Discovery Report

Nashua Watershed, 01070004
Middlesex and Worcester Counties, Massachusetts; Hillsborough County, New Hampshire
Communities listed inside cover
Report Number 02

10/31/2016

FEMA

Project Area Community List

Community Name
Middlesex County, MA
Town of Ashby
Town of Ayer
Town of Dunstable
Town of Groton
Town of Pepperell
Town of Townsend
Worcester County, MA
Town of Ashburnham
Town of Berlin
Town of Bolton
Town of Boylston
Town of Clinton
City of Fitchburg
City of Gardner
Town of Harvard
Town of Holden
Town of Hubbardston
Town of Lancaster
City of Leominster
Town of Lunenburg
Town of Paxton
Town of Princeton
Town of Rutland
Town of Sterling
Town of West Boylston
Town of Westminster
City of Worcester

Community Name
Hillsborough County, NH
Town of Brookline
Town of Greenville
Town of Hollis
Town of Mason
Town of Milford
City of Nashua
Town of New Ipswich
Town of Wilton

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I. General Information

The Nashua HUC8 Watershed is an inland watershed drained by Nashua River and its tributaries in north central Massachusetts and south central New Hampshire. Most of the watershed covers relatively rural areas, though there a few large centers of population. The terrain is fairly hilly, with a mean elevation of 623 feet NAVD88, a maximum elevation of 2,007 feet NAVD88, and a mean slope of 10.7% (all determined from LiDAR). The Nashua Watershed drains 532 square miles through 1,016 catalogued river miles. The major rivers draining the watershed include Nashua River, Nissitissit River, North Nashua River, Quinapoxet River, Stillwater River, Squannacook River, and Whitman River.

Because of the low population density in most of the study area, many communities and flooding sources in the Cape Cod Watershed have not been prioritized in the past for detailed flood studies. Most small rivers are currently mapped as Zones A with only approximate levels of detail in available flooding information (256 total miles, according to CNMS [FEMA, 2015]). However, there are still many miles of Zones AE, indicating areas of detailed study (210 total miles).

The Nashua Watershed is an inland area with a centroid latitude of 42.6 degrees. The typical climate (NOAA's Massachusetts Climate Division 2) is an average January temperature of 23.5 °F, an average July temperature of 70.4 °F, and an average annual precipitation total of 44.86 inches (NOAA, 2016).

There are 35 communities in 3 counties and 2 states that touch the study area in the Nashua Watershed. (See the cover and the Project Area Community List.) According to the 2010 census (USCB, 2010), the 36 communities have a total population of about 282,000. Many of the peripheral communities have some area outside the watershed, so the total population inside the watershed is a smaller number, but it probably isn't much smaller. The Nashua Watershed study area has a population density of about 530 people per square mile.

FEMA's Discovery effort in the Nashua Watershed study area involves data collection, cursory analysis, and community outreach for the purpose of prioritizing work for new engineering analysis (surveying, hydrology, and hydraulics) and floodplain mapping within a limited financial budget.

II. Watershed Stakeholder Coordination

Watershed stakeholders include the communities in or touching the Nashua Watershed, non-governmental organizations (NGOs) such as watershed associations and regional planning commissions, and state and Federal agencies. The Federal agencies involved in Discovery for the Nashua Watershed study are FEMA – the agency initiating the study – and the U.S. Geological Survey (USGS), the mapping partner performing the study. In the Commonwealth of Massachusetts, the Department of Conservation and Recreation (MADCR) manages the National Flood Insurance Program (NFIP) and is directly involved with Discovery. In the State of New Hampshire, the Office of Energy and Planning (NHOEP) manages the NFIP and is directly involved with Discovery. The 35 communities and 8 NGOs in Massachusetts and New Hampshire that touch the Nashua Watershed were contacted in March 2016 through an invitation letter to the Discovery Meeting. The full list of stakeholders contacted is included in this report as Appendix 1.

Community and NGO stakeholders were invited to submit data collection questionnaires and supporting technical data throughout the Discovery timeline. Data collection questionnaires were available as an online webform, a hardcopy paper form, and a digital Excel spreadsheet available online after the Discovery Meeting. Of the 43 stakeholder organizations identified, 6 responded by at least one of these means. In total, 6 organizations furnished data applicable to Discovery. The remaining 37 organizations provided no response. Overall, stakeholder engagement was minimally effective, positive, and informative.

