REPORT

Dedham, MA

Violet Avenue – Riverdale Area Drainage Evaluation Hydraulic Flow Model Report

October 2014

Weston & Sampson

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Town of Dedham, Massachusetts
Weston & Sampson Project No. 2140053

October 22, 2014

Mr. Jason L. Mammone, PE
Director of Engineering
55 River Street
Dedham, Massachusetts 02026

Re: Violet Avenue – Riverdale Area Drainage Evaluation Hydraulic Flow Model Report

Dear Mr. Mammone:

Weston & Sampson Engineers, Inc. is pleased to submit our final report on the Drainage System Hydraulic Flow Model outlining the hydraulic modeling procedure and results for the Violet Avenue evaluation. The purpose of developing the drainage system model was to evaluate the current capacity of the mainline drainage system and to identify potential system problems or deficiencies that may contribute to the drainage system flooding along the low lying area on Violet Avenue. The report describes how the model was constructed, the methodology for selecting flow inputs, and results of the model runs. The Stormwater and Wastewater Management Model Program (XP-SWMM) was used for the simulations.

Project Background

The existing Riverdale Area drainage system that traverses cross-country between Violet Avenue and Kiely Road experiences flooding when storm flow exits the drainage system from a drainage structure on the property of 76 Violet Avenue. Various degrees of flooding have recently occurred on the following dates, as shown in Table 1 – Flooding History.

Table 1 Flooding History Rainfall Events

Storm Event	Date	Peak Intensity (inches/hour) (1)	Recurrence Interval 1 Hour	Total Storm Rainfall (inches) (1)
1	4/9/2010	0.20	< 3 Month	1.03
2	4/16/2010	0.12	< 3 Month	0.34
3	10/15/2010	0.37	< 3 Month	1.44
4	7/23/2013	0.96	1 Year	1.50
5	9/1/2013	NA	NA	2.24
6	7/28/2014	1.04	1 Year	1.09

(1) Source Weather Underground Website: Weather Station ID: KMADEDHA1 Station Name: I-95 / MA-109

This flooding mainly affects the properties of 70, 76, 84, 86 Violet Avenue and 81 Kiely Road with back yard flooding as high as approximately 4 feet based on observations by residents.

The Riverdale Area Drainage system discharges to the Charles River. The dynamics of the flooding that occurs in the Riverdale area are not uncommon. This area, which is tributary to the Charles River, collects flow from a significant land area, which is predominantly residential impervious. The flow is conveyed to the Charles River via approximately 5,500 feet of tributary drain system that discharge to the Bridge Street outfall. See Figure 1 Existing System, Attached

Project Scope of Services

The Town's project objective is to develop a list of potential improvements to alleviate flooding in the area of Violet Avenue. This will be accomplished through completion of the following tasks:

- Data Collection & Field Reconnaissance
- Hydrology and Hydraulic Modeling Analysis
- Model Results Design Model Alternatives Analysis
- Alternative Cost Analysis
- Permit Review

The drainage system hydraulic model created to evaluate potential improvements included the following project scope of services:

- Phase 1 Preliminary Model Analysis
- Phase 2 Rehabilitation Plan Model Analysis
- Phase 3 Design Model Analysis

The three phase scope was utilized to pinpoint the actual cause of the flooding and what combination of the following three potential reasons contributed to the flooding in the Violet Avenue - Riverdale Area:

1. The storm drain conveyance system is undersized and no longer has the carrying capacity to convey storm runoff flow tributary to the system. (Flows may have increased from the original design due to land development)

2. The conveyance system is adequately sized to handle tributary storm runoff flow but has limiting obstructions. (Debris, Collapsed Pipes, Utility Conflicts Reducing Flow Area)

3. The tail water elevation in the Charles River is preventing the local drainage from draining.

Phase 1 Preliminary Model Analysis and Phase 2 Rehabilitation Plan Model Analysis – Scope and Results

Weston & Sampson Engineers, Inc. has performed a Hydrologic & Hydraulic analysis of

the tributary area for the Charles River Bridge Street outfall. Hydrologic analysis is the creation of subarea runoff hydrographs for various storm events based on hydrologic parameters. Hydraulic analysis is the evaluation and determination of the drainage system hydraulic carrying capacity and hydraulic grade line.

