:
    - Curve Number
  - Time of Concentration:
    - Velocity Method
  - Routing:
    - Muskingum-Cunge
  - Precipitation
    - NOAA Atlas 14

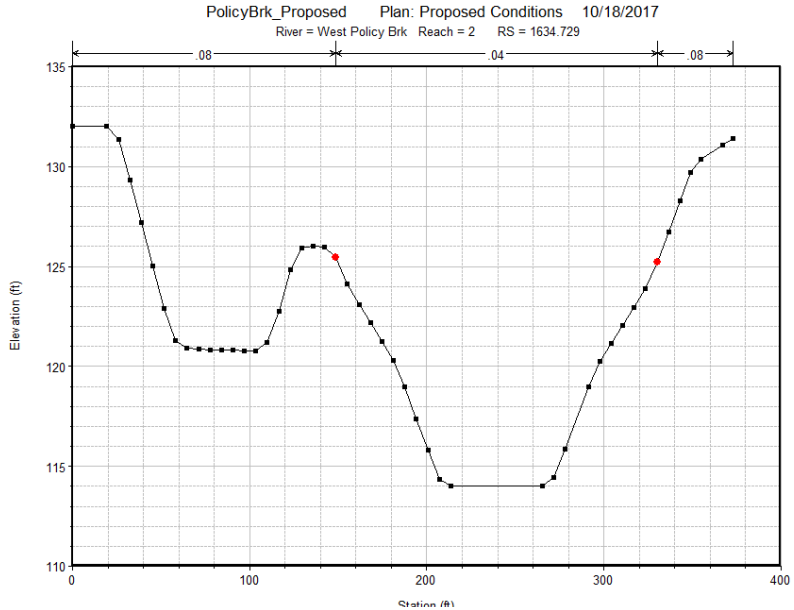
Hydraulics - Overview

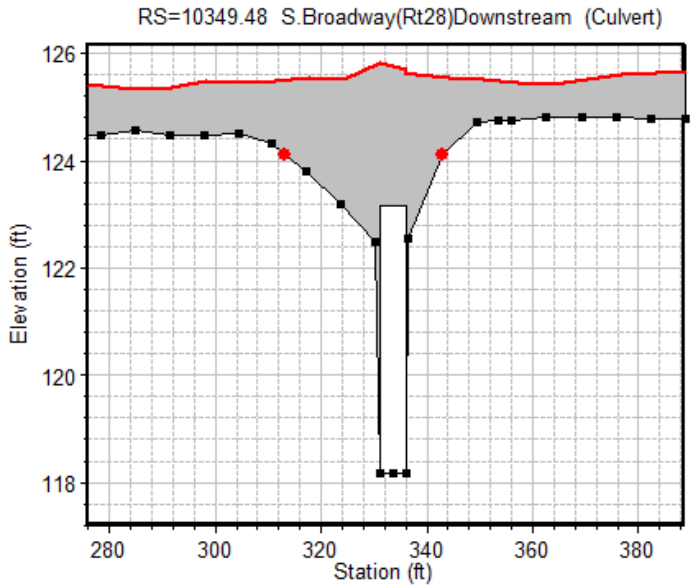


- **HEC-RAS**
- **Flows are Inputs**
- **Steady State Modeling**
  - Manning's Equation
  - $V = \frac{1.486}{n} R_h^{2/3} S^{1/2}$
    - » Where:
      - V = velocity (ft/second)
      - *n* = Manning's roughness coef.
      - R_h = hydraulic radius (ft)
      - S = channel slope ft/ft
- **Geometry**