In addition to data furnished for the purposes of shaping the scope of an engineering project, stakeholders provided information about their needs in understanding, assessing, and communicating flood risk in their communities. Communities that requested help from FEMA in various topics relating to flood risk are listed in Appendix 2, with the nature of the assistance needed.

III. Data Analysis

Data collected for or during Discovery are described below and discussed in two different categories – data that can be used directly for Flood Risk Projects, and other data. Other data include data that provide information that assists in the selection during Discovery of high-priority reaches for study in a potential Flood Risk Project, but that are likely not useful to the analysis in any other way.

i. Data that can be used for Flood Risk Projects

This section describes the availability and analysis of data that could potentially be used in the development of regulatory and (or) non-regulatory products in a Flood Risk Project (RiskMAP program).

Topographic Data

Lidar elevation data are available for the entire Nashua Watershed and were used in First Order Approximation (see below). Lidar data for the majority of the watershed are from 2011 (FEMA, 2011a); data for fringes on the north and east are from 2011 and 2012 (FEMA, 2012); data for fringes on the west and some of the south are from 2013 and 2014 (USGS, 2015); data for fringes on the rest of the south are from 2010 (FEMA, 2011b); and data for fringes on the southeast are from 2010 (FEMA, 2011c). A mosaicked lidar dataset for the entire watershed was created and will be available for floodplain mapping and analysis in a Flood Risk Project.

Basemap Data

Transportation features shown on the Discovery Map were obtained from the U.S. Census Bureau as part of the TIGER/Line Files (USCB, 2016). Hydrography and watershed features shown on the Discovery and Community Information Map were obtained from the U.S. Geological Survey as part of the National Hydrography Dataset (USGS, 2010a). Political boundary and effective flood hazard features were obtained from FEMA as part of the National Flood Hazard Layer (FEMA, 2016a). All basemap features will be useful in the FIRM database for a potential flood risk project.

First Order Approximation Data

First Order Approximation (FOA) is a FEMA initiative, taking place during Discovery, that involves performing an approximate engineering analysis, updated floodplain mapping, and CNMS validation for all Zones A in the watershed (FEMA, 2014). In the Nashua Watershed study, FOA was performed in part for all Zones A (FEMA, 2016b). Updated floodplain mapping was not performed for these zones. The results of the analysis and mapping could be very useful in a potential flood risk project. Current results include water surfaces for the 10%, 4%, 2%, 1%, and 0.2% annual exceedance probability (AEP) floods for all analyzed reaches. Once generated from the surfaces, the floodplains can be used directly in updated regulatory mapping (i.e., FIRM panels), and the water surfaces and depth grids can be used directly in non-regulatory products, such as the Flood Risk Report and the Hazus loss analysis that accompanies it. Water surfaces can also be used in the validation of Letters of Map Change (LOMCs) that FEMA receives regarding properties that are mapped in Zones A. Currently, it is difficult to determine if a property or structure is actually above the flood level, because no numerical water surface is available. With the creation of these new water surfaces, a numerical value for the flood height is now available for comparison with the property and structure elevations to determine the validity of a LOMC.

Effective FIS/FIRM Data

Two of the counties (Middlesex and Hillsborough) touching the Nashua Watershed had a countywide FIS and digital FIRM (with database) released during the Map Modernization program. Worcester County had only a partial countywide FIS and digital FIRM released during Map Modernization. The partial countywide study included only the southeast half of the county, and the Nashua Watershed is mostly in the northwest half of the county. Therefore, only 9 of the 20 Worcester County communities in the Nashua Watershed have digital countywide products. Of the 35 communities touching the watershed, 24 have a countywide FIS and digital FIRMs and database. The remaining 11 have non-digital products in effect dating back several decades.

Portions of the effective FIS reports in digital format can be copied directly into revisions of those reports for a potential flood risk project. Likewise, much of the content of the effective FIRM database and panels can be copied directly into revisions of the database and panels, with minor or no editing necessary. These include tables such as the FIRM panel index, the political areas, and the areas of coastal flooding, which would not be updated, since the flood risk project following this Discovery would focus on riverine flooding sources only.

ii. Other Data and Information

This section describes the availability and analysis of data that could not potentially be used directly in the development of regulatory and (or) non-regulatory products, but instead could be very useful in directing the scope, focus, and outreach of a flood risk project.

