CITY OF MELROSE
DEPARTMENT OF PUBLIC WORKS

LOMR SUBMITTAL

Ell Pond Drainage Improvements

FEMA Community No.: 250206

Melrose, Massachusetts

November 30, 2017

CDM Smith

CDM Smith

75 State Street, Suite 701
Boston, Massachusetts 02109
tel: 617 452-6000

November 30, 2017

LOMC Clearinghouse
3601 Eisenhower Avenue, Suite 500
Alexandria, VA 22304-6426

Subject: Application for Letter of Map Revision (LOMR)
Ell Pond, Melrose, Massachusetts
NFIP Community No. 250206

Dear LOMC Clearinghouse:

On behalf of the City of Melrose, Massachusetts, CDM Smith is pleased to submit this Application for a Letter of Map Revision (LOMR) for Ell Pond. The City engaged CDM Smith to update the existing hydrologic and hydraulic analysis to study the benefit of recently constructed Ell Pond Drainage improvements for reducing the Base Flood Elevation (BFE) for Ell Pond.

Please find with this letter the completed MT-2 Application Forms and supporting documentation.

The updated detailed study supports a reduction of the effective BFE from 53.4-feet (NAVD88) to 49.9-feet (NAVD88).

We believe that the information provided is complete and adequate for your review. Please contact us if you have any questions or require any additional information.

Sincerely,

Ronald D. Miner, P.E.
Associate, CDM Smith Inc.
Email: MinerRD@cdmsmith.com
Phone: 617-452-6088

cc: John V. Scenna, DPW Director, City of Melrose
Elena Proakis Ellis, P.E., BCEE, City Engineer, City of Melrose
Derek Etkin, P.E., CDM Smith

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ELL POND
HYDROLOGIC AND HYDRAULIC SUBMITTAL
Executive Summary

Middlesex County
Melrose, Massachusetts

November 2017

In March 2017, the City of Melrose contracted CDM Smith to evaluate the validity of the existing FEMA stillwater Base Flood Elevation (BFE) for Ell Pond. The current BFE is based on an engineering analysis performed in 1981. Since that study was completed, the City of Melrose constructed a new pond outlet works in 2007, including an adjustable crest gate, and a second storm drain conduit. The new 48" storm drain was designed to increase the capacity of the outlet discharge.

In April, 2017, CDM Smith submitted a technical memorandum to the City describing a detailed and updated hydrologic and hydraulic analysis of the 100-year peak annual water surface elevation in Ell Pond. The proposed 100-year peak annual water surface is lower than the effective BFE. The submission of this MT-2 application represents the City's intent to have FEMA issue a Letter of Map Revision (LOMR) for Ell Pond to reflect this updated BFE.

The following narrative parts one through three provide background information, describe the updated study approach, document hydrologic and hydraulic computations in support of the proposed BFE.

This document and supporting information details the requirements of the LOMR submission and the steps taken to prepare the Corrected Effective Model. It also contains appropriate data and information (either in paper of digital form) needed to support the proposed map revision for Ell Pond stillwater BFE.

Completed Forms

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires February 28, 2014

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
250206	City of Melrose	MA	25017C	0433	06/04/10
250206	City of Melrose	MA	25017C	0429	06/04/10

2. a. Flooding Source: Ell Pond

   b. Types of Flooding: ☐ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)
   ☐ Alluvial fan ☒ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Ell Pond H&H Analysis Update

4. FEMA zone designations affected: AE (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

   a. The basis for this revision request is (check all that apply)

   ☒ Physical Change ☒ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes
   ☐ Coastal Analysis ☒ Hydraulic Analysis ☒ Hydrologic Analysis ☒ Corrections
   ☒ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes
   ☒ New Topographic Data ☐ Other (Attach Description)

   Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

b. The area of revision encompasses the following structures (check all that apply)

Structures:

- ☐ Channelization
- ☐ Levee/Floodwall
- ☒ Bridge/Culvert
- ☐ Dam
- ☐ Fill
- ☐ Other (Attach Description)

6. ☐ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

C. REVIEW FEE

Has the review fee for the appropriate request category been included?

☐ Yes Fee amount: $Exempt

☒ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm for Fee Amounts and Exemptions.

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Ronald D. Miner	Company: CDM Smith Inc.	
Mailing Address: 75 State Street, Suite 701 Boston, MA 02109	Daytime Telephone No.: 617-452-6088	Fax No.: 617-345-3901
	E-Mail Address: MinerRD@cdmsmith.com	
Signature of Requester (required):	Date: November 30, 2017	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirements for when fill is placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Robert J. Dolan, Mayor, City of Melrose	Community Name: Melrose, MA	
Mailing Address: City of Melrose 562 Main Street Melrose, MA 02176	Daytime Telephone No.: 781-979-4440	Fax No.: 781-662-2182
	E-Mail Address: mayorsoffice@cityofmelrose.org	
Community Official's Signature (required):	Date: November 30, 2017	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Ronald D. Miner	License No.: 33047 MA Civil	Expiration Date: 6/30/2018
Company Name: CDM Smith	Telephone No.: 617-452-6088	Fax No.: 617-345-3901
Signature:	Date: 11/30/17	E-Mail Address: MinerRD@cdmsmith.com

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if ...
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☒ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

COMMONWEALTH OF MASSACHUSETTS
RONALD D.
MINER
CIVIL
No. 33047
REGISTERED
PROFESSIONAL ENGINEER

Seal (Optional)

Explanation of Review Fee:

This LOMR application is based on submission of an updated detailed study following construction of a project where 50 percent or more of the project's costs were federally funded. In this case the City of Melrose constructed a new pond outlet works in 2007-2008 in part with 75% funding from FEMA's Pre-Disaster Mitigation (PDM-C) Program. According to the fee schedule located at https://www.fema.gov/flood-map-related-fees viewed on November 30, 2017, the fee is waived.

The "FEMA Grant Funding Approval Letter 2005.pdf" document is attached to support this explanation of fee.

Reference: https://www.fema.gov/flood-map-related-fees

Fee Exemption for Map Change Requests (excerpt)

In accordance with Section 72.5 of the NFIP regulations, review and processing fees are not required for the following types of map change requests:

- Federally sponsored flood-control projects where 50 percent or more of the project's costs are federally funded

RECEIVED

NOV 14

dcr

MELROSE-PUBLIC WORKS

THE COMMONWEALTH OF MASSACHUSETTS

MASSACHUSETTS EMERGENCY MANAGEMENT AGENCY
400 WORCESTER RD., FRAMINGHAM, MA 01702-5399 508-820-2000 FAX 508-820-1404

DEPARTMENT OF CONSERVATION AND RECREATION
251 CAUSEWAY STREET, SUITE 600-900, BOSTON, MA 02114-2104 617-626-1250 FAX 617-626-1351

Cristine McCombs
DIRECTOR

Mitt Romney
GOVERNOR

Stephen H. Burrington
COMMISSIONER

November 10, 2005

Bob-
Sorry for the delay -- Scott

Bob Beshara, City Engineer
Town of Melrose
City Hall
562 Main St.
Melrose, MA 02176

Re: Pre-Disaster Mitigation (PDM-C) Program
Grant Number PDM-C 05-10
Ell Pond Flood Hazard Mitigation Project

Dear Mr. Beshara:

The Federal Emergency Management Agency (FEMA) has approved PDM-C funding for the City of Melrose '*Ell Pond Flood Hazard Mitigation Project*'.

The City of Melrose has received an award of $1,745,700 and will be reimbursed for 75% of approved, allowable and eligible costs, up to the award, as stipulated by the grant agreement and OMB Circular A-87. This is a reimbursable grant program and expenses have to be incurred and paid prior to being reimbursed.

In order to execute this agreement, the following tasks relative to the attached grant agreement must be completed:

1) The CEO must complete, sign and HAND date the **Standard Contract Form.**
2) Please complete a planning work schedule and budget as specified in **Attachment B (Budget Information) and B-II (Work Schedule)** and have the CEO sign.
3) The CEO must appoint a local Project Manager / Applicant's Agent for this Agreement. Once this appointment is made, please complete and sign the **Designation of Applicant's Agent Form** provided as **Attachment D.**
4) The CEO must sign and have notarized **Attachment D-II (Contractor Authorized Signature Verification Form).**

5) The CEO must complete and sign **Attachment E (Commonwealth Terms and Conditions)**.

6) **Attachment F (Request for Funds)** is included for your reference and will need to be completed and accompany future requests for reimbursement. Funds can be requested at any point in the work schedule. Once you are ready to request funds, please contact me and I will send you guidance to assist you with this process.

7) The CEO must complete and sign **Attachment G-III (Certification of Compliance with OMB Circular A-133), G-IV (MEMA Quarterly Report).** As described in **Attachment C (Additional Terms & Conditions), Attachment G-IV** must be provided on a quarterly basis.

Please return this fully executed contract package to:

Scott MacLeod, Mitigation Grants Manager
Massachusetts Emergency Management Agency
400 Worcester Rd.
Framingham, MA 01702

Once the CEO has signed all required forms, MEMA will approve the contract and return an executed copy to you; the Applicant Agent can then assume signatory authority if the CEO desires. Please carefully review all provisions of the attached grant agreement prior to execution. **Attachment A** outlines the scope of the project and if you have any questions, please feel free to contact us about it.

Please do not hesitate to contact me at (508) 820-1445 with any questions or concerns regarding the PDM-C grant agreement and associated paperwork.

Sincerely,

Scott C. MacLeod

Scott MacLeod
Mitigation Grants Manager

Enclosures

U.S. DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 3.5 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington VA 20958-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Ell Pond

Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

   ☐ Not revised (skip to section B) ☐ No existing analysis ☒ Improved data
   ☒ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)

3. Methodology for New Hydrologic Analysis (check all that apply)

   ☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model → Specify Model: HEC-HMS
   ☐ Regional Regression Equations ☐ Other (please attach description)

   Please enclose all relevant models in digital format, maps, computations (including computation of parameters), and documentation to support the new analysis.

4. Review/Approval of Analysis

   If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

   Is the hydrology for the revised flooding source(s) affected by sediment transport? ☐ Yes ☒ No

   If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation..

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit*	Lower Spot Pond Brook	U.S. limit of study	el. 39.4 ft NAVD88	same
Upstream Limit*	Ell Pond	N/A	el. 53.4 NAVD88	el. 49.9 NAVD88

*Proposed/Revised elevations must tie-into the Effective elevations within 0.5 foot at the downstream and upstream limits of revision.

2. Hydraulic Method/Model Used: EPA SWWM

3. Pre-Submittal Review of Hydraulic Models*

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS.

4.

Models Submitted	**Natural Run** File Name:	Plan Name:	**Floodway Run** File Name:	Plan Name:	**Datum**
Duplicate Effective Model*	EllPond_01_DupEffec		N/A	N/A	ft NAVD88
Corrected Effective Model*	EllPond_02_CorEffect				ft NAVD88
Existing or Pre-Project Conditions Model	EllPond_02_CorEffect				ft NAVD88
Revised or Post-Project Conditions Model	EllPond_04_Revised				ft NAVD88
Other - (attach description)					

* For details, refer to the corresponding section of the instructions.

☒ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic work map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted (preferred)

Topographic Information: LiDAR New England CMGP Sandy LiDAR (USGS)

Source: MassGIS - USGS Contract No. G10PC00057 Date: 2013-2014

Accuracy: Vertical Accuracy Average Error = 0.024 m

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM**, at the same scale as the original, annotated to show the boundaries of the revised 1%-and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%-and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area on revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:

      - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot compared to pre-project conditions.
      - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot compared to pre-project conditions.

   b. Does this LOMR request cause increase in the BFE and/or SFHA compared with the effective BFEs and/or SFHA? ☐ Yes ☒ No

      If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notifications can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(A)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being established. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For CLOMR requests, please submit documentation to FEMA and the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA).

For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA. Please see the MT-2 instructions for more detail.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

DEPARTMENT OF HOMELAND SECURITY
FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE STRUCTURES FORM

O.M.B. NO. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 7 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20598-3005, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

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DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a NFIP Flood Insurance Rate Maps (FIRM).

Flooding Source: Ell Pond

Note**:** Fill out one form for each flooding source studied.