Hydraulic Analysis







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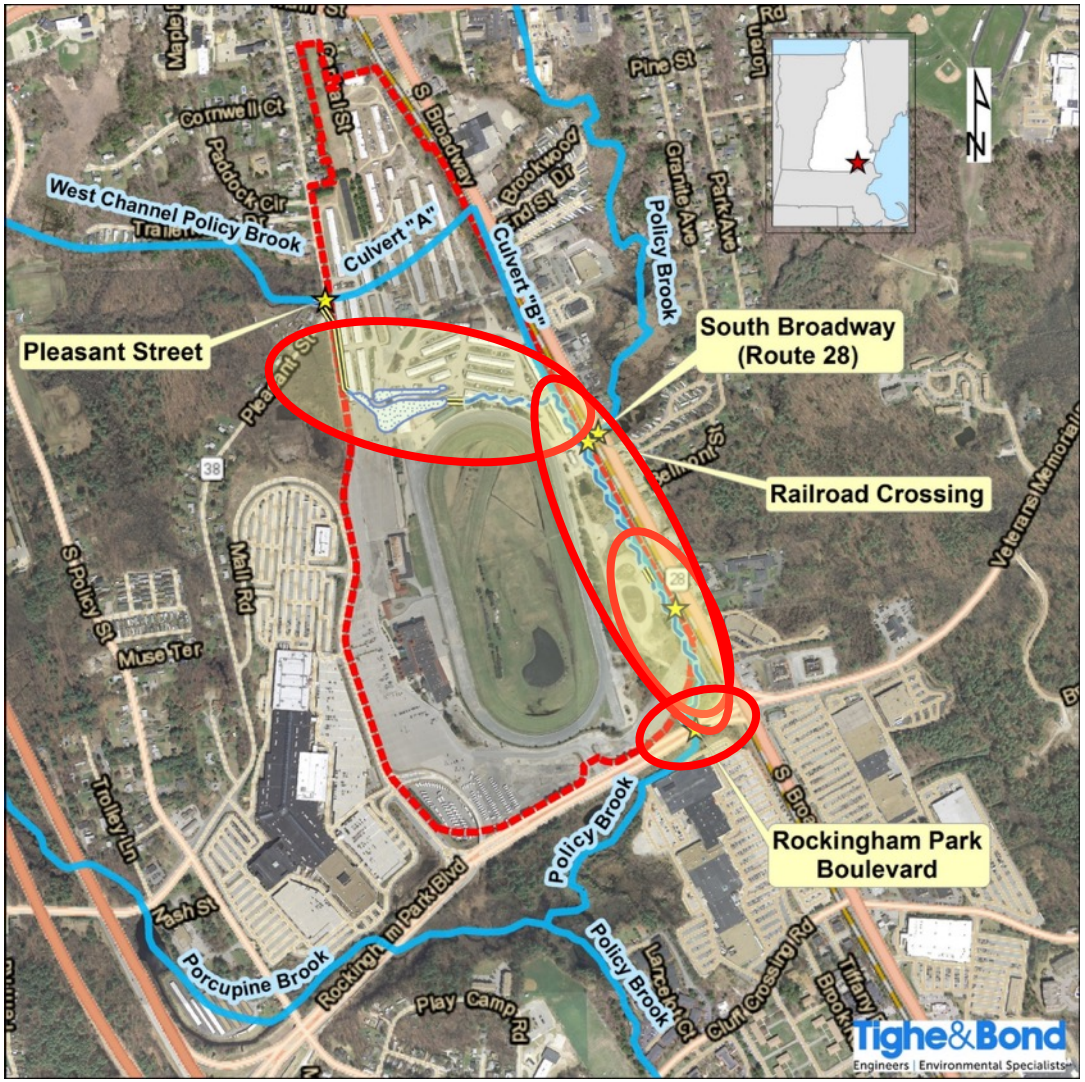
Hydraulic Analysis – Proposed Conditions

- **Stream Daylighting**
  - West Channel (center of site)
  - Rockingham Park Culvert (south east of site)
- **Stream Restoration**
- **Sediment Removal**
- **Proposed Culverts**
  - Replacement of Pleasant Street Culvert
  - Bridged as part of redevelopment
  - Culverts sized for 50-year storm event