Community Data

Large volumes of aggregate community data related to the NFIP were downloaded from the Community Information System (CIS), an online FEMA database with restricted access. There are many available CIS reports, some of which report the same information. Among CIS reports that contained the same information, there were some small discrepancies in values for some communities. In cases of discrepancies, the value from the first report consulted was kept. Many of the data obtained from CIS were used to fill out the Community Information Sheets distributed to the community stakeholders before the Discovery Meeting.

Community populations were obtained from the 2010 national census (USCB, 2010). This information was also included on the Community Information Sheets. The Community Information Sheets and corresponding maps are included as Appendices 3 and 4, respectively, to this report.

CNMS Data

The most recent Coordinated Needs Management Strategy (CNMS) validation of effective Zones AE in FEMA Region I (New England) was completed on August 31, 2015. CNMS is a FEMA spatial database that tracks the viability of effective studies and alerts FEMA when an effective study is considered obsolete based on updates in available topography, hydrology, or human development (FEMA, 2015). Re-assessment of all reaches in CNMS is required by law every five years.

According to the 2015 CNMS assessment, Zone AE reaches listed below in Table 1 are "Unverified," indicating that at least one critical (C) element and/or at least four secondary (S) elements have failed for the reach. Reaches are ranked from most to least critical elements failing and then most to least secondary elements failing.

Table 1: Prioritization of Restudy Reaches Based on CNMS Assessment

Number of Critical Elements Failing	Number of Secondary Elements Failing	Reach	Elements Failing
2	4	Nashua River	C2, C4, S2, S6, S9, S10
2	2	Squannacook River	C1, C2, S2, S4
2	1	Nissitissit River	C1, C2, S10
1	4	Nashua River	C2, S2, S4, S6, S9
1	3	North Nashua River	C2, S2, S4, S6
1	2	Nashua River	C1, S4, S9
0	5	Reedy Meadow Brook	S1, S2, S4, S6, S10
0	4	Counterpane Brook	S1, S2, S9, S10
0	4	Catacoonamug Brook	S1, S6, S9, S10
0	4	James Brook	S1, S4, S6, S10
0	4	Morse Brook	S1, S4, S6, S10
0	4	Trout Brook 2	S1, S4, S6, S10

Number of Critical Elements Failing	Number of Secondary Elements Failing	Reach	Elements Failing
0	4	Goodridge Brook	S1, S4, S6, S10
0	4	Gates Brook	S1, S4, S6, S10

Effective FIS/FIRM Data

Floodplain Mapping

An inventory of Letters of Map Change (LOMCs) for each of the 35 communities touching the Nashua Watershed was obtained from FEMA, with a grand total of 518 LOMCs. Of those 518, 348 are currently valid. Coordinates listed in the inventory are precise only to the hundredth of a degree and therefore are not very useful in a hotspot or cluster analysis, but the inventory also lists the flooding source for most valid LOMCs. The flooding sources with the most associated valid LOMCs are ranked in Table 2. "Local flooding" (usually designating unnamed Zones A) is left out of this table, since it is impossible to trace the exact flooding source. A high number of LOMCs indicates faulty or imprecise mapping that should be considered a high priority for restudy or redelineation.

Table 2: Prioritization of Redelineation Reaches Based on Number of LOMCs

Flooding Source	Community(ies)	Number of valid LOMCs
Nashua River	Bolton, Clinton, Dunstable, Groton, Lancaster, Leominster, Nashua, Pepperell	20
Squannacook River	Groton, Townsend, Shirley	9
North Nashua River	Leominster	8
Monoosnoc Brook	Leominster	7

Hydrology

The "Summary of Discharges" table from each county's effective FIS report was analyzed for accuracy against nearby U.S. Geological Survey streamgages, where available. Streamgages with applicable statistics were available for 3 reaches in the Nashua Watershed. Of these 3, all were found to compare poorly to streamgage statistics.

The "Summary of Discharges" tables were also analyzed for discontinuities in discharge, such as a lower discharge at a point further downstream in a reach, due to very different analyses performed in different communities and counties touching a single reach. Problems in either hydrologic analysis were used to choose reaches that may be in need of updated analysis. Ten reaches were selected by this analysis.