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization..............complete Section B
Bridge/Culvert...............complete Section C
Dam..............................complete Section D
Levee/Floodwall............complete Section E
Sediment Transport........complete Section F (if required)

Description Of Modeled Structure

1. Name of Structure: Crest Gate Inlet Structure

   Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: Ell Pond Outlet

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

2. Name of Structure: Ell Pond Drain (48-in RCP)

   Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: Extends 3,500 feet from Ell Pond Outlet to Ell Pond Brook Culvert

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

3. Name of Structure: Ell Pond Brook Culvert

   Type (check one) ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam

   Location of Structure: Original outlet culvert from Ell Pond Outlet 4,800 ft to Lower Spot Pond Brook

   Downstream Limit/Cross Section: _____

   Upstream Limit/Cross Section: _____

NOTE: FOR MORE STRUCTURES, ATTACH ADDITIONAL PAGES AS NEEDED.

B. CHANNELIZATION

Flooding Source: Ell Pond

Name of Structure: _____

1. Hydraulic Considerations

The channel was designed to carry _____ (cfs) and/or the _____-year flood.
The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions

☐ Other locations (specify): _____

2. Channel Design Plans

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Accessory Structures

The channelization includes (check one):

☐ Levees [Attach Section E (Levee/Floodwall)] ☐ Drop structures ☐ Superelevated sections

☐ Transitions in cross sectional geometry ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)] ☐ Energy dissipator

☐ Weir ☐ Other (Describe):

4. Sediment Transport Considerations

Are the hydraulics of the channel affected by sediment transport? ☐ Yes ☐ No

If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

C. BRIDGE/CULVERT

Flooding Source: Ell Pond

Name of Structure: Crest Gate, Ell Pond Drain (48-in RCP), and Ell Pond Brook Culvert

1. This revision reflects (check one):

☒ Bridge/culvert not modeled in the FIS

☐ Modified bridge/culvert previously modeled in the FIS

☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): SWMM
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

☒ Dimensions (height, width, span, radius, length)

☒ Shape (culverts only)

☒ Material

☒ Beveling or Rounding

☐ Wing Wall Angle

☐ Skew Angle

☒ Distances Between Cross Sections

☐ Erosion Protection

☒ Low Chord Elevations – Upstream and Downstream

☒ Top of Road Elevations – Upstream and Downstream

☒ Structure Invert Elevations – Upstream and Downstream

☒ Stream Invert Elevations – Upstream and Downstream

☐ Cross-Section Locations

4. Sediment Transport Considerations

Are the hydraulics of the structure affected by sediment transport? ☐ Yes ☒ No

If Yes, then fill out Section F (Sediment Transport) of Form 3. If no, then attach an explanation.

D. DAM/BASIN

Flooding Source: Ell Pond
Name of Structure: Ell Pond

1. This request is for (check one): ☐ Existing dam/basin ☐ New dam/basin ☒ Modification of existing dam/basin

2. The dam/basin was designed by (check one): ☐ Federal agency ☐ State agency ☐ Private organization ☒ Local government agency

   Name of the agency or organization: City of Melrose

3. The Dam was permitted as (check one): ☐ Federal Dam ☐ State Dam

   Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

   Permit or ID number __________________ Permitting Agency or Organization ______________________________

   a. ☐ Local Government Dam ☐ Private Dam

   Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☒ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm? (must account for the maximum volume of runoff)

   ☒ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why debris/sediment analysis was not considered?

6. Does the Base Flood Elevation behind the dam/basin or downstream of the dam/basin change? ☒ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

	Stillwater Elevation Behind the Dam/Basin	
FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)	48.2 ft.	47.0 ft.
50-year (2%)	51.6 ft.	49.1 ft.
100-year (1%)	53.4 ft.	49.9 ft.
500-year (0.2%)	53.9 ft.	52.6 ft.
Normal Pool Elevation	N/A	43.9 ft.

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one): ☐ upgrading of an existing levee/floodwall system ☐ a newly constructed levee/floodwall system ☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc. Station _____ to _____
☐ structural floodwall Station _____ to _____
☐ Other (describe): Station _____ to _____

c. Structural Type (check one): ☐ monolithic cast-in place reinforced concrete ☐ reinforced concrete masonry block ☐ sheet piling
☐ Other (describe): _____

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency? _____

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers: _____
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers: _____
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers: _____
4. A layout detail for the embankment protection measures. Sheet Numbers: _____
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, Floodwall structure, closure structures, and pump stations. Sheet Numbers: _____

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout ☐ Yes ☐ No

3.5 feet or more at the upstream end ☐ Yes ☐ No

4.0 feet within 100 feet upstream of all structures and/or constrictions ☐ Yes ☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater). ☐ Yes ☐ No

2.0 feet above the 1%-annual-chance stillwater surge elevation ☐ Yes ☐ No

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope land side is: _____

b. The maximum levee slope flood side is: _____

c. The range of velocities along the levee during the base flood is: _____ (min.) to _____ (max.)

d. Embankment material is protected by (describe what kind): _____

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:
_____

☐ Overall height: Sta.: _____, height _____ ft.

☐ Limiting foundation soil strength:

Strength ϕ = _____ degrees, c = _____ psf

Slope: SS = _____ (h) to _____ (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):
_____

c. Summary of stability analysis results:

E. LEVEE/FLOODWALL (CONTINUED)

5. Embankment And Foundation Stability (continued)

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is _____ hours.

Attach engineering analysis to support construction plans.

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one): ☐ UBC (1988) ☐ Other (specify): _____

b. Stability analysis submitted provides for: ☐ Overturning ☐ Sliding If not, explain: _____

c. Loading included in the analyses were: ☐ Lateral earth @ P_A = _____ psf; P_p = _____ psf

☐ Surcharge-Slope @ _____, ☐ surface _____ psf

☐ Wind @ P_w = _____ psf

☐ Seepage (Uplift); _____ ☐ Earthquake @ P_{eq} = _____ %g

☐ 1%-annual-chance significant wave height: _____ ft.

☐ 1%-annual-chance significant wave period: _____ sec.

d. Summary of Stability Analysis Results: Factors of Safety.
Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)
Note: (Extend table on an added sheet as needed and reference)

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability (continued)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is _____ ft. to _____ ft.

c. Settlement of the levee crest is determined to be primarily from : ☐ Foundation consolidation ☐ Embankment compression ☐ Other (Describe): _____

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: _____ acres
Draining to ponding area: _____ acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: _____ cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

e. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is _____ cfs

h. The length of levee system used to drive this seepage rate in item g: _____ ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants: _____ For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem

Hydrocompaction ☐ is ☐ is not a problem

Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No Attach supporting documentation

d. Sediment Transport Considerations:

Was sediment transport considered? ☐ Yes ☐ No
If Yes, then fill out Section F (Sediment Transport). If No, then attach your explanation for why sediment transport was not considered.

10. Operational Plan And Criteria

a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations?
☐ Yes ☐ No

c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations?
☐ Yes ☐ No If the answer is No to any of the above, please attach supporting documentation.

E. LEVEE/FLOODWALL (CONTINUED)

11. <u>Maintenance Plan</u>

Please attach a copy of the fomal maintenance plan for the levee/floodwall

12. <u>Operations and Maintenance Plan</u>

Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

CERTIFICATION OF THE LEVEE DOCUMENTION

This certification is to be signed and sealed by a licensed registered professional engineer authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.10(e) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: _____	License No.: _____	Expiration Date: _____
Company Name: _____	Telephone No.: _____	Fax No.: _____
Signature: _____	Date: _____	E-Mail Address: _____

F. SEDIMENT TRANSPORT

Flooding Source: _____

Name of Structure: _____

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume _____ acre-feet

Debris load associated with the base flood discharge: Volume _____ acre-feet

Sediment transport rate _____ (percent concentration by volume)

Method used to estimate sediment transport: _____

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition: _____

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport: _____

Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

Project Narrative

ELL POND
HYDROLOGIC AND HYDRAULIC SUBMITTAL
Part 1: Project Narrative

Middlesex County
Melrose, Massachusetts

November 2017

In March 2017, the City of Melrose contracted CDM Smith to evaluate the validity of the existing FEMA stillwater Base Flood Elevation (BFE) for Ell Pond that is shown on the effective Flood Insurance Rate Map (FIRM) and recorded in the effective Flood Insurance Study (FIS) for Middlesex County, Massachusetts: Study No. 25017CV001C (FEMA, 2016).

The current BFE is based on an engineering analysis performed in 1981 that represented the contributing watershed runoff to Ell Pond, and the Ell Pond Brook Culvert which drains Ell Pond to a confluence with Spot Pond Brook downstream. Since that study was completed, the City of Melrose constructed a new pond outlet works in 2007-2008 in part with funding from FEMA's Pre-Disaster Mitigation (PDM-C) Program. The work included an adjustable crest gate, and a second storm drain conduit from Ell Pond to Lower Spot Pond Brook. The new 48" storm drain was designed to increase the capacity of the outlet discharge, especially during large storm events. **Figure 1-1** shows a map of the watershed, original Ell Pond Brook Culvert, and newer 48" Ell Pond Drain.

In April 2017, CDM Smith submitted a technical memorandum to the City of Melrose describing a detailed and updated hydrologic and hydraulic analysis of the 100-year peak annual water surface elevation in Ell Pond. The new 100-year peak annual water surface is lower than the BFE. The submission of this MT-2 application represents the City of Melrose's request to have FEMA issue a Letter of Map Revision (LOMR) for Ell Pond to reflect this updated BFE.

Previous Studies

The detailed study that is the basis of the current BFE for Ell Pond is based on an analysis performed by Camp Dresser and McKee over 35 years ago. The analysis was part the *Mystic River Comprehensive Hydrology Study* presented to the Metropolitan District Commission (MDC) in 1981 (CDM Smith, 1981). Using the MITCAT model (CDM Smith, 1980), Camp Dresser and McKee built a runoff model of the entire Mystic River Basin upstream of the Amelia Earhart Dam, for evaluating flood alleviation alternatives. The model includes a single node representing the Ell Pond drainage area which was determined to be 1,160 acres (1.81 square miles) and represents the basin and outlet characteristics. The Ell Pond outlet rating curve was taken from an earlier 1954 Camp Dresser and McKee study completed for the MDC. The input model files used for the MITCAT model are not available in the FEMA archive library.

Table 1-1 summarizes the effective flood elevations for Ell Pond taken from the 1981 Mystic River study. All elevations referenced in this narrative and MT-2 application are in NAVD88 vertical datum.

Table 1-1 – Stillwater Elevations for Ell Pond in effective FEMA FIS

10-Percent Annual Chance [1]	2-Percent Annual Chance [1]	1-Percent Annual Chance [1]	0.2-Percent Annual Chance [1]
el. 48.2 ft. NAVD88	el. 51.6 ft. NAVD88	el. 53.4 ft. NAVD88 [2]	el. 53.9 ft. NAVD88

[1] Source "Table 9 – Summary of Stillwater Discharges" for Ell Pond Flooding Source

[2] el. 53.4 ft. NAVD88 = el. 54.2 ft. NGVD29 = el. 159.8 ft. MDC

Following major flood events in 1996 and 1998, the City of Melrose hired consultants to study the Ell Pond Brook Culvert. In 2001, Malcom Pirnie conducted a video inspection of the Ell Pond Brook Culvert and survey of culvert dimensions (Malcom Pirnie, 2001).

In 2003, The Beta Group completed an additional drainage study of Ell Pond (The Beta Group, 2003) that included a topographic survey of Ell Pond and the Ell Pond Brook Culvert inverts. The study included a HydroCAD model of the contributing watershed and the hydraulics of Ell Pond and the Ell Pond Brook Culvert. Assuming a normal pool of el. 46.0 ft. NAVD88 (el. 46.8 ft. NGVD29), a 4-ft. x 5-ft. existing stone outlet, and rainfall depths from TR-55 (USDA, 1986), The Beta Group calculated that the peak stillwater elevation in Ell Pond associated with the 1% annual event is el. 49.7 ft. NAVD88. This estimate is 3.7 feet lower than the effective BFE from 1981.