Hydraulic Analysis – Objectives/Results

- **Representation of existing conditions**

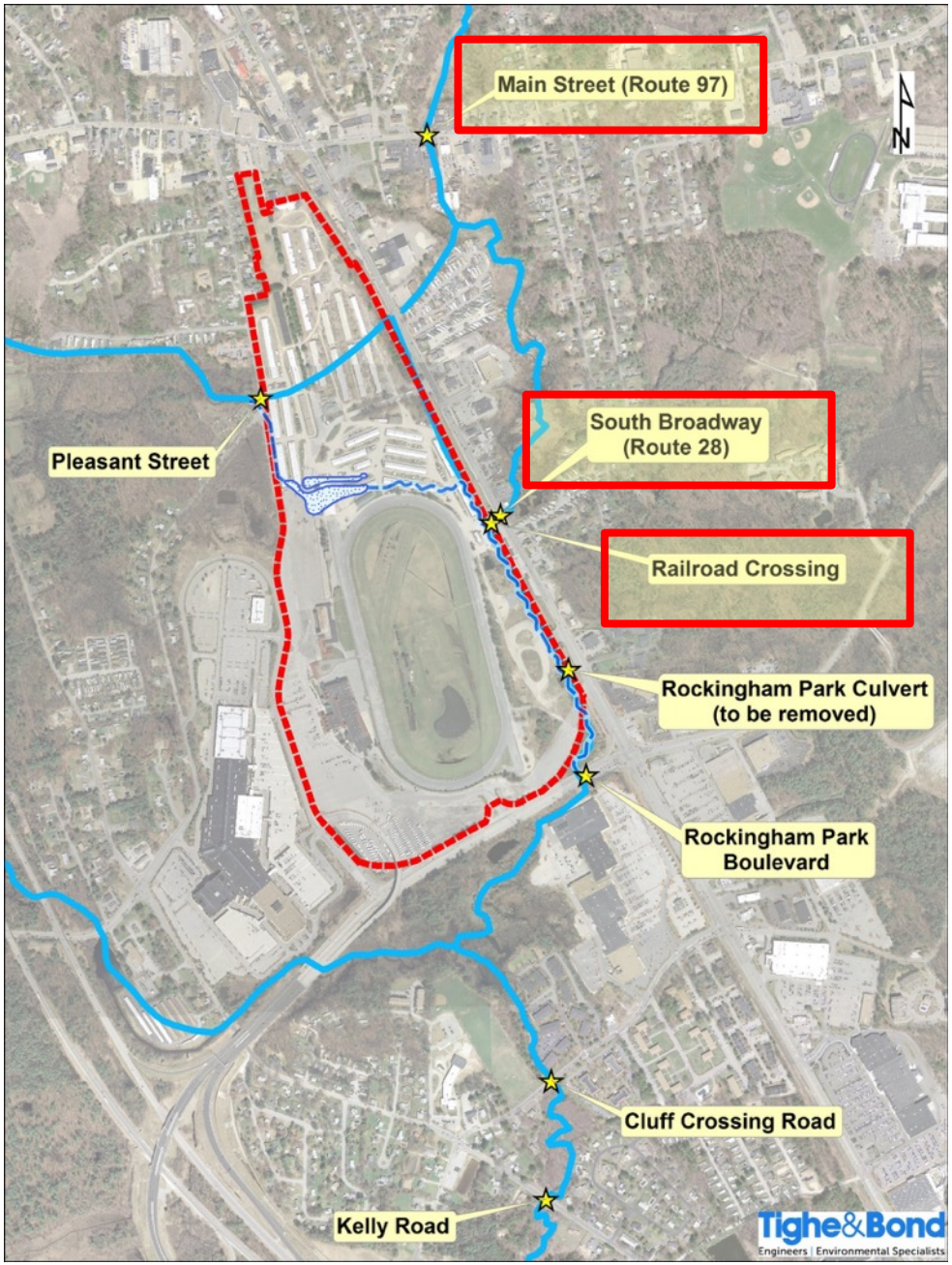
Location	Approx. Min. Elevation to Overtop Road	Upstream Water Surface Elevations[4] (NGVD29)				
		2-year	10-year	25-year	50-year	100-year
Main Street (Route 97)[1]	127.5	124.1	128.0	128.1	128.3	128.5
Pleasant Street[2]	130.3	127.0	130.6	130.9	131.1	131.1
South Broadway (Route 28)[3]	125.6	123.3	125.8	126.4	127.0	127.4
Railroad Bridge[3]	125.7	123.2	125.3	126.4	127.0	127.4
Rockingham Park Boulevard[3]	126.5	120.2	121.4	123.6	126.7	126.7
Cluff Crossing Road[3]	122.8	116.3	120.4	122.5	124.1	124.6
Kelley Road[3]	117.3	114.1	116.7	118.0	118.8	119.8

- **Evaluation of proposed design**
- **Assessment of increased resiliency**

Location	Approx. Min. Elevation to Overtop Road	Upstream Water Surface Elevations[4] (NGVD29)				
		2-year	10-year	25-year	50-year	100-year
Main Street (Route 97)[1]	127.5	124.1	127.9	128.1	128.3	128.5
Pleasant Street[2]	130.3	125.7	127.7	129.1	129.9	131.2
South Broadway (Route 28)[3]	125.6	120.9	123.1	125.1	126.2	127.6
Railroad Bridge[3]	125.7	120.8	123.0	124.9	126.2	127.6
Rockingham Park Boulevard[3]	126.5	120.2	122.0	124.2	125.4	126.7
Cluff Crossing Road[3]	122.8	116.3	120.9	123.3	124.2	124.4
Kelley Road[3]	117.3	114.1	117.1	118.2	119.0	119.7

Hydraulic Analysis – Public Benefit

- **Services Beyond Typical Design Scope**
  - Alternatives for potential future improvements by the Town of Salem
  - Three undersized culverts upstream of site considered
  - Recommendations developed in coordination with the Town of Salem