Hydraulics

There were 17 high-water marks (HWMs) found and surveyed by the U.S. Geological Survey after the spring 2010 flooding in the Nashua Watershed (USGS, 2010b). Of these 17 HWMs, all were located on Zone AE reaches (specifically, Nashua River) with flood profiles in the effective FIS reports and had verified elevations. The elevations of these HWMs were plotted on the flood profiles, and the recurrence intervals on which they fell were recorded. These recurrence intervals were then compared to the published recurrence intervals on their respective reaches from the spring 2010 flood (USGS, in press). The results of the comparison for these 17 HWMs are shown below in Table 3, ranked from worst to best percentage of disagreeing recurrence intervals ("Score").

Table 3: Prioritization of Reaches Based on Comparison of HWM Recurrence Intervals

Reach	Total HWMs	Score	Rank
Nashua River	17	0.29	1

First Order Approximation Results

In the Nashua Watershed, FOA was performed in part for all Zones A needing CNMS validation (see section on "First Order Approximation Data" on page 3). In addition to the potential applications of FOA results to Flood Risk projects, FOA results were also used in the prioritization of reaches for detailed study in potential future Flood Risk projects in this watershed. The particular result that is useful in evaluating each reach is a pass/fail metric based on a numerical evaluation of the effective floodplain against two of the new water-surface elevations generated in FOA. The two water surfaces are the "1%+" and "1%-" – the surfaces calculated from the 1% AEP flows plus the positive standard error from regression equations and minus the negative standard error, respectively. Along the boundary of the effective floodplain, a point is created every 100 feet. Within a 37.5-foot radius around each point, the ground surface elevation from the lidar DEM is compared against the water-surface elevations – plus a vertical tolerance buffer – of the 1%+ and 1%- profiles at the point. (The value of the vertical tolerance is one half of the contour interval used to map the effective Zone A.) If the ground surface elevation is between the buffered 1%+ and 1%- water-surface elevations, then the point passes; otherwise, it fails. For each reach, all passing and failing points are counted, and a reach passes if 95% or more of the points pass and fails otherwise. For a more thorough discussion of the FOA process and the Zone A evaluation metrics, see the FOA report (FEMA, 2016b) and its appendices for more details.

A summary of FOA pass/fail results is in Table 4. A second pass/fail value has been added, this time not buffering the 1%+ and 1%- values with the vertical tolerance. The vertical tolerance is required by FEMA, but it effectively results in an evaluation of the effective zone against the topography on which it was originally mapped, ignoring how well the effective zone may perform against new, more precise topography. The second pass/fail value, then, indicates how well the zone is mapped against the best currently available topography. Although there were many Zones A that scored poorly in the FOA validation, none were selected for detailed study.

Table 4: Pass/Fail Results of FOA Zone A Validation

Vertical Tolerance	Total Zones	Passing Zones	Failing Zones
With	203	87	116
Without	203	1	202

State NFIP Coordinator Priorities

The NFIP Coordinator's offices for the Commonwealth of Massachusetts and State of New Hampshire publish annual reports for FEMA outlining a business plan for each year. These plans discuss mapping progress and current mapping needs based on known issues and data gaps. The most recent business plan was written in December 2014 for Massachusetts and in February 2015 for New Hampshire.

The Massachusetts business plan highlights two major concerns. First, it points out that there are many mismatches in floodplains and water-surface elevations along community boundaries, where they are supposed to match but often don't because of the community-centered analysis and mapping practices of the past. This needs to be addressed by performing new detailed studies across community boundaries that tie into or completely replace effective studies. Second, it points out an unfortunate consequence of FEMA's preference for mapping an entire county at one time: counties with large unpopulated areas don't get mapped at all, leaving their communities and residents with antiquated hardcopy maps and no access to the enhanced digital tools of the modern programs. The business plan recommends that this be addressed by making exceptions to the countywide rule so that populated areas in largely unpopulated counties can still be mapped. However, given that funds for study and mapping are limited, the Massachusetts State NFIP Coordinator still gave higher priority to updating existing maps in densely populated areas than to creating new digital maps in currently unmapped areas.

The New Hampshire business plan highlights another major concern: the very high percentage of approximate studies in the State that are categorized as not valid in CNMS. The New Hampshire

State NFIP Coordinator identifies the validation and, potentially, restudy of these reaches as a mapping need. Finally, the New Hampshire coordinator recommends the Floodplain Boundary Standard (FBS) on effective reaches as a potential method for evaluating effective floodplain maps. This recommendation has been incorporated into this Discovery process.