In 2007, with financial support from the FEMA Pre-Disaster Mitigation Grant Program (75% Federal Share, 25% Local Share), the City of Melrose constructed a new outlet structure for Ell Pond and a new 48" reinforced concrete circular drain which joins to the Ell Pond Brook Culvert at Grove Street as shown in **Figure 1-1**. The new construction also includes a 72" x 30" crest gate and hydraulic actuation system controlled by a programmable logic controller (PLC).

<u>Updated Detailed Study Approach</u>

To reevaluate the effective BFE for Ell Pond, CDM Smith performed a detailed hydrologic and hydraulic analysis. The hydrologic analysis started with an evaluation of the contributing runoff area using the most recent LiDAR data for the area and the location of subsurface storm drains in urbanized areas. A detailed runoff model of that watershed was built using HEC-HMS following the SCS Curve Number method (USDA, 1986) to generate a set of inflow hydrographs associated with each design event (10-, 50-, 100-, and 500-yr floods).

The hydraulic analysis of the peak annual 100-year stillwater elevation was performed in EPA SWMM 5.0, which is best suited to represent the closed conduits that convey outflows from Ell Pond. The SWMM model represented the storage and stage in Ell Pond as well as the outlet hydraulics of the Ell Pond Brook Culvert, 48" Ell Pond Storm Drain, and the hydraulically-actuated crest gate.

Since the original MITCAT model input files were not available, the "Duplicate Effective Model" was based on the available information in the 1981 Mystic River Comprehensive Report. Adjustments were made until the model results matched the BFE.

Next, the “Corrected Effective Model” was built to represent the Ell Pond condition prior to the 2007 construction of the 48” Ell Pond Storm Drain or actuated crest gate. Inflows to Ell Pond associated with the flood events from the HEC-HMS runoff model are based on the most recently updated hyetograph statistics (NOAA, 2015), contributing drainage area, and routing parameters. The hydraulics of the Ell Pond outlet capacity are based on the video survey of the Ell Pond Brook Culvert performed by Malcom Pirnie (2001).

Finally, a “Revised Conditions Model” was built in SWMM that includes the additional capacity of the crest gate and 48” Ell Pond Storm Drain. The model geometry of these features is based on the record drawings of the completed 2007-2008 construction. The logic of the crest gate PLC is based on the operations manual for the crest gate maintained by the City of Melrose. **Table 1-2** shows the new peak stillwater elevation proposed for Ell Pond and the relative change from the effective peak stillwater elevations.

Table 1-2 – “Revised Conditions” Stillwater Elevations for Ell Pond and relative change from effective

10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
el. 47.0 ft. NAVD88 (-1.2 ft.)	el. 49.1 ft. NAVD88 (-2.5 ft.)	el. 49.9 ft. NAVD88 (-3.5 ft.)	el. 52.6 ft. NAVD88 (-1.3 ft.)

References

The Beta Group (2003) “Ell Pond Drainage Study and Flood Management Plan” for The City of Melrose September 2003.

CDM Smith (1981) “Mystic River Comprehensive Hydrology Study Final Report” presented to Metropolitan District Commission on September 14, 1981. Waltham, MA.

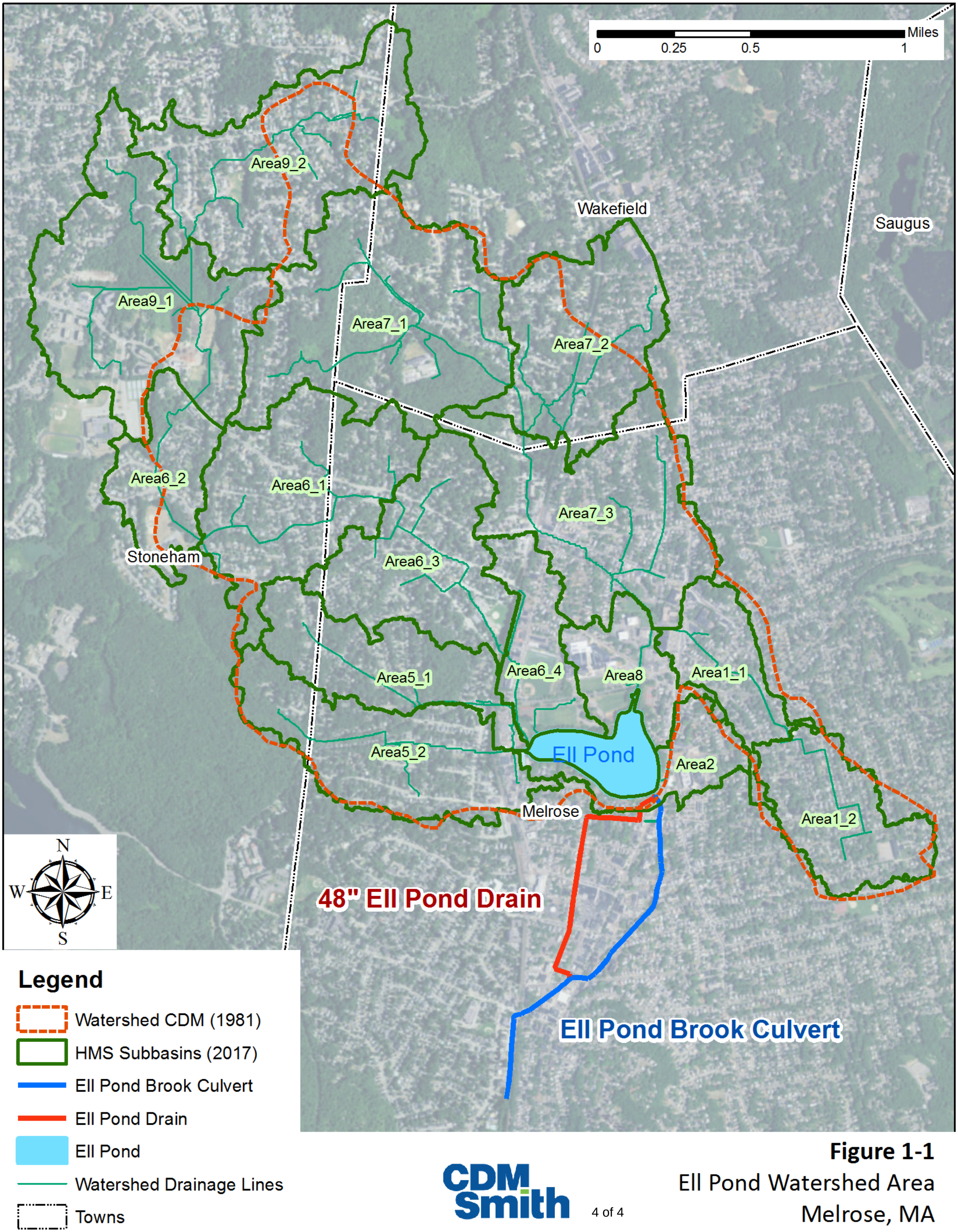
CDM Smith (1980) “MITCAT User’s Manual” Boston, MA

Federal Emergency Management Agency (2016) “Preliminary Flood Insurance Study for Middlesex County Massachusetts” Study Number 25017CV001C. Revised: July 6, 2016.

Malcom & Pirnie (2001) “Ell Pond Watershed Drainage Study Flood Management Plan” presented to City of Melrose on June 2001. Wakefield, MA.

U.S. Department of Agriculture (1986) “Urban Hydrology for Small Watersheds” Technical Release 55, Soil Conservation Service, Washington DC, 1986.

U.S. Department of Commerce (2015) “Precipitation-Frequency Atlas of the United States” Atlas 14 Volume 10 Version 2.0: Northern States (Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont), National Oceanographic and Atmospheric Administration, Silver Spring, MD, 2015. Available online at http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ma Accessed March 2017.



CDM Smith

Figure 1-1
Ell Pond Watershed Area
Melrose, MA

ELL POND
HYDROLOGIC AND HYDRAULIC SUBMITTAL
Part 2: Hydrologic Computations

Middlesex County
Melrose, Massachusetts
November 2017

This section describes the hydrologic methodology used to generate inflow hydrographs to Ell Pond during the 10%, 2%, 1%, and 0.2% peak annual scenarios. The hydrographs generated were used as input to the hydraulic model that determined the peak still water flood elevation in Ell Pond. A rainfall-runoff model approach was used, as described in Section C.2.4.4 of Appendix C of the FEMA Guidelines for Flood Mapping Hazard Maps (FEMA, 2009). The runoff model is HEC-HMS version 4.2.

Basin Delineation

The area of study is the still water elevation of Ell Pond which has a BFE from detailed study in the effective FIS (FEMA, 2010). The contributing watershed in the effective 1981 analysis was 1.81 square miles, the approximated extent of which is shown in **Figure 1-1**. As part of this LOMR submission, CDM Smith reevaluated the contributing runoff area using 1-meter resolution LiDAR published by USGS which is the most recent topographic information for the area (USGS, 2015). In combination with storm drain asset data from the City of Melrose and the Town of Stoneham, The ArcHydro for ArcGIS (version 2.0) extension was used to delineate 15 subcatchments with a total area of 2.13 square miles. **Table 2-1** shows the surface area of each subcatchment, which were used in the HEC-HMS runoff model.

Table 2-1 – Ell Pond Subcatchments used in HEC-HMS Runoff Model

Subcatchment	Area (acres)	CN	Lag Time
Area1_1	45.4 acres	71.5	19.0 minutes
Area1_2	64.2 acres	77.3	23.7 minutes
Area2	31.8 acres	79.0	9.0 minutes
Area5_1	71.6 acres	58.9	15.4 minutes
Area5_2	100.4 acres	57.8	12.5 minutes
Area6_1	116.6 acres	59.5	21.8 minutes
Area6_2	50.3 acres	61.3	24.4 minutes
Area6_3	96.1 acres	61.1	22.3 minutes
Area6_4	46.3 acres	70.5	22.9 minutes
Area7_1	166.9 acres	61.2	27.3 minutes
Area7_2	101.2 acres	65.8	40.5 minutes
Area7_3	131.9 acres	65.9	20.0 minutes
Area8	42.0 acres	74.7	13.6 minutes
Area9_1	156.9 acres	73.2	19.4 minutes
Area9_2	140.5 acres	65.2	39.1 minutes
Total	1,362 acres	65.5	19.0 minutes

Rainfall

A set of synthetic hydrographs representing the 10-, 50-, 100-, and 500-year peak annual 24-hour precipitation storm events was generated as input to the runoff model. The 24-hour storm was selected because the time of concentration of the system including attenuation from Ell Pond itself does not exceed 24-hours, which was validated by the final results.

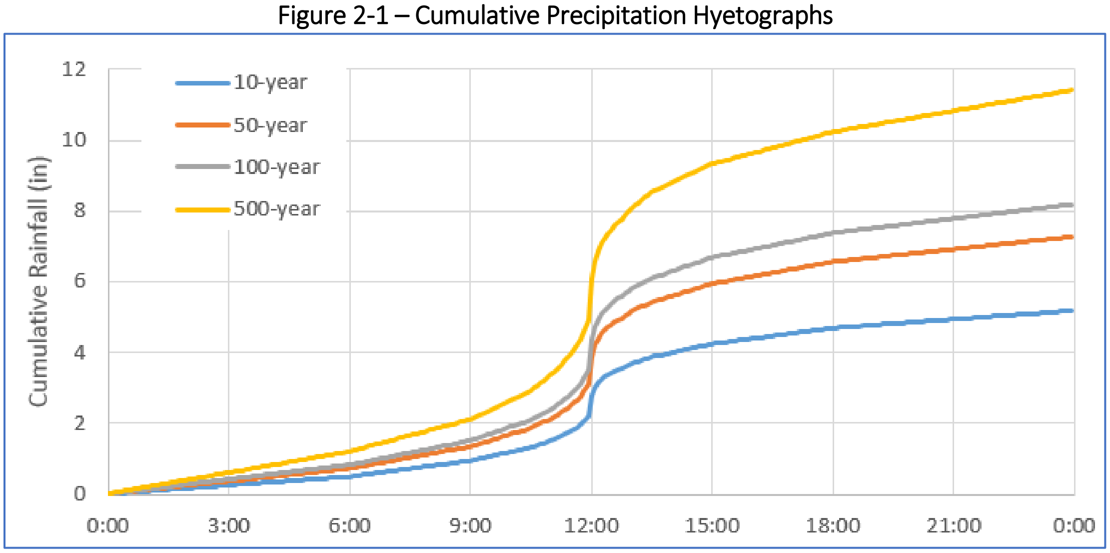
The intensity-duration-frequency relationship for extreme precipitation in the Ell Pond watershed was obtained from the NOAA Atlas 14 website at the centroid of the watershed (42.4780°N, 71.0768°W), and is shown in **Table 2-2**.