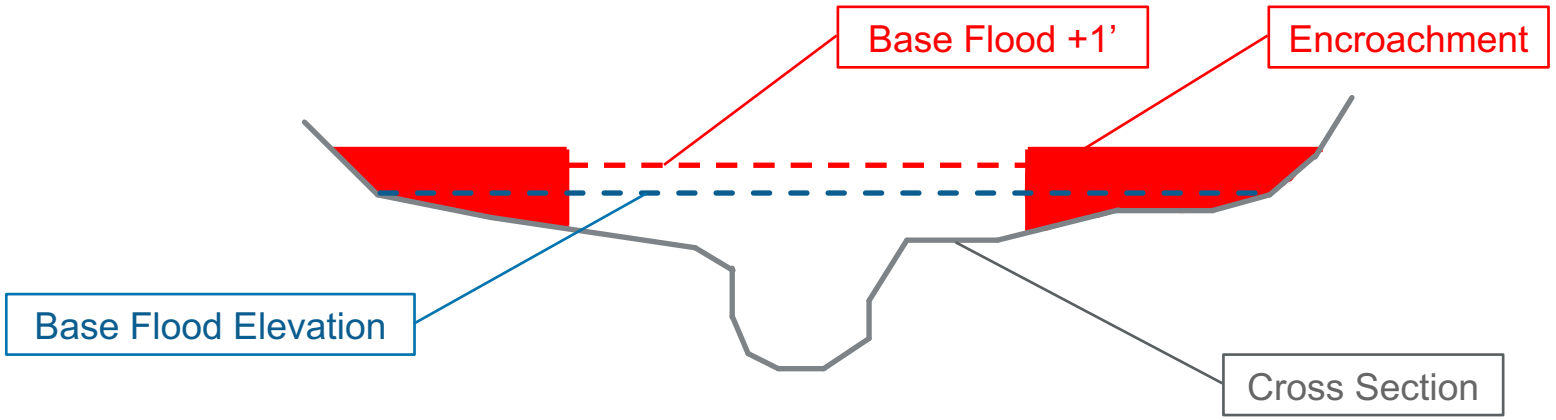
Hydraulic Analysis – Public Benefit (cont.)

Storm Return Frequency	Water Surface Elevation Upstream of South Broadway (Route 28)					
	Existing	Proposed	Scenario "A"	Scenario "B"	Scenario "C"	Scenario "D"
10-year	125.8	123.1	123.1	122.9	122.8	122.9
25-year	126.4	125.1	124.2	124.8	124.7	124.9
50-year	127.0	126.2	125.7	126.1	126.0	126.0
100-year	127.4	127.6	127.6	127.4	127.6	127.6

- **How does this all tie into FEMA requirements?**
  - Evaluation of alternatives did not play role
  - Portions of the hydraulic model used

CLOMR – FEMA Definitions

- Base Flood = 1-percent annual chance flood = “100-year flood”
- Special Flood Hazard Area (SFHA) = The land area covered by the floodwaters of the base flood = 100-year floodplain
- Regulatory Floodway = Area to be kept free of encroachments so base flood can be conveyed **without** causing an increase of a specified elevation (typically 1-foot)



- LOMR = Letter of Map Revision
  - Required after changes are made that impact FEMA Flood Insurance Study
- CLOMR = Condition Letter of Map Revision
  - Required **PRIOR** to **CERTAIN** changes

Flood Insurance Rate Map (FIRM) panels. The study area includes FIRM map number 33015C0563E (Panel 563 of 681)