The coordinator's list of ranked priorities is copied below from the business plan as Table 5. None of the priorities are relevant to the Nashua Watershed except number 12 for Massachusetts.

Table 5: State NFIP Coordinator's Top Mapping Priorities

State	Rank	Description	Cited Reason
MA	**1**	PMRs to incorporate data submitted by communities for areas too extensive to be handled by LOMR	
MA	**2**	Ipswich River Watershed	Discrepancy between peak streamflow data from effective FIS and from USGS streamgages; new regional regression equations
MA	**3**	Merrimack River Watershed	Discrepancy between peak streamflow data from effective FIS and from USGS streamgages; new regional regression equations
MA	**4**	Parker River Watershed	Discrepancy between peak streamflow data from effective FIS and from USGS streamgages; new regional regression equations
MA	**5**	Saugus River Watershed	Discrepancy between peak streamflow data from effective FIS and from USGS streamgages; new regional regression equations
MA	**6**	Spicket River Watershed	Discrepancy between peak streamflow data from effective FIS and from USGS streamgages; new regional regression equations

State	Rank	Description	Cited Reason
MA	**7**	Community mismatches due to new studies (e.g., South Hadley Connecticut River)	WSE mismatches violate FEMA program requirement and make risk analysis and management difficult
MA	**8**	Berkshire County full countywide digital conversion, incorporating USGS Hoosic River and Deerfield River studies	No DFIRM; FIRMs very inadequate, imprecise, and outdated; new engineering available
MA	**9**	Hampshire County full countywide digital conversion, including Connecticut River restudy	No DFIRM; FIRMs very inadequate, imprecise, and outdated; new engineering available
MA	**10**	Franklin County full countywide digital conversion, incorporating USGS Deerfield River study and including Connecticut River restudy	No DFIRM; FIRMs very inadequate, imprecise, and outdated; new engineering available
MA	**11**	Charles River Watershed	Discrepancy between peak streamflow data from effective FIS and from USGS streamgages; new regional regression equations; high-water marks (HWMs) from spring 2010 flood
MA	**12**	Northern Worcester County digital conversion and Nashua River restudy	No DFIRM; FIRMs very inadequate, imprecise, and outdated
NH	**1**	Digital conversion of Belknap County	No DFIRM; FIRMs very inadequate, imprecise, and outdated
NH	**2**	Lower Connecticut River Watershed	Best watershed with lidar availability, high flood risk, and highest-priority CNMS mapping needs
NH	**3**	PMR to incorporate Suncook River study	Too extensive to be handled by LOMR

NFIP Claims Data

FEMA furnished a dataset of all claims made against the National Flood Insurance Program (NFIP) since its inception in the 1970s until December 31, 2015. About 1.9% were discarded from analysis because of ambiguity in geographic location or because it was found that they were classified under the wrong community and were actually located outside the project area. In the 35 communities touching the Nashua Watershed, the data pull returned 212 valid NFIP claims in that period, totaling $1,943,841.96. Of these claims, 168 (or 79.2%) were successful (i.e., were reimbursed a non-zero dollar amount), with an average reimbursement of $11,570.49.

Note that, almost all the time, a successful NFIP claim occurs when a property is flooded that, according to the effective FIRM, is at risk of flooding during the base flood. (The exceptions are claims against "discount" policies for properties that are located outside the SFHA. The percentage of claims in this category could not be ascertained with the data provided but is assumed to be small.) Therefore, NFIP claims data cannot be used to draw any conclusions for Discovery about reaches that may be high priorities for restudy because of outdated hydrology, hydraulics, topography, or structure inventories. However, high concentrations of NFIP claims (especially expensive ones) may draw attention to hotspots where population, structure inventories, and flood hazard are all unusually high, highlighting the highest-priority opportunities for mitigation.

NFIP claims hotspots were determined by a point density analysis calculating the cumulative dollar value of claims within a one-kilometer radius. According to this spatial analysis, areas of highest priority for mitigation are ranked in Table 6. Note that this analysis does not take the timing of claims into account, so mitigation efforts may have already been undertaken on some or all of these reaches in response to flood events early in the history of the NFIP.