Table 2-2 – Precipitation Intensity-Duration-Frequency for Ell Pond Watershed

Duration	10-Year	50-yr	100-yr	500-yr
5-min	0.57 in	0.78 in	0.88 in	1.19 in
10-min	0.80 in	1.11 in	1.24 in	1.68 in
15-min	0.94 in	1.30 in	1.46 in	1.98 in
30-min	1.30 in	1.79 in	2.01 in	2.73 in
60-min	1.66 in	2.29 in	2.56 in	3.49 in
2-hr	2.18 in	3.04 in	3.41 in	4.74 in
3-hr	2.55 in	3.56 in	4.00 in	5.59 in
6-hr	3.30 in	4.60 in	5.17 in	7.21 in
12-hr	4.20 in	5.84 in	6.55 in	9.03 in
24-hr	5.18 in	7.27 in	8.18 in	11.41 in

The 24-hour temporal distribution of the synthetic storm was built in a 5-minute time step from all ten available durations in the intensity-duration-frequency relationship obtained from Atlas 14. The cumulative hyetographs of all four design storms is shown in **Figure 2-1**.

Figure 2-1 – Cumulative Precipitation Hyetographs



Rainfall Losses

Rainfall losses for each subcatchment were calculated using the Natural Resources Conservation Service (NRCS) runoff curve number (CN) approach (USDA, 2004). The CN of an area is the function of the property of the soils and land use. Geospatial soils data for the watershed was downloaded from the Soil Survey Geographic (SSURGO) databased maintained by NRCS. National Land Cover Database (NLCD) land use data was downloaded from the U.S. Geologic Survey (USGS) and reclassified to the categories in the curve number tables in TR-55 (USDA, 1986).

Spatially-averaged curve numbers were calculated for each subcatchment from the geospatial union of the soils and land use data. The initial abstraction was calculated for each subcatchment using methodology in TR-55 (USDA, 1986). **Table 2-1** shows the NRCS curve numbers for each subcatchment in the Ell Pond watershed.

Subcatchment Response

The runoff response from each of the subcatchments was calculated using the NRCS Unit Hydrograph approach (USDA, 2007), first published as the TR-55 SCS Unit Hydrograph (USDA, 1986). The unit hydrograph parameter, Time of Concentration, was calculated for each subcatchment using the velocity method as described by the NRCS (USDA, 2010). The total Time of Concentration for each subcatchment is the sum of the travel times associated with sheet flow and shallow concentrated flow. The ArcHydro GIS extension was used to determine the longest path of flow for each catchment.

Sheet Flow occurs over the first 100 feet of the drain line (USDA, 1986). The upstream and downstream elevations of the sheet flow path in each subcatchment were calculated using the available topographic data. The associated slope was used to calculate the travel time for sheet flow (Overton and Meadows, 1976). A manning's roughness of n=0.24 was selected to represent the forested and heavily grassed areas in the watershed (USDA, 2010).

After the first 100 feet of the drain line, it was assumed that overland flow transitioned into Shallow Concentrated Flow. The longest path of each subcatchment was subdivided into segments of similar slope and land use. The travel time of each segment was calculated using the slope, length, and velocity coefficient associated with the land use as described in the NRCS National Engineering Handbook Part 630.1502(b) Table 15-3 (USDA, 2010 and Kent, 1964). The total Shallow Concentrated Flow travel time is for each subcatchment the sum of the segment travel times.

Table 2-1 shows the total Time of Concentration for each subcatchment. The Lag Time used to define the unit hydrograph response for each subcatchment was assumed to be 60% of the Time of Concentration, based on Equation 15-3 in the NRCS National Engineering Handbook Part 630.1501(e) (USDA, 2010 and Simas, 1996). The Lag Time for each subcatchment was input to the HEC-HMS model and is shown in **Table 2-1**.

Reach Routing

In six places there are reaches downstream of the outlet of subcatchment. **Figure 2-2** shows the reaches, all of which are included in the HEC-HMS model. Because the reaches are relatively short, the routing was simulated using a simple lag time, with no attenuation or storage. Travel time was estimated by Manning's equation for velocity in an open rectangular channel (USDA, 1986). A Manning's roughness of n=0.035 was used, corresponding to a relatively smooth channel bottom (Barnes, 1967). A

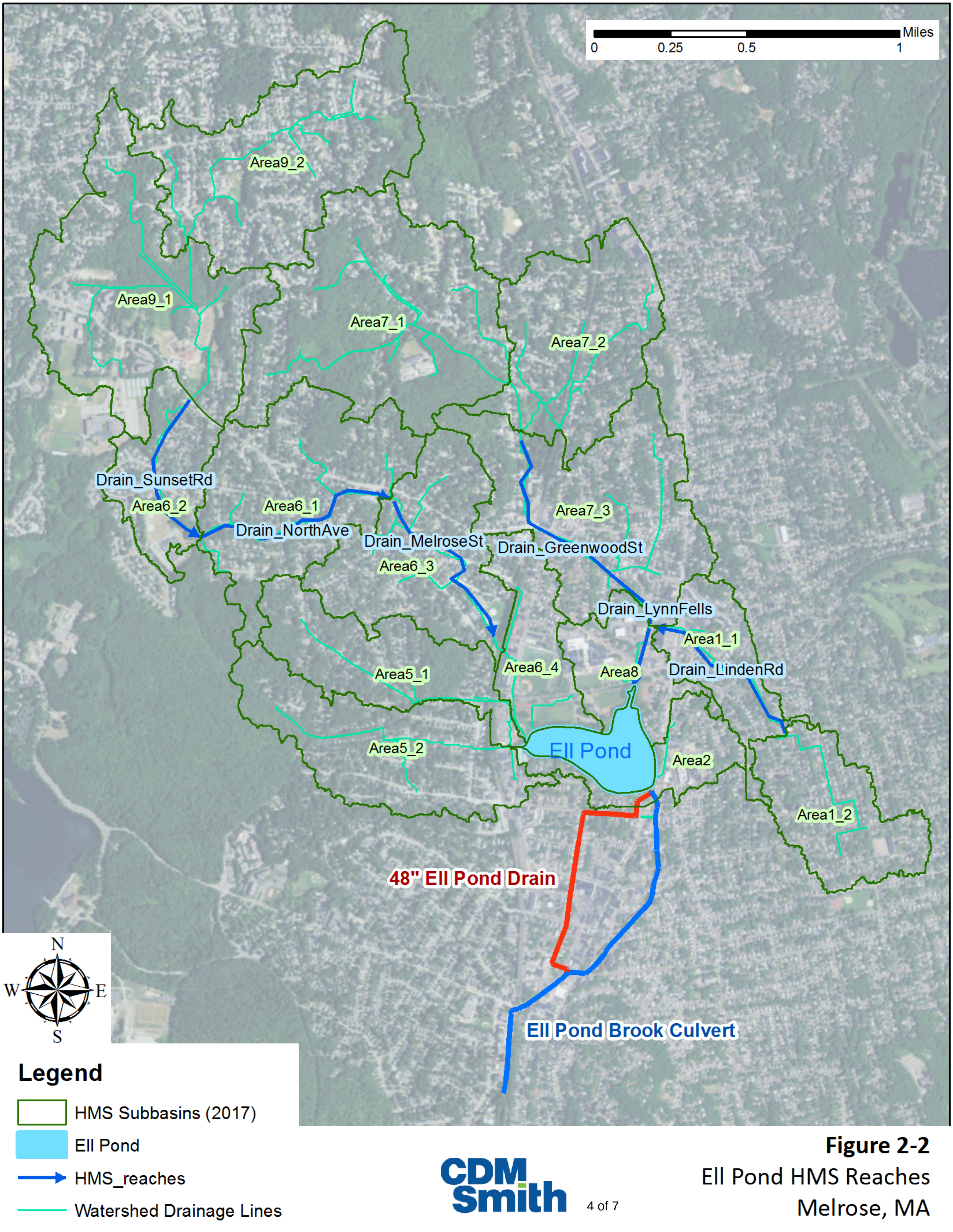


Figure 2-2
Ell Pond HMS Reaches
Melrose, MA

hydraulic radius of 0.5 feet was assumed for open channel flow in all reaches. **Table 2-3** shows the length, slope and travel time for all six modeled reaches.

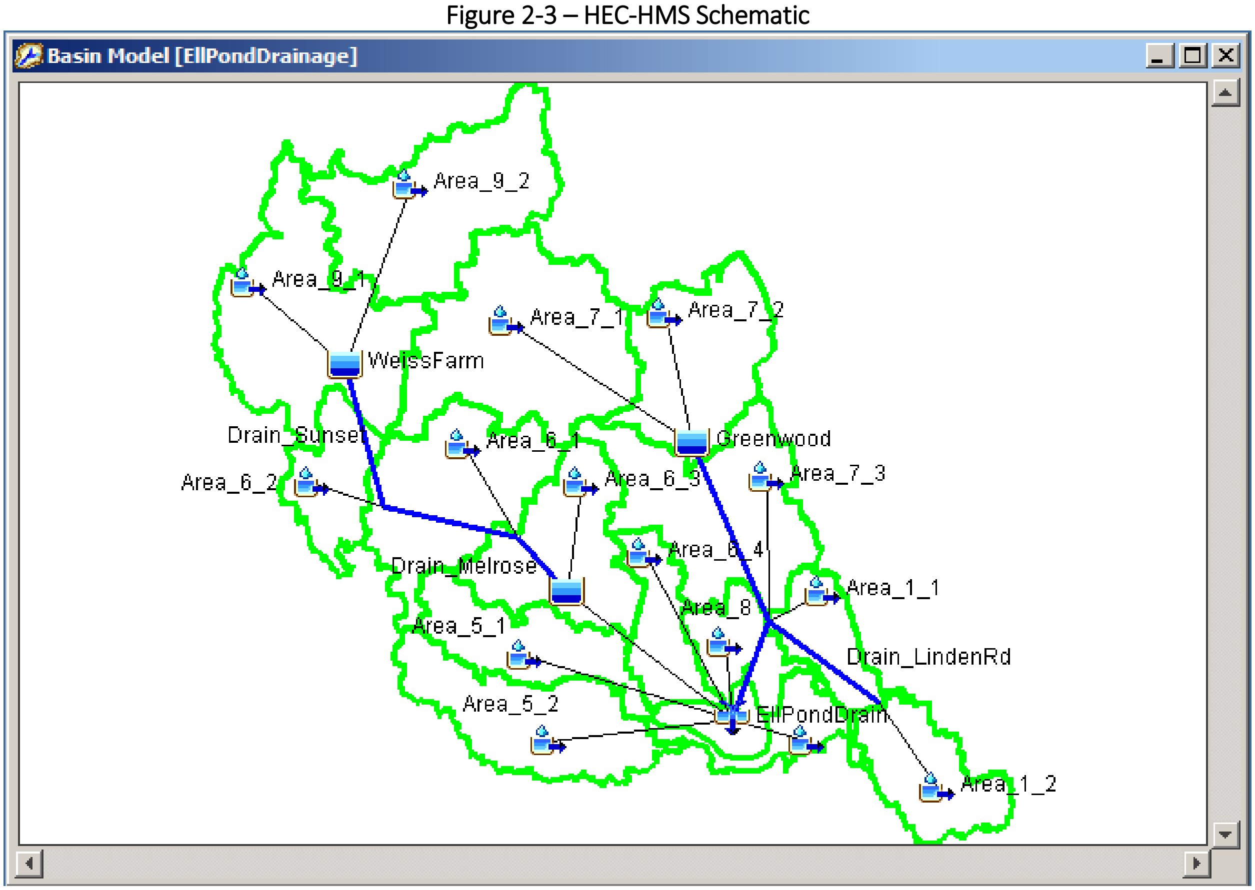
Table 2-3 – Reach Routing

Model Reach	Length	Slope	Travel Time
Drain_SunsetRd	2,140 ft.	0.0023	17.5 min.
Drain_NorthAve	2,770 ft.	0.0180	9.9 min.
Drain_MelroseSt	2,490 ft.	0.0221	7.4 min.
Drain_GreenwoodSt	3,240 ft.	0.0056	21.9 min.
Drain_LynnFells	765 ft.	0.0052	4.3 min.
Drain_LindenRd	2,360 ft.	0.0191	10.6 min.