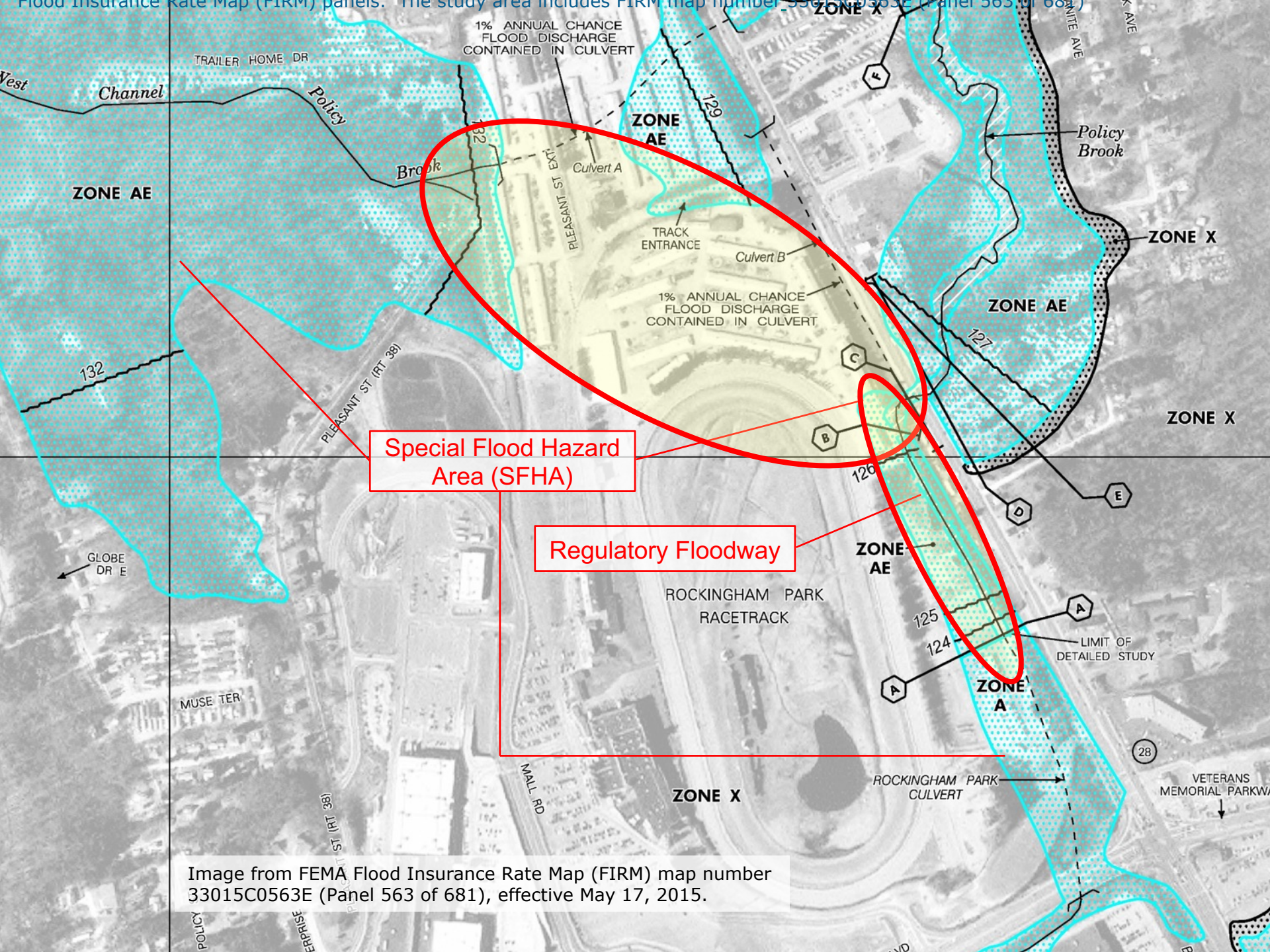
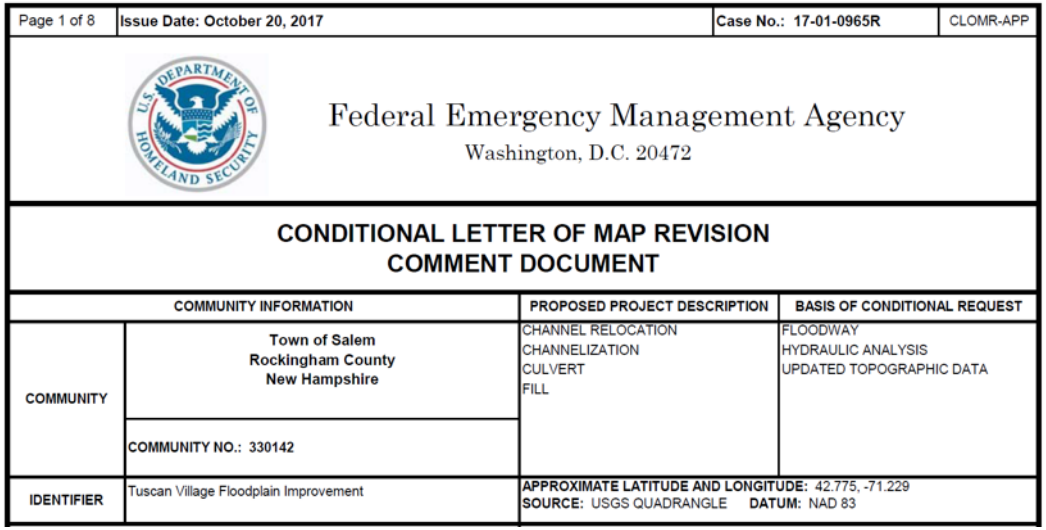


Image from FEMA Flood Insurance Rate Map (FIRM) map number 33015C0563E (Panel 563 of 681), effective May 17, 2015.

CLOMR – Background

- **Why a CLOMR was required**
  - Stream restoration modified regulatory floodway
  - Previous modeling did not account for backwater from downstream culverts
  - New SFHA for areas without a regulated floodway established
- **CLOMR Requirements**
  - Narrative
  - MT-2 Application Form
  - Hydrologic Analysis (if applicable)
  - Hydraulic Analysis
  - Certified Topographic Work Map
  - Annotated FIRM
  - Endangered Species Act Compliance
  - Documentation of legal notice to affected property owners