Table 6: Priority Areas of Mitigation Based on NFIP Claims

Rank	Flooding Source	Communities
1	Nashua River	Ayer, Clinton, Groton, Lancaster, Nashua, Pepperell, Shirley
2	Baker Brook	Fitchburg
3	North Nashua River	Fitchburg, Lancaster
4	Monoosnoc Brook	Leominster
5	Goodridge Brook	Lancaster
5	Nissitissit River	Brookline, Pepperell

Rank	Flooding Source	Communities
5	Waushacum Brook	West Boylston

Community Interviews

The communities in the watershed were solicited for information about their flood risk and mitigation capabilities. Communities were asked for the following types of information:

- Desired study areas
- Existing data studies
- Funding
- Levees
- Mitigation planning
- Mitigation projects
- Areas of Mitigation Interest (AOMIs)
- Environmentally sensitive areas
- GIS data
- Communication and outreach
- Compliance and training

Responses in the category of desired study areas can be used to prioritize reaches for a potential flood risk project. Mapping needs identified by communities are summarized in Table 7 below.

Table 7: Community Mapping Needs

Community	Description
City of Fitchburg	Baker Brook
Town of Lancaster	Nashua River, North Nashua River
City of Leominster	Fall Brook, Monoosnoc Brook, North Nashua River, Tributary A to Fall Brook, Tributary B to Fall Brook, Tributary C to Fall Brook, Tributary to Monoosnoc Brook
City of Nashua	Nashua River
Town of Pepperell	Nashua River, Nissitissit River, Reedy Meadow Brook
Town of Townsend	Squannacook River bypass

Reach Selection

By synthesizing the results of all analyses presented above, as well as study age, map age, and risk (how many structures and people are in the effective floodplain), a final list of reaches was selected for updated engineering and mapping. The selection is presented in Table 8 below. The list of all reaches considered is included as Appendix 5.

Table 8: Final Reach Selection List

Flooding Source	Study Length (mi)	Study Type	Study Limits
Baker Brook	6.0	Detailed	From confluence with North Nashua River, Fitchburg, MA to headwaters at Scott Reservoir, Fitchburg, MA
Fall Brook	4.4	Detailed	From confluence with North Nashua River, Leominster, MA to outlet of Fall Brook Reservoir, Leominster, MA
Monoosnoc Brook	5.0	Detailed	From confluence with North Nashua River, Leominster, MA to downstream crossing of State Route 2, Leominster, MA
Nashua River	45.3	Detailed	From confluence with Merrimack River, Nashua, NH to headwaters at Wachusett Reservoir, Clinton, MA
Nissitissit River	4.3	Detailed	From confluence with Nashua River, Pepperell, MA to confluence with Gulf Brook, Brookline, NH
North Nashua River	19.1	Detailed	From confluence with Nashua River, Lancaster, MA to confluence with Phillips Brook, Fitchburg, MA
Reedy Meadow Brook	1.7	Detailed	From confluence with Nashua River, Pepperell, MA to effective limit of detailed study at Wyman Road, Groton, MA

IV. Discovery Meeting

Two Discovery Meetings were hosted by FEMA and the USGS in the Nashua Watershed. The meetings are summarized below in Table 9. The agenda for both meetings was the same, and all organizations (Federal, State, community, and non-governmental stakeholders) were invited to either of them. Invitations are included as Appendix 6. Lists of attendees at and minutes from each of the three meetings are also included as Appendices 7 and 8, respectively. At each meeting, an opening presentation (Appendix 9) was made, followed by breakout sessions in which stakeholders were given the opportunity to consult with project team members on flood risk issues particular to their communities or watersheds. Community input on mapping and other needs was received during these breakout sessions and during the four weeks following the meetings. After the four weeks, all information received from the stakeholders was aggregated and used with other data sources to prioritize mapping needs for the Nashua Watershed.

Table 9: Discovery Meetings

Date	Time	Location
Wednesday, April 27, 2016	9:30 AM	Leominster Library Auditorium 30 West Street Leominster, MA 01453
Wednesday, April 27, 2016	1:00 PM	Leominster Library Auditorium 30 West Street Leominster, MA 01453

V. Sources Cited

Sources cited are listed in Table 10 below.