Input Hydrographs

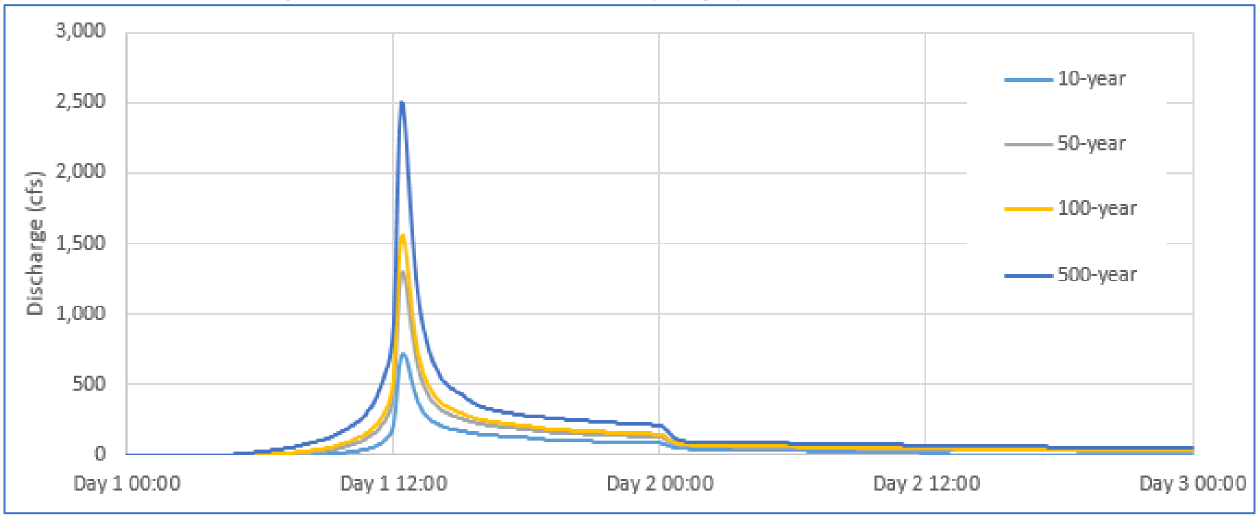
A schematic of the HEC-HMS runoff model of the Ell Pond watershed that was built for this analysis is shown in **Figure 2-3.** The model was run with a 5-minute time step for 48 hours including 24-hours following the 24-hour rainfall hyetograph. The completed HEC-HMS model was built using version 4.2 and is included in the electronic submission.

Figure 2-3 – HEC-HMS Schematic



For each design storm (10-, 50-, 100-, and 500-year) the summed total of all the hydrographs entering Ell Pond is shown in **Figure 2-4**.

Figure 2-4 – Ell Pond Total Inflow Hydrographs (HEC-HMS Results)



A summary of each of the four storm events including the Ell Pond total inflow is shown in **Table 2-4**.

Table 2-4 – 24-hour Precipitation Event Runoff Values

	10-Percent Annual Chance (10-year Event)	2-Percent Annual Chance (50-year Event)	1-Percent Annual Chance (100-year Event)	0.2-Percent Annual Chance (500-year Event)
Total Rainfall Depth	5.12 inches	7.18 inches	8.08 inches	11.27 inches
Infiltration Losses	3.37 inches	3.92 inches	4.10 inches	4.57 inches
Total Runoff	220 acre-feet	394 acre-feet	465 acre-feet	713 acre-feet
Peak Discharge	720 cubic feet per second (cfs)	1,300 cfs	1,560 cfs	2,500 cfs

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ELL POND
HYDROLOGIC AND HYDRAULIC SUBMITTAL
Part 3: Hydraulic Computations

Middlesex County
Melrose, Massachusetts
November 2017

This section describes the hydraulic methodology used to generate the still water base flood elevation (BFE) for Ell Pond in Melrose, MA.

Due to the dynamic interaction between the rate of discharge from Ell Pond, the hydraulic profile in the outlet culverts, and the automated crest gate elevation in the existing conditions, a one-dimensional unsteady hydraulic model approach was used for hydraulic computations. This methodology meets the guidelines described in Section 3.3.2 of Appendix C of the FEMA Guidelines for Flood Mapping Hazard Maps (FEMA, 2009). Because the Ell Pond outlets are long covered culverts with variable dimensions, it was necessary to use EPA SWMM version 5.1 to model the unsteady outlet hydraulic profile as well as the Ell Pond stage and storage.

As described in the Modeling Narrative (Part 1), three hydraulic models were built to represent the (1) "Duplicate Effective Model" replicating the original results from the effective 1981 detailed analysis, (2) "Corrected Effective Model" representing the Ell Pond stillwater flood elevation prior to the 2007 construction of the 48" Ell Pond Storm Drain and hydraulically-actuated crest gate, and (3) "Revised Conditions Model" representing the current condition following the 2007 improvements.

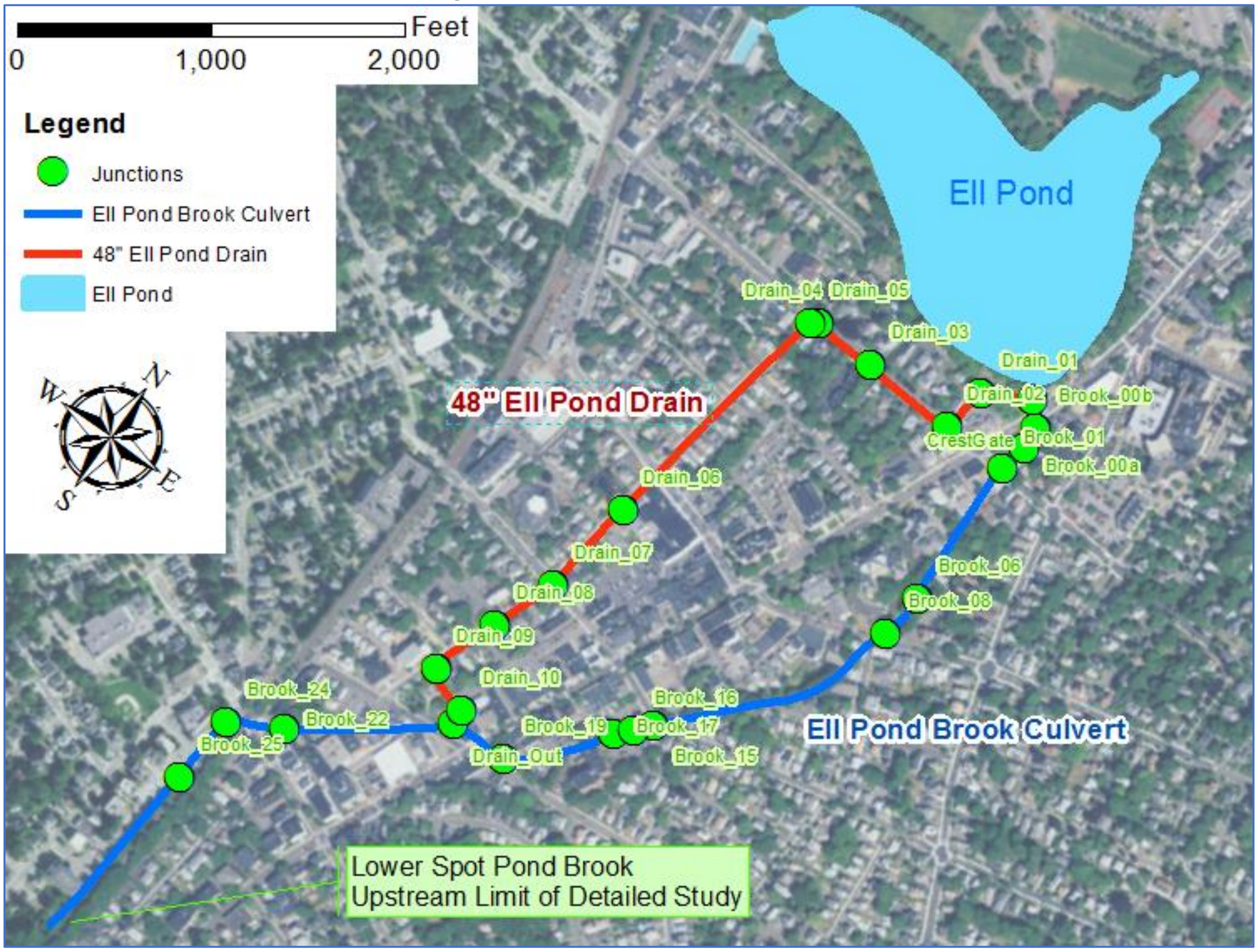
<u>Study Area and Modeling Approach</u>

The hydraulic study area is Ell Pond, which has a single outlet on the southeast corner of the lake. The Ell Pond outlet connects to the 4,800-ft long Ell Pond Brook Culvert that daylights to the Lower Spot Pond Brook. In 2007, the City of Melrose constructed a second culvert called the Ell Pond Storm Drain that is 48-inches in diameter, 3,500-ft long, and re-connects to the Ell Pond Brook Culvert approximately 2,900 downstream of the Ell Pond outlet.

An unsteady hydraulic model of Ell Pond, the outlet crest grate, and the outlet conduits was built in EPA SWMM 5.1 using the best available geometric information. The inflow boundary condition is the set of inflow hydrographs to Ell Pond generated by the HEC-HMS runoff model described in the Hydrologic Narrative (Part 2). The downstream boundary condition is the effective hydraulic profile at the limit of detailed study of the Lower Spot Pond Brook.

Figure 3-1 shows the SWMM model objects including the conduits and junctions representing the two conduits that drain Ell Pond.

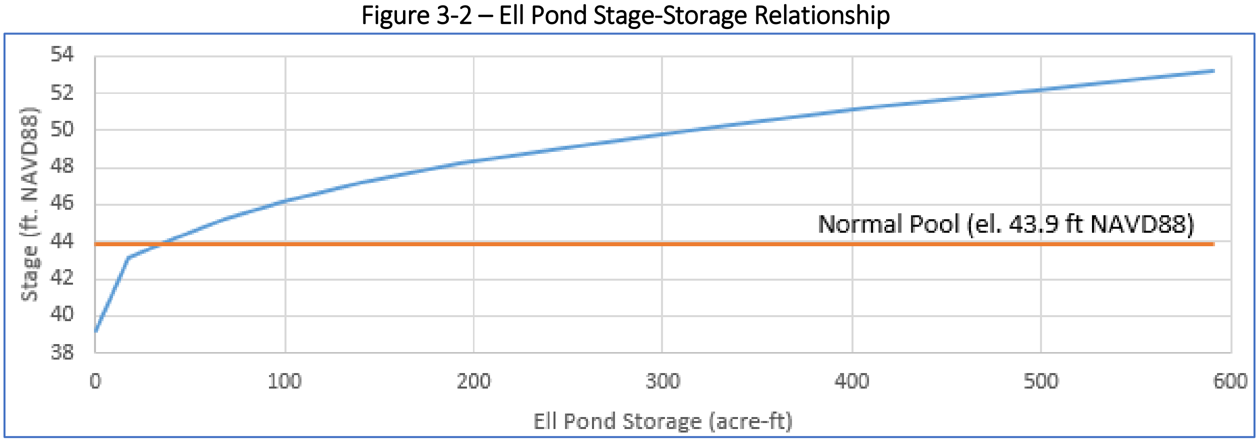
Figure 3-1 – SWMM Model Extents



Model Geometry

In all three models ("Duplicate Effective," "Corrected Effective" and "Revised Conditions"), the SWMM modeling represents the stage and storage in Ell Pond with a single node associated with a stage-storage relationship above the normal pool (el. 43.9 ft. NAVD88) that was extracted from the best available LiDAR in the area (USGS, 2015). Below the normal pool, storage was based on bathymetric survey from 1963 (Malcom Pirnie, 2001). **Figure 3-2** shows the stage-storage relationship used in the SWMM model.