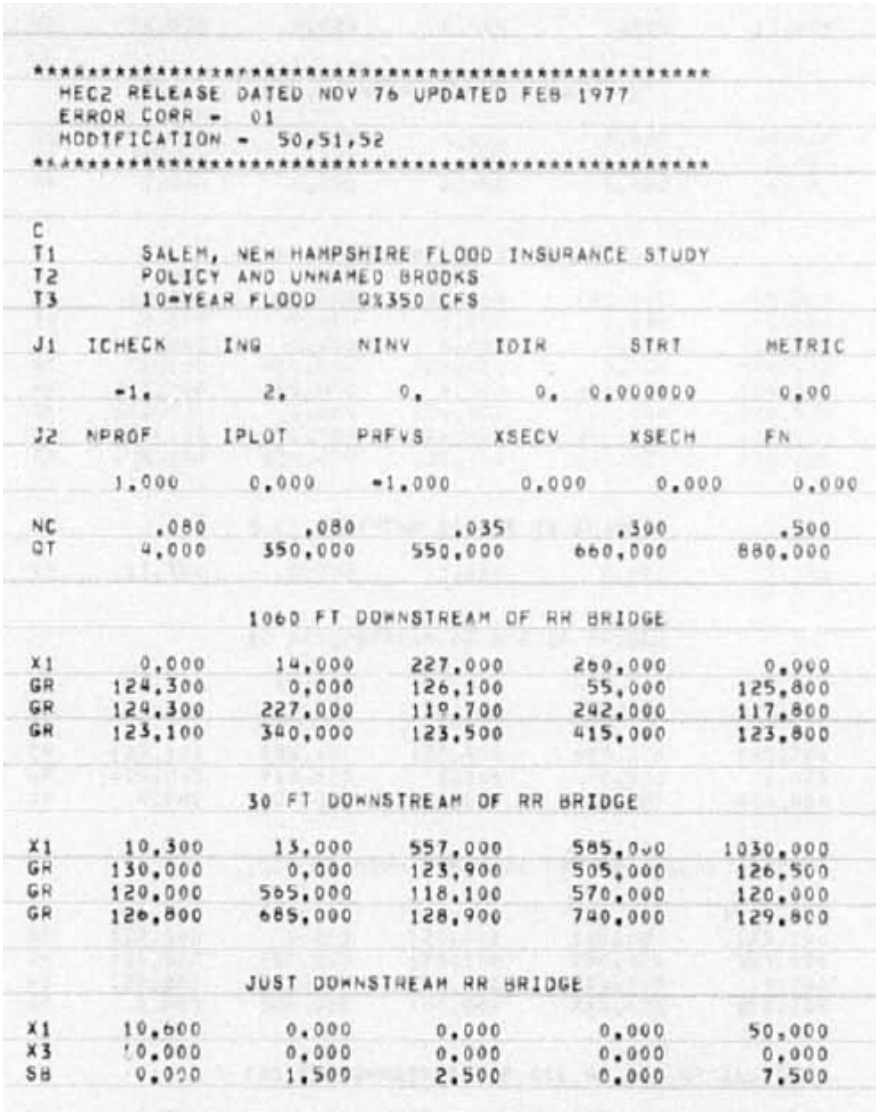
Page 1 of 8	Issue Date: October 20, 2017	Case No.: 17-01-0965R	CLOMR-APP

Federal Emergency Management Agency
Washington, D.C. 20472

CONDITIONAL LETTER OF MAP REVISION
COMMENT DOCUMENT

COMMUNITY INFORMATION		PROPOSED PROJECT DESCRIPTION	BASIS OF CONDITIONAL REQUEST
COMMUNITY	Town of Salem Rockingham County New Hampshire	CHANNEL RELOCATION CHANNELIZATION CULVERT FILL	FLOODWAY HYDRAULIC ANALYSIS UPDATED TOPOGRAPHIC DATA
	COMMUNITY NO.: 330142		
IDENTIFIER	Tuscan Village Floodplain Improvement	APPROXIMATE LATITUDE AND LONGITUDE: 42.775, -71.229 SOURCE: USGS QUADRANGLE DATUM: NAD 83	

CLOMR – Modeling and Extent



```
**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED FEB 1977
  ERROR CORR -  01
  MODIFICATION -  50,51,52
**************************************************

C
T1       SALEM, NEW HAMPSHIRE FLOOD INSURANCE STUDY
T2       POLICY AND UNNAMED BROOKS
T3       10-YEAR FLOOD   QX350 CFS

J1  ICHECK     INQ        NINV       IDIR       STRT       METRIC

       -1.       2.         0.         0.   0.000000        0.00

J2  NPROF      IPLOT      PRFVS      XSECV      XSECH      FN

      1.000      0.000     -1.000      0.000      0.000      0.000

NC      .080       .080       .035       .300       .500
QT     4.000    350.000    550.000    660.000    880.000

                1060 FT DOWNSTREAM OF RR BRIDGE

X1      0.000     14.000    227.000    260.000      0.000
GR    124.300      0.000    126.100     55.000    125.800
GR    124.300    227.000    119.700    242.000    117.800
GR    123.100    340.000    123.500    415.000    123.800

                30 FT DOWNSTREAM OF RR BRIDGE

X1     10.300     15.000    557.000    585.000   1030.000
GR    130.000      0.000    123.900    505.000    126.500
GR    120.000    565.000    118.100    570.000    120.000
GR    120.800    685.000    128.900    740.000    129.800

                JUST DOWNSTREAM RR BRIDGE

X1     10.600      0.000      0.000      0.000     50.000
X3     10.000      0.000      0.000      0.000      0.000
SB      0.000      1.500      2.500      0.000      7.500
```