Table 10: Sources Cited

Citation	Reference
FEMA, 2011a	*2011 FEMA Risk Mapping, Assessment, and Planning (Risk MAP) Lidar: Nashua River Watershed (Massachusetts, New Hampshire)*. Washington, DC: Federal Emergency Management Agency, 15 Jul 2011. Web. <https://coast.noaa.gov/dataviewer/#/lidar/search/where:ID=2513>
FEMA, 2011b	*2011 Federal Emergency Management Agency (FEMA) Topographic Lidar: Massachusetts and Rhode Island*. Washington, DC: Federal Emergency Management Agency, 2 May 2011. Web. <https://coast.noaa.gov/dataviewer/#/lidar/search/where:ID=2557>
FEMA, 2011c	*2010 Federal Emergency Management Agency (FEMA) Topographic Lidar: Concord River Watershed, Massachusetts*. Washington, DC: Federal Emergency Management Agency, 1 May 2011. Web. <https://coast.noaa.gov/dataviewer/#/lidar/search/where:ID=2549>
FEMA, 2012	*2012 FEMA Risk Map Lidar: Merrimack River Watershed (Massachusetts, New Hampshire)*. Washington, DC: Federal Emergency Management Agency, 14 Sep 2011. Web. <https://coast.noaa.gov/dataviewer/#/lidar/search/where:ID=2516>
FEMA, 2014	"First Order Approximation." *Guidance for Flood Risk Analysis and Mapping*. Washington, D.C.: Federal Emergency Management Agency, November 2014. Print.
FEMA, 2015	"CNMS Technical Reference." *Guidelines and Standards for Flood Risk Analysis and Mapping*. Washington, D.C.: Federal Emergency Management Agency, May 2015. Print.
FEMA, 2016a	*National Flood Hazard Layer*. Washington, D.C.: Federal Emergency Management Agency, 2016. Web. <http://msc.fema.gov>
FEMA, 2016b	*FOA Report, Nashua Watershed, 01070004*. Washington, D.C.: Federal Emergency Management Agency, 31 Oct 2016. Print.

Citation	Reference
NOAA, 2016	*NOAA National Centers for Environmental Information, Climate at a Glance: U.S. Time Series*. National Oceanic and Atmospheric Administration, Dec 2016. Web. 21 Dec 2016. <http://www.ncdc.noaa.gov/cag/>.
USCB, 2010	"2010 Census." *Census.gov*. U.S. Census Bureau, 21 Dec 2010. Web. 1 Apr 2015. <http://www.census.gov/2010census/>.
USCB, 2016	*TIGER/Line Files*. Washington, D.C.: U.S. Census Bureau, 2016. Web. 20 Dec 2016. <https://www.census.gov/geo/maps-data/data/tiger-line.html>
USGS, 2010a	*National Hydrography Dataset*. Reston, VA: U.S. Geological Survey, 2010. Web. <http://nhd.usgs.gov>
USGS, 2010b	Zarriello, P.J. and Bent, G.C. *Elevation of the March-April 2010 flood high water in selected river reaches in central and eastern Massachusetts*. Open-File Report 2010-1315. Reston, VA: U.S. Geological Survey, 2010. Print.
USGS, 2015	*2013-2014 U.S. Geological Survey CMGP LiDAR: Post Sandy (MA, NH, RI)*. Reston, VA: U.S. Geological Survey, 19 Feb 2015. Web. <https://coast.noaa.gov/dataviewer/#/lidar/search/where:ID=4914>
USGS, in press	Zarriello, P.J. *Magnitude of flood flows for selected annual exceedance probabilities in Massachusetts through 2013*. Scientific Investigations Report 2015-xxxx. Reston, VA: U.S. Geological Survey, in press. Print.

VI. Appendix and Tables

Table 11: Appendices

No.	Description	File Name	File Size (MB)
1	List of stakeholders contacted during Discovery	stakeholder_list.xlsx	0.1
2	List of communities requesting assistance from FEMA	watershed_communities_ requesting_assistance.xlsx	0.1
3	Community Information Sheets	CIS.pdf	0.2
4	Community Information Maps	CIM.pdf	174
5	Complete list of reaches considered in prioritization for restudy	priority_ranking.xlsx	0.1
6	Discovery Meeting invitations	Invitations.zip	2.1
7	Discovery Meeting attendees	Attendance.xlsx	0.1
8	Discovery Meeting minutes	Minutes.zip	0.1
9	Discovery Meeting presentation	Presentation.zip	7.5