Figure 3-2 – Ell Pond Stage-Storage Relationship



The SWMM model represents the Ell Pond Brook Culvert as a set of thirteen manhole junctions with fixed invert elevations connected by a series of fourteen closed conduits of various geometries. Built over 100 years ago, the conduit cross sections are variable and range from sections that are as little as 18 square feet (3’ H x 6’ W) to 110 square feet (9.2’ H x 12’ W). Cross section geometry in the model is based on survey performed by National Water Main Cleaning Company on behalf of Malcom Pirnie (2001) and included in this MT-2 submission. Invert and rim elevations at each manhole junction were based on survey performed by Surveying and Mapping Consultants (SMC) on behalf of The Beta Group (2003).

At each manhole junction, a conservative flooding depth with a 100 square-foot pool surface above the rim elevation was allowed to ensure that no flood volume was lost from the system during extreme flooding situations; all simulated inflows discharge through the outlet to Lower Spot Pond Brook.

In the “Revised Conditions Model,” the Ell Pond Storm Drain is represented by eleven manhole junctions with fixed invert elevations connected by a series of 48-inch circular closed conduits as recorded in the 2009 as-built drawings after the construction was completed and included in this MT-2 submission.

Crest gate geometry and operation is represented by an “Orifice” object with a 6-ft long weir and a control rule that follows the standard operating logic documented in the Operations and Maintenance Manual for the Rodney Hunt 72”x30” Crest Gate and Hydraulic Actuation System owned by the City of Melrose and included in this MT-2 submission. The programmable logic controller (PLC) is set to lower the gate when the pond water surface elevation rises above the normal pool (el. 43.9 ft. NAVD88). The gate is fully lowered at el. 42.7 ft. NAVD88.

It should be noted that the model was built entirely in NGVD29, which is the standard datum for the City of Melrose. All of the elevations in this report are listed in NAVD88. The conversion based on CorpsCon6 is el. 100.000 ft. NAVD88 = el. 100.807 ft. NGVD29.

<u>Energy Loss Coefficients</u>

The Ell Pond hydraulic model represents hydraulic losses in conduits using the Manning’s equation. Roughness coefficients in the Ell Pond Brook Culvert were conservatively selected as n=0.03 to represent the irregular rock faces within the conduit. The 48-inch Ell Pond Storm Drain is based on a Manning’s roughness of n=0.013 representing reinforced concrete pipe.

<u>Boundary Conditions</u>

The primary inflow boundary condition for the Ell Pond hydraulic model is a set of hydrographs generated by the HEC-HMS model and representing the 10-, 50-, 100-, and 500-year flood event runoff to Ell Pond. The generation of these hydrographs is discussed in Hydrologic Computations Part 2 of this MT-2 application. In the SWMM model these hydrographs are set as inflow to the Ell Pond node.

During flood conditions, the Ell Pond Brook Culvert receives inflows from storm drains connected to the conduit, which reduce the capacity of the conduit to convey outlet discharges from Ell Pond. Using the storm drain asset data obtained from the City of Melrose, and the available LiDAR, the drainage area of these contributions was estimated and associated with nodes along the conduit. **Table 3-1** lists the eight contributing areas and the associated node in the SWMM model.

Table 3-1 – Storm Drain Contributions to Ell Pond Brook Culvert

SWMM Node	Drainage Area (acres)
Drain_05	31.4
Brook_01	18.9
Brook_06	24.8
Brook_08	15.5
Brook_17	127.8
Brook_19	96.3
Brook_22	29.4
Brook_24	79.9

To estimate the inflows to the Ell Pond Brook Culvert, the inflow hydrograph to Ell Pond was used as inflow to each of the eight nodes along the conduit, and scaled appropriately against the 1,362-acre contributing area of Ell Pond.

The downstream boundary condition for the Ell Pond hydraulic model is the peak flood condition on the Lower Spot Pond Brook as published by FEMA in the effective FIS (FEMA, 2010). The outlet of the modeled Ell Pond Brook Culvert is located at the upstream limit of detailed study of the Lower Spot Pond Brook, which is 4,800 feet upstream of the Malden Tunnel Inlet as shown in profile Panel 281 P in the effective FIS for Middlesex County (FEMA, 2010). **Table 3-2** shows the effective peak flood elevation used for the downstream boundary condition on the Ell Pond hydraulic model.

Table 3-2 – Downstream Boundary Condition at Lower Spot Pond Brook Upstream Limit of Detailed Study

	10-Percent Annual Chance (10-year Event)	2-Percent Annual Chance (50-year Event)	1-Percent Annual Chance (100-year Event)	0.2-Percent Annual Chance (500-year Event)
Effective Profile Elevation at u/s Limit of Detailed Study (FEMA, 2010)	el. 38.3 ft. NAVD88	el. 39.1 ft. NAVD88	el. 39.4 ft. NAVD88	el. 41.7 ft. NAVD88

Duplicate Effective Model Results

The "Duplicate Effective" model represents a duplicate of the original 1981 analysis that is the basis for the current Ell Pond stillwater BFE = el. 53.4 ft. NAVD88 (FEMA, 2010). Because it was not possible to obtain or run original MITCAT input files from the "Mystic River Comprehensive Hydrology Study Final Report" (CDM Smith, 1981), it was necessary build a "Duplicate Effective" model from recently available data and adjust the geometry and parameters to generate the same BFE. A larger initial water surface elevation (el 47.2 ft.) was also assumed. **Table 3-3** shows a summary of the Ell Pond stillwater elevations associated with the "Duplicate Effective" model, which are the effective flood elevations.

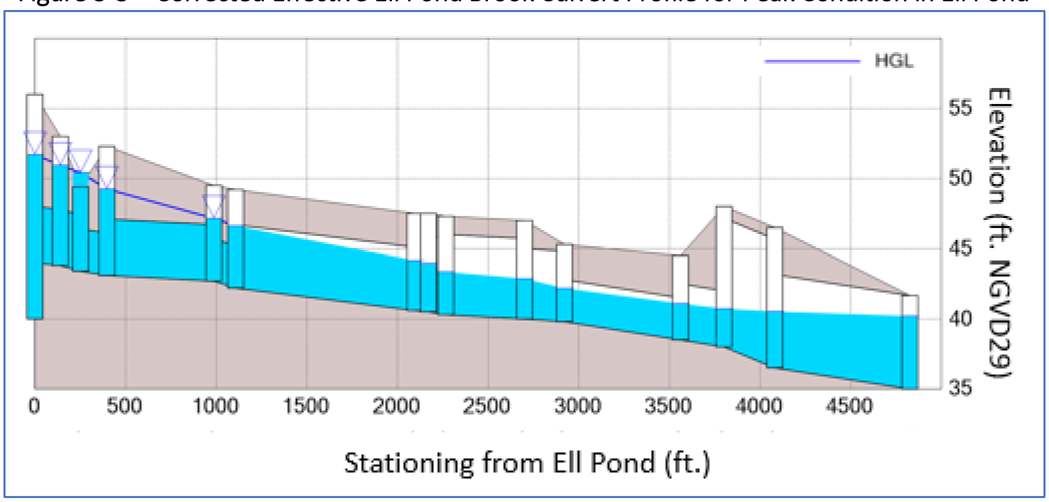
Table 3-3 – Stillwater Peak Flood Elevation for Ell Pond (ft. NAVD88)

	10-Percent Annual Chance (10-year Event)	2-Percent Annual Chance (50-year Event)	1-Percent Annual Chance (100-year Event)	0.2-Percent Annual Chance (500-year Event)
Duplicate Effective	el. 48.2 ft.	el. 51.6 ft.	el. 53.4 ft.	el. 53.9 ft.
Corrected Effective	el. 48.4 ft.	el. 50.2 ft.	el. 50.9 ft.	el. 53.4 ft.
Revised Conditions	el. 47.0 ft.	el. 49.1 ft.	el. 49.9 ft.	el. 52.6 ft.

<u>Corrected Effective Model Results</u>

The "Corrected Effective" model simulates Ell Pond prior to the 2007 construction of the hydraulically-actuated crest gate and 48-inch Ell Pond Drain using the best available information. This includes the model geometry based on the 2001 Malcom Pirnie survey and an initial normal pool elevation of el. 46.0 ft. NAVD88 documented prior to the installation of the crest gate (The Beta Group, 2003). **Table 3-3** shows a summary of the Ell Pond still water elevations for the "Corrected Effective" model. **Figure 3-3** shows the hydraulic profile of the Ell Pond Brook Culvert for the "Corrected Effective" 100-year flood for the peak stillwater elevation in Ell Pond (el. 50.9 ft. NAVD88).

Figure 3-3 – Corrected Effective Ell Pond Brook Culvert Profile for Peak Condition in Ell Pond

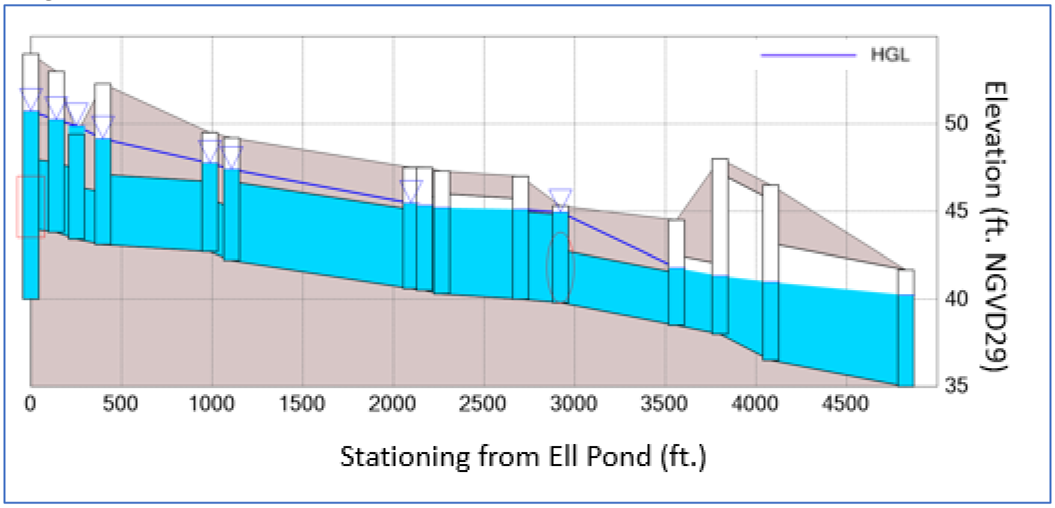


<u>Revised Conditions Model Results</u>

The "Revised Effective" model simulated the current condition of Ell Pond, the hydraulically-actuated crest gate, and the dual outlet conduits. The initial water surface elevation in Ell Pond is assumed to be el. 43.9 ft. NAVD88 based on the effective operating programming for the crest gate. The conduit geometry is based on the Malcom Pirnie survey of the Ell Pond Brook Culvert (2001), and the record drawings of the 48" Ell Pond Drain from 2009. **Table 3-3** shows a summary of the Ell Pond still water elevations for the "Revised Conditions" model. **Figure 3-4** shows the hydraulic profile of the Ell Pond

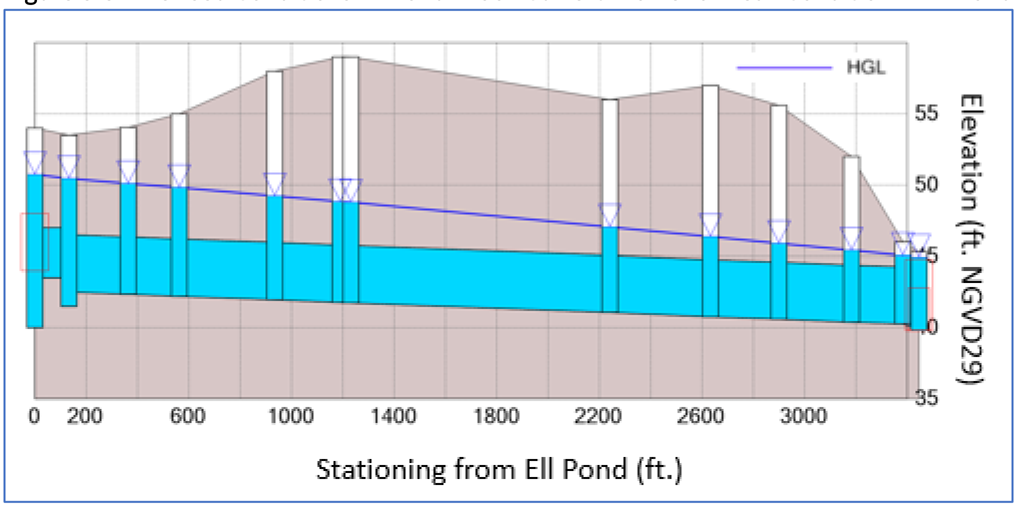
Brook Culvert for the "Revised Conditions" 100-year flood for the peak stillwater elevation in Ell Pond (el. 49.9 ft. NAVD88).