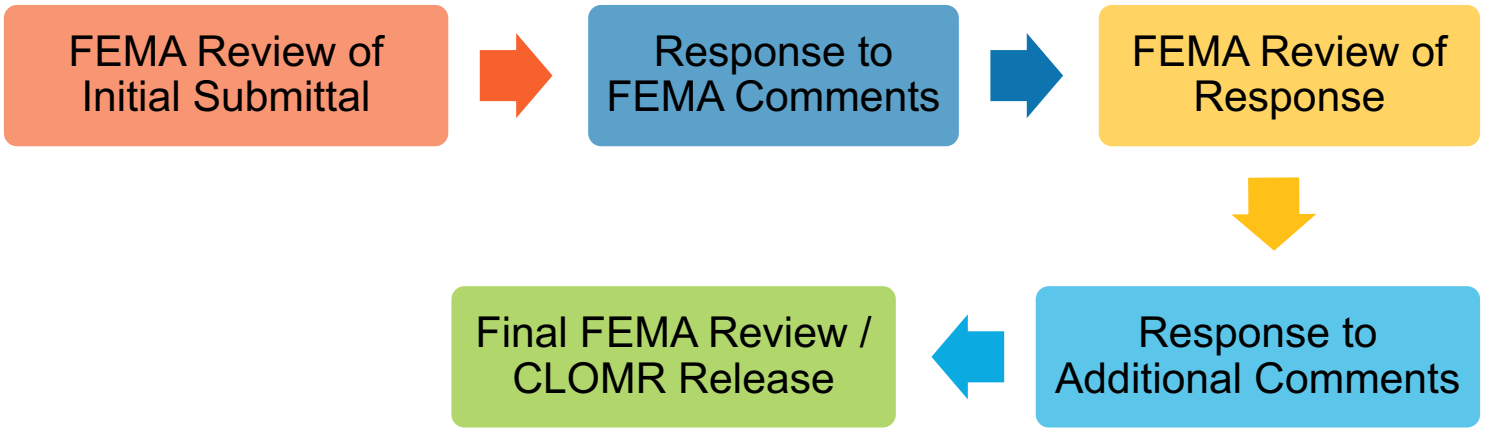
- **Required Models**
  - Duplicate Effective Model
    - Effective models used HEC-2, WSP2, and hand calculations
  - Corrected Effective Model
  - Existing or Pre-Project Conditions Model
  - Revised or Post-Project Conditions Model
- **Required Extent**
  - Extend until base flood elevations +/- 0.5 feet of the effective FEMA model
  - Decrease in BFE required extending of West Channel
  - Subset of overall hydraulic model

CLOMR – Purpose and Timing

- **Rational for Floodplain Management**
  - Protect lives and property

"Permitting and government approvals helped keep my project schedule"

- Said no one.

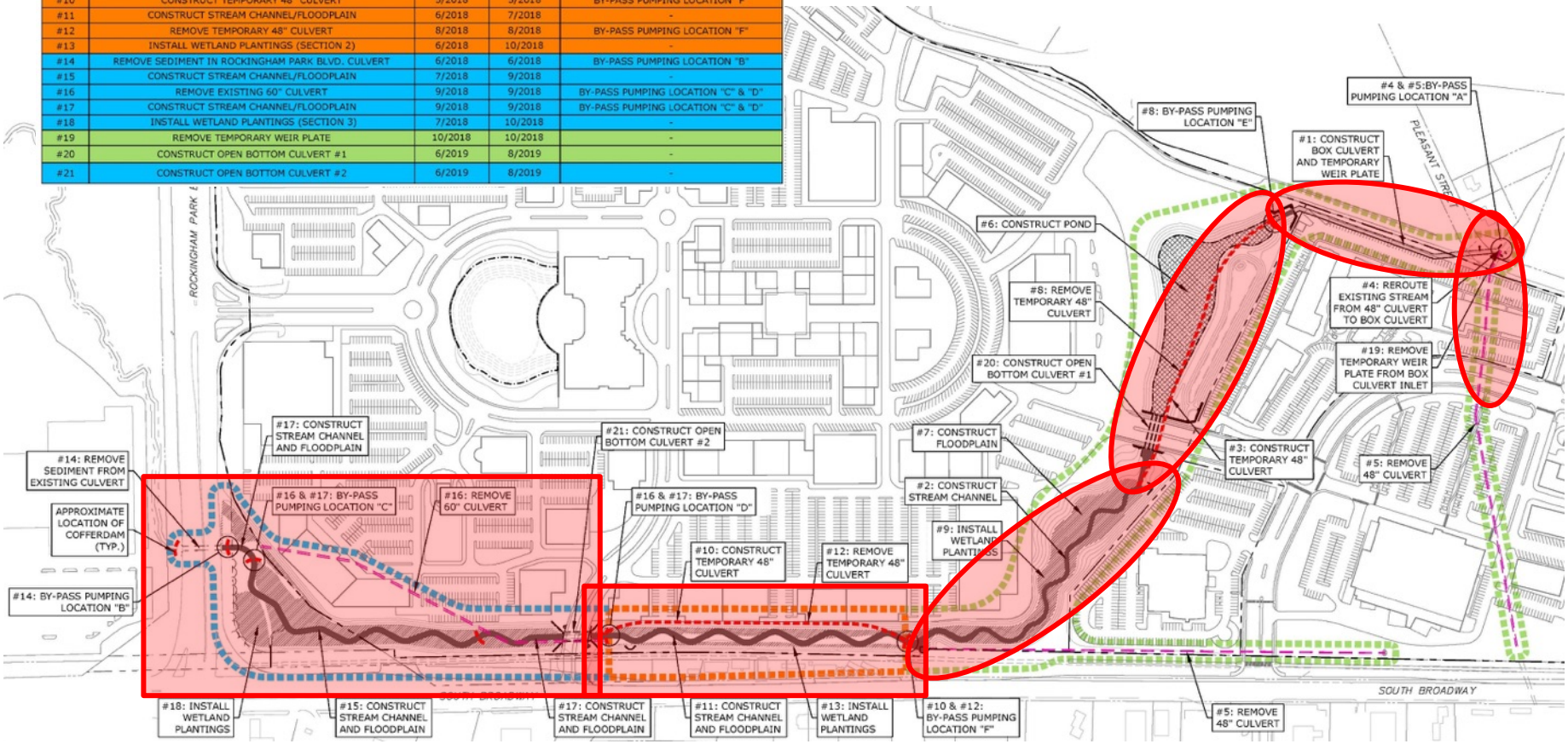


- **8 month process after initial submittal**
  - Complicated case (as noted by CLOMR reviewer)
  - Construction of hydraulic elements could begin following CLOMR release

Construction Sequencing Plan

CONSTRUCTION SEQUENCE TABLE

ITEM NO.	DESCRIPTION	START DATE (APPROX.)	END DATE (APPROX.)	NOTES
#1	CONSTRUCT 5' X 11' BOX CULVERT AND TEMPORARY WEIR PLATE	9/2017	11/2017	SEE NOTE #1
#2	CONSTRUCT STREAM CHANNEL	9/2017	11/2017	-
#3	CONSTRUCT TEMPORARY 48" CULVERT	10/2017	11/2017	-
#4	REROUTE STREAM	11/2017	11/2017	BY-PASS PUMPING LOCATION "A"
#5	REMOVE EXISTING 48" CULVERTS	11/2017	12/2017	BY-PASS PUMPING LOCATION "A"
#6	CONSTRUCT POND	12/2017	4/2018	-
#7	CONSTRUCT FLOODPLAIN	5/2018	7/2018	-
#8	REMOVE TEMPORARY 48" CULVERT	5/2018	5/2018	BY-PASS PUMPING LOCATION "E"
#9	INSTALL WETLAND PLANTINGS (SECTION 1)	5/2018	10/2018	-
#10	CONSTRUCT TEMPORARY 48" CULVERT	5/2018	5/2018	BY-PASS PUMPING LOCATION "F"
#11	CONSTRUCT STREAM CHANNEL/FLOODPLAIN	6/2018	7/2018	-
#12	REMOVE TEMPORARY 48" CULVERT	8/2018	8/2018	BY-PASS PUMPING LOCATION "F"
#13	INSTALL WETLAND PLANTINGS (SECTION 2)	6/2018	10/2018	-
#14	REMOVE SEDIMENT IN ROCKINGHAM PARK BLVD. CULVERT	6/2018	6/2018	BY-PASS PUMPING LOCATION "B"
#15	CONSTRUCT STREAM CHANNEL/FLOODPLAIN	7/2018	9/2018	-
#16	REMOVE EXISTING 60" CULVERT	9/2018	9/2018	BY-PASS PUMPING LOCATION "C" & "D"
#17	CONSTRUCT STREAM CHANNEL/FLOODPLAIN	9/2018	9/2018	BY-PASS PUMPING LOCATION "C" & "D"
#18	INSTALL WETLAND PLANTINGS (SECTION 3)	7/2018	10/2018	-
#19	REMOVE TEMPORARY WEIR PLATE	10/2018	10/2018	-
#20	CONSTRUCT OPEN BOTTOM CULVERT #1	6/2019	8/2019	-
#21	CONSTRUCT OPEN BOTTOM CULVERT #2	6/2019	8/2019	-



Tighe&Bond

Box Culvert Installation

Pleasant Street Headwall

Box Culvert Installation

Temporary Bypass

West Channel Policy Brook Construction

West Channel Policy Brook Construction

West Channel Policy Brook Construction

West Channel Policy Brook Construction

West Channel Policy Brook Construction

Water Levels During Construction


Tuscan Village
April 26, 2018

Osprey

Tighe&Bond

Engineers | Environmental Specialists