Figure 3-4 – Revised Conditions Ell Pond Brook Culvert Profile for Peak Condition in Ell Pond



The "Revised Conditions" include the 48-inch RCP Ell Pond Drain. **Figure 3-5** shows the hydraulic profile of Ell Pond Drain for the "Revised conditions" 100-year flood during the peak stillwater elevation in Ell Pond.

Figure 3-5 – Revised Conditions Ell Pond Brook Culvert Profile for Peak Condition in Ell Pond



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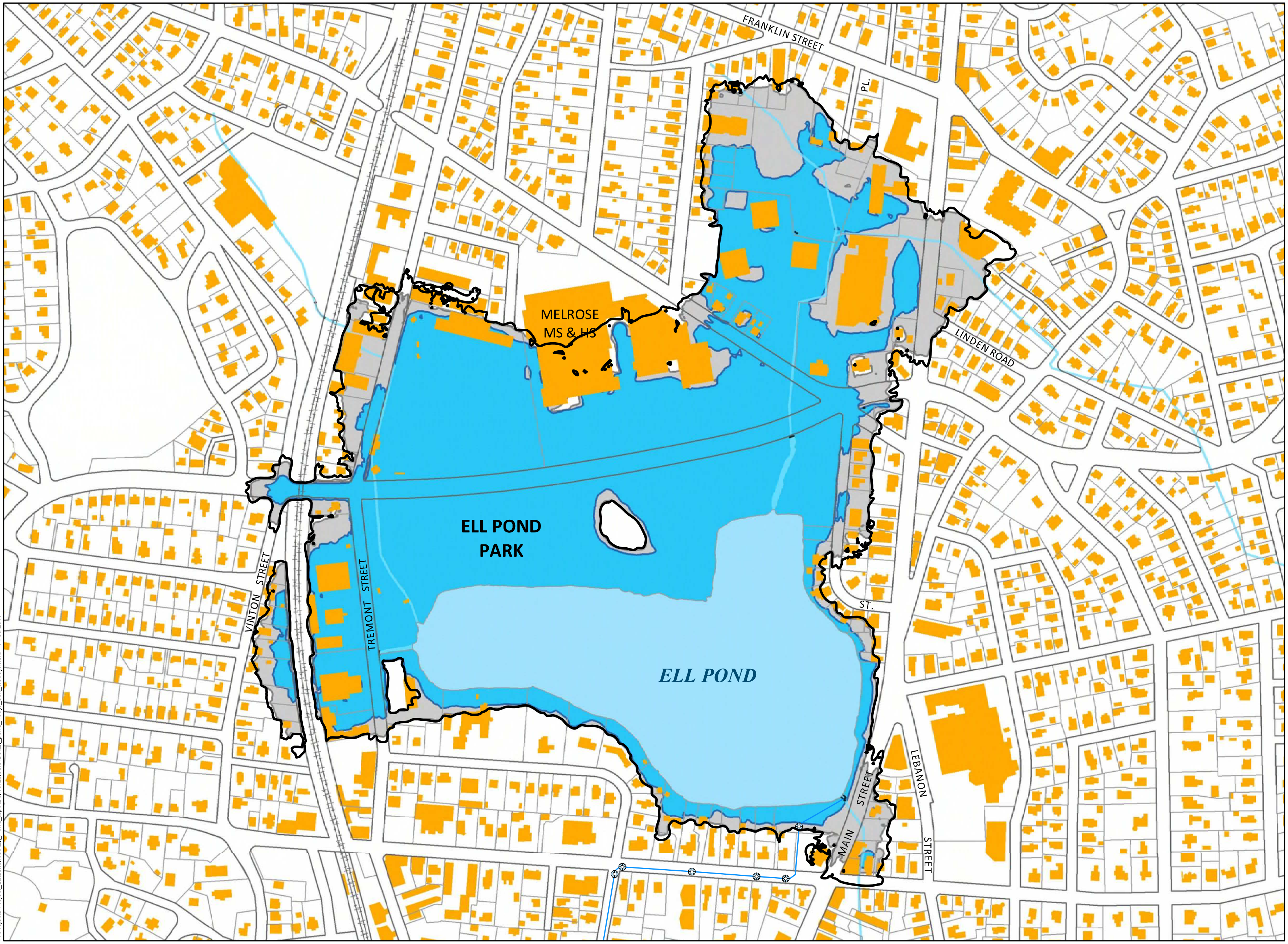
Draft LOMR Maps

(Reduced Size, Full size maps provided electronically)



City of Melrose, MA

ELL POND FLOOD AREA

Proposed Revisions to Effective Floodzone

November 2017

Legend

- 100 yr. based on current BFE (53.4' NAVD88)
- 100 yr. minus 3.5 feet (49.9' NAVD88)
- 500 yr. (52.6' NAVD88)

Note: The delineation of the 100 year floodzones are based off elevations taken from the 2013-2014 Sandy LiDAR DEM.

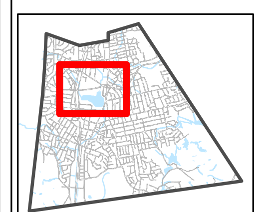
Basemap

- Road Edge
- Parcel Boundary
- Building Footprint

N

0 170 340 Feet

1 inch = 340 feet



CDM Smith

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NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study Report for this jurisdiction.

The AE Zone category has been divided by a **Limit of Moderate Wave Action (LiMWA)**. The LiMWA represents the approximate landward limit of the 1.5-foot breaking wave. The effects of wave hazards between the VE Zone and the LiMWA (or between the shoreline and the LiMWA for areas where VE Zones are not identified) will be similar to, but less severe than those in the VE Zone.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study Report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Massachusetts State Plane Mainland Zone (FIPS zone 2001). The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713- 3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1998 or later.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip .

LEGEND

AREA OF REVISION

Flood Hazard Lines

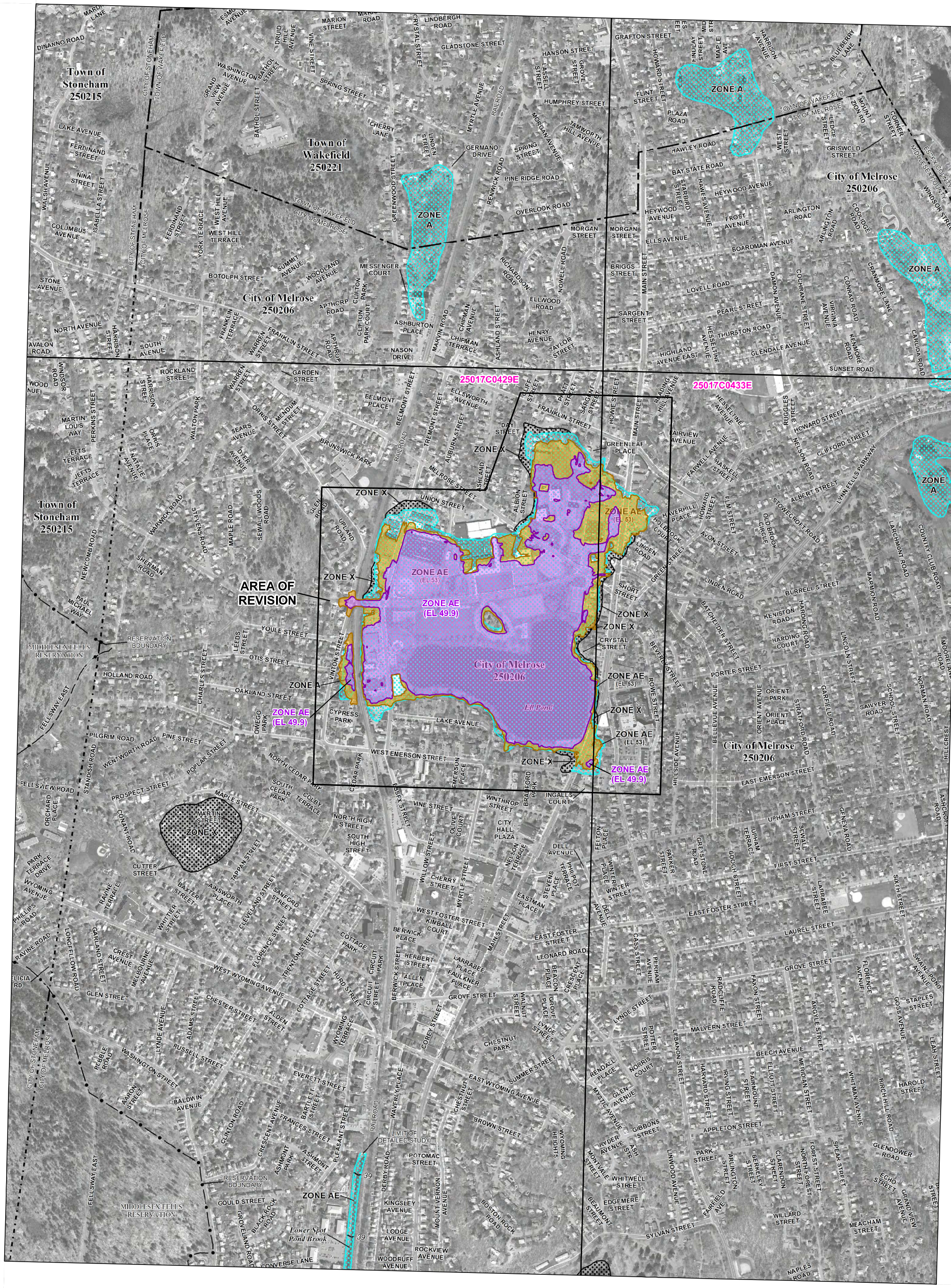
0.2 PCT ANNUAL CHANCE FLOOD HAZARD

1 PCT ANNUAL CHANCE FLOOD HAZARD

Flood Hazard Areas

0.2 PCT ANNUAL CHANCE FLOOD HAZARD

ZONE AE



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities.

Limit of Moderate Wave Action

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - 23	Transect line
	Culvert
	Bridge
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000 M	1000-meter ticks: Massachusetts State Plane Mainland Zone (FIPS Zone 2001), Lambert Conformal Conic projection
$^{49}89^{000m}$ N	1000-meter Universal Transverse Mercator grid values, zone 19N
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
September 25, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 500'

250 0 500 1000 FEET

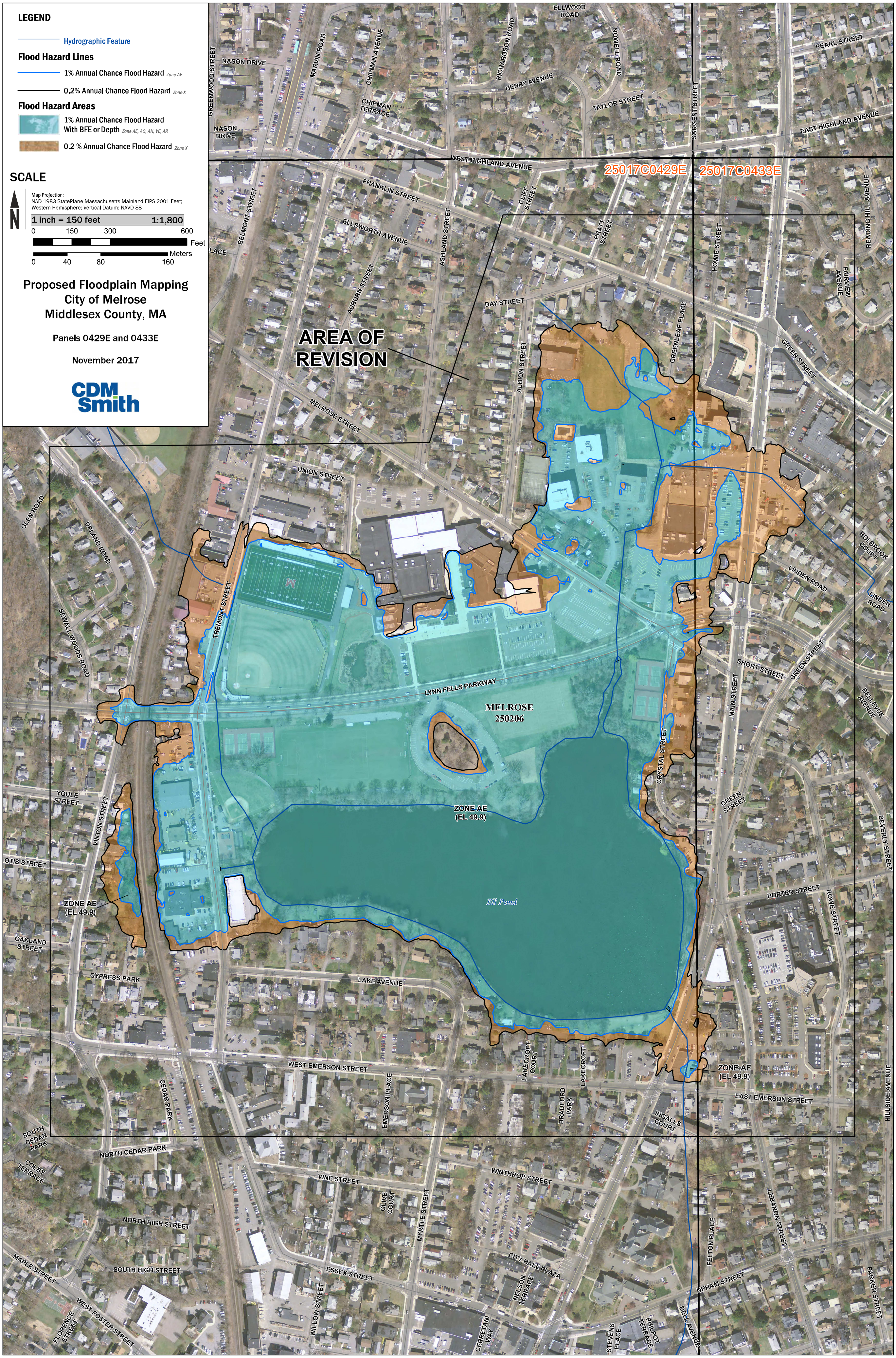
150 0 150 300 METERS

Annotated FIRM
City of Melrose
Middlesex County, MA

November 2017

Effective FIRM and Proposed Changes
Panels 0429E and 0433E

CDM Smith


LEGEND
Hydrographic Feature
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NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet; Western Hemisphere; Vertical Datum: NAVD 88
1 inch = 150 feet
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Proposed Floodplain Mapping
City of Melrose
Middlesex County, MA
Panels 0429E and 0433E
November 2017
CDM Smith
25017C0429E
25017C0433E
AREA OF REVISION
MELROSE 250206
ZONE AE (EL 49.9)
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Ell Pond
LYNN FELLS PARKWAY
WEST HIGHLAND AVENUE
EAST HIGHLAND AVENUE
WEST EMERSON STREET
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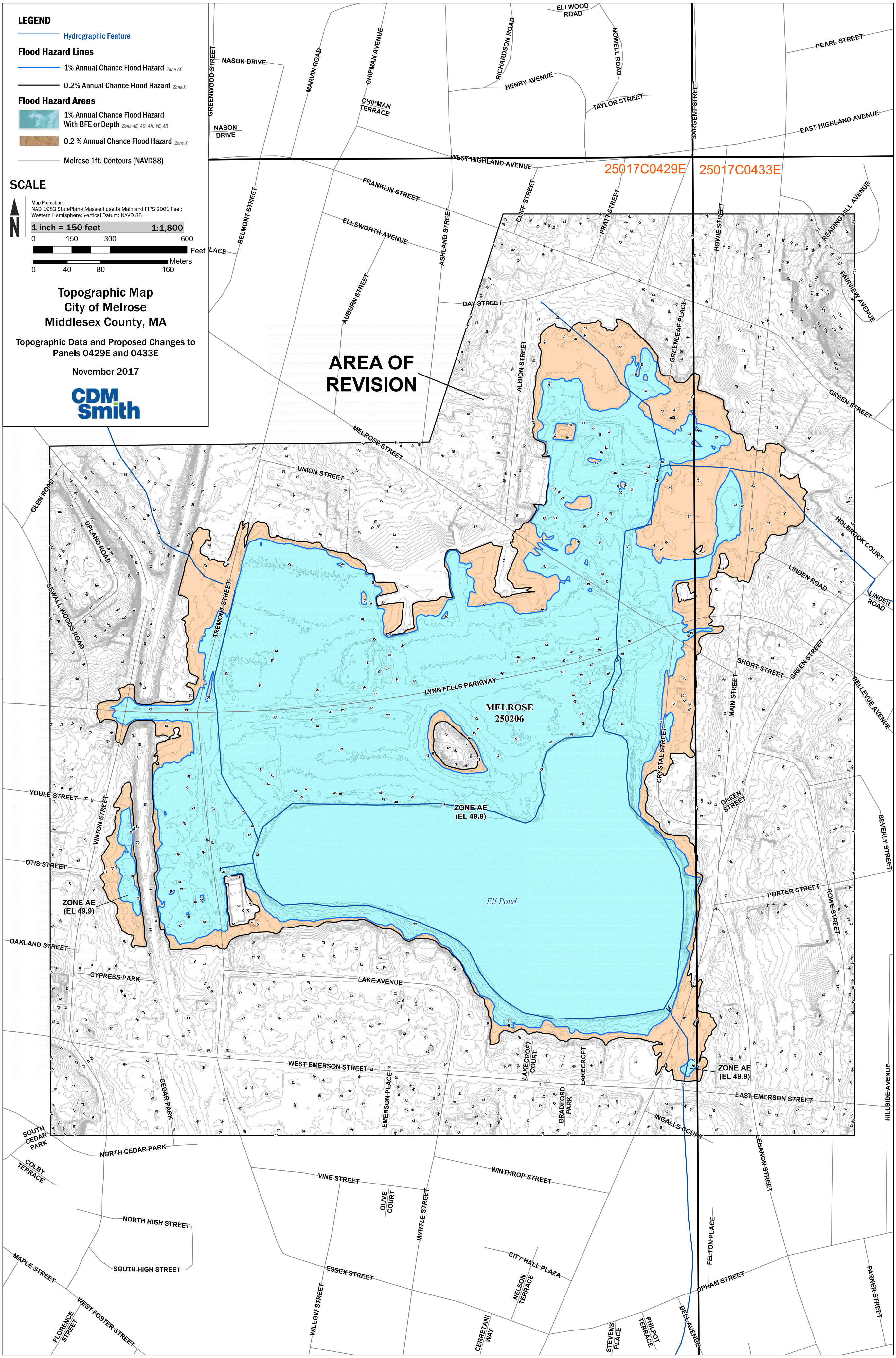

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November 2017
CDM Smith
25017C0429E
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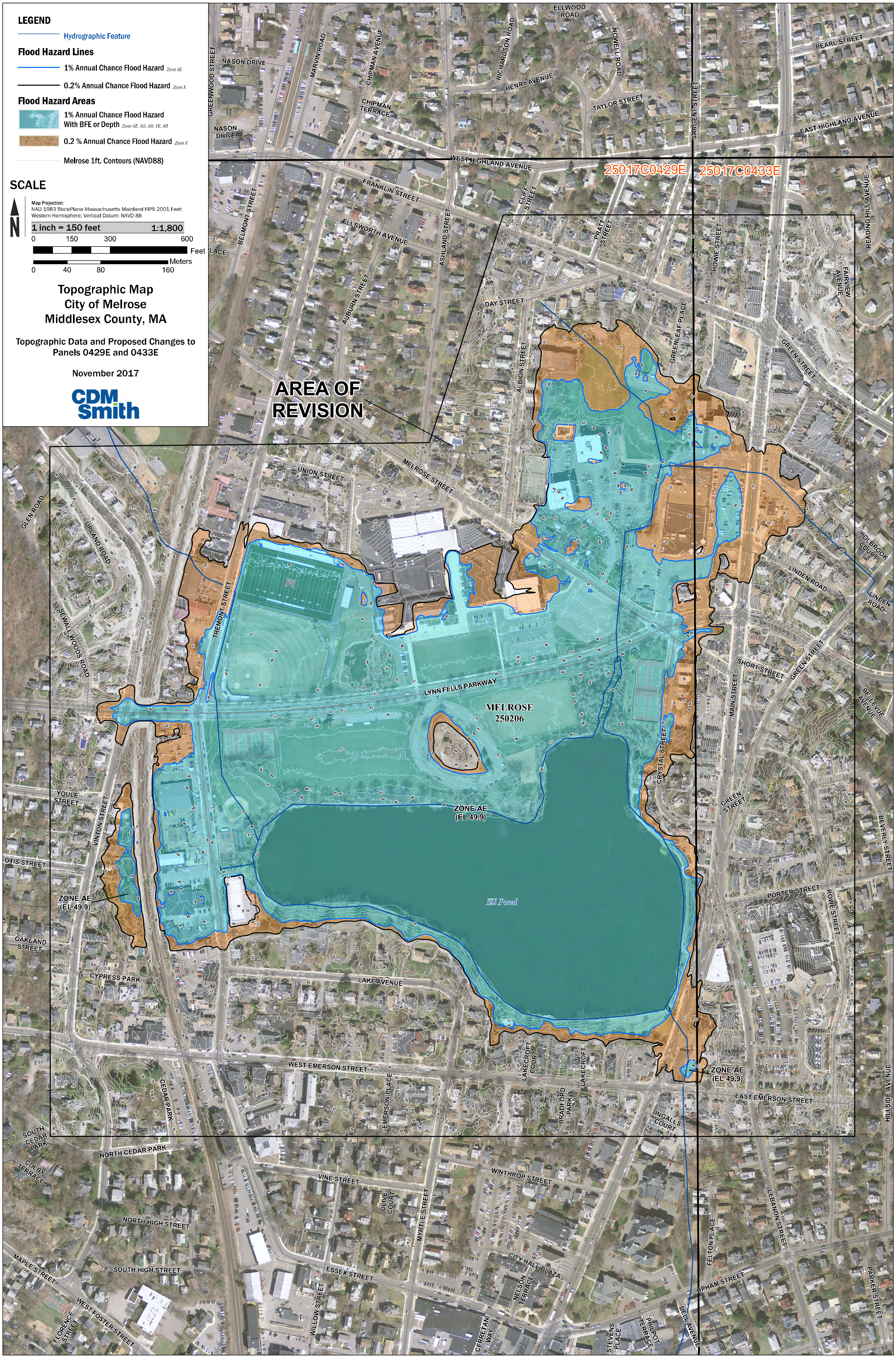

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  - 3 - Draft LOMR Maps
  - 4 - Data and Engineering
    - 1 - Effective and Historic Data
    - 2 - Elevation Data
    - 3 - As-Build Drawings-Operations
    - 4 - Hydrology
    - 5 - Hydraulics
    - 6 - Mapping

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cdmsmith.com