The Phase 1, Phase 2, and Phase 3 Hydrologic & Hydraulic analysis were performed by utilizing the XPSWMM 2012 modeling software program. The four key components to developing a Hydrologic and Hydraulic model were:

1. Collection of Hydraulic System Data (Rim Elevation, Invert Elevations, Pipe Size, Pipe Length, Mannings “n” Value)

2. Collection of Tributary Hydrologic Data (SubAreas, Soils Type, Landuse Category, Time of Concentration)

3. Rainfall Design Storm Selection For Flow Hydrographs

4. Model Calibration

Under the Phase 1 Preliminary Model Analysis we collected the following data for utilization with the models:

Data Collection & Field Reconnaissance

1. Collected Hydraulic System Data (Rim Elevations, Invert Elevations, Pipe Size, Pipe Length, Mannings “n” Value) from Town reports, studies, record drawings and GIS.

2. Collected tributary Hydrologic Data (Sub Areas, Percent Impervious, Sub Area Width, and Sub Area Slope) from available Town reports, studies, record drawings, GIS, as well as state and federal agency resources such as MassGIS Office of Geographic and information.

3. Conducted field investigation and onsite field survey within the project area to collect system data mapping for the Hydrologic and Hydraulic models. (Approximately 7,000 feet and 60 storm drain structures)

4. Conducted TV inspection of as many as 1,150 feet of mainline storm drain from Violet Avenue to the Bridge Street outfall to determine the existing drain system conditions and establish potential restrictions that may be limiting flow capacity.

5. Reviewed the TV inspection video to define the system parameters for inclusion with the hydraulic modeling.

6. Collected rainfall data from rainfall records shown in Table 1.

7. Coordinated and interviewed Town staff and local residents from 70 & 76 Violet Avenue during a project meeting at the resident’s home and site of the flooding.

8. The field and record drawing collection research included:

    - Storm drain record drawing research and supplemental survey of the tributary area upstream of Charles River Bridge Street outfall. Along Zoar Avenue, upstream to Violet Avenue and the upper limits of Volk Road.
    - Inspection and field observations during four rain storm events to document their impact.
    - Field survey of rim to invert measurements to confirm data for use in the models.

Information obtained during the field reconnaissance was combined with the Town's available record drawings to develop local drainage areas, site topography, and storm drain system data.

Television Inspection Results

In March 2014 New England Pipe Cleaning Company (NEPCCO) performed television inspection services of the Zoar Avenue mainline drain from DMH321, on the property of 76 Violet Ave, to the Bridge Street outfall of the Charles River. The objective of the television program is to identify system deficiencies or blockages that limit carrying capacity. The observations from the March 2014 television inspection, shown in Figure 2 – TV Inspection Results, Attached , are:

1. Heavy sag in section from DMH 1338 to DMH 615

2. Heavy debris (1/2 pipe) in section from DMH 615 to DMH 321

3. Moderate debris (1/4 pipe) in section from CB 667 to CB 668

4. Heavy debris (1/3 pipe) in section from CB 668 to DMH 124

5. Heavy debris (1/2 pipe) in section from DMH 124 to DMH 426

6. Heavy debris (1/3 pipe) in section from DMH 426 to DMH 877

7. Heavy debris (1/3 pipe) in section from DMH 877 to Outfall. Pipe full of debris and standing water before first bend.

8. Partially collapsed pipe 53 feet upstream of outfall on Bridge Street.

The above observations were incorporated into the calibration model as contributing factors to hydraulic capacity evaluation. The Town of Dedham has performed improvement projects to increase capacity and remove deficiencies observed during the television inspection program, including:

1. Drain line cleaning by NEPCCO in May 2014 Violet Ave To Bridge Street. (Partial Cleaning Accomplished)

2. Replaced 36-inch collapsed drain pipe at Bridge Street Outfall To Charles River in May 2014.

3. Installed new 36-inch drain to reroute flow around existing pipe sag and restriction caused by system configuration.

System Survey Results

In April 2014 staff members from Weston & Sampson Engineers, Inc performed a land survey to establish Rim and Invert elevations of drainage structures within the project area. The objective of the survey was to provide up to date real world information for use in the evaluation and to update the Town's GIS which was based on Town record drawings. The survey was done in NAD83 and NAVD88 survey datum.

The land survey results, Figure 3 – Survey Results, Attached show the following deficiencies in the mainline drain pipe that contribute to limiting the system capacity:

1. Conduit C-DMH121 Volk RD : Flat Slope

2. Conduit C-CBNEW Volk RD : Back Pitched Negative Slope

3. Conduit C-DMH122 Volk RD : Back Pitched Negative Slope

4. Conduit C-CB657 Volk RD : Back Pitched Negative Slope

5. Conduit C-DMH123 Stivaletta RD : Back Pitched Negative Slope

6. Conduit C-CB659 Cross-Country Stivaletta to Violet AVE : Back Pitched Negative Slope

7. Conduit C-DMH615 Violet AVE : Back Pitched Negative Slope

8. Conduit C-DMH321 Cross-Country Violet Ave to Kiely RD : Back Pitched Negative Slope

9. Conduit C-CB667 Kiely RD : Back Pitched Negative Slope

10. Conduit C-CB668 Kiely RD : Back Pitched Negative Slope

11. Conduit C-DMH1589 Bridge ST : Back Pitched Negative Slope

Hydrologic & Hydraulic Model Analysis

Initial hydrologic and hydraulic analysis models were created under the Phase 1 Preliminary Model Analysis and Phase 2 Rehabilitation Plan Model Analysis to calibrate the system and hydrologic data and included the following tasks:

1. Develop an existing condition Hydrologic Model to create runoff hydrographs of tributary sub areas for use in the Hydraulic model analysis.

2. Develop an existing condition Hydraulic Model of compiled collected system data to determine system capacity.

3. Combine Hydrologic and Hydraulic Models to develop and analyze the Calibration Models to validate the Hydrologic and Hydraulic data in the model.

4. Summarize calibration model results.

5. Create Rehabilitation Model To Represent System Improvements projects conducted by the Town of Dedham to reflect deficiencies observed during the television inspection program.

6. Evaluate the project direction for Phase 3 Design Model Analysis.

Three calibration models were created that incorporated the system data collected including blockages and sediment buildup documented from the TV Inspection video. Rainfall record data was routed through the Hydrologic and Hydraulic models and compared to observed flooded volumes and Hydraulic Grade Line (HGL). Calibration results are displayed in Table 2A – Calibration Results.

Table 2A Calibration Results

Storm Event	Estimated Observed Flooded Volume (CF)	Estimated Calibration Model Flooded Volume (CF)	Percent Difference
7/23/2013	52,000	33,300	36%
7/28/2014	15,500	14,000	10%
8/13/2014	86.15 FT HGL*	86.32 FT HGL	0.20%

* System did not flood, system HGL measurements documented.

Existing Calibration Model Hydraulic Data

Hydraulic data was collected for approximately 50 drain pipes, 28 catch basins, and 20 drain manholes. A summary of modeled sewer pipes by pipe diameter is shown in Table 2B- Calibrated Hydraulic Data.

Table 2B Calibration Hydraulic Data

Pipe Width (in)	Pipe Length (ft)	Manning's "n" Value	Pipe Shape
42	854	0.017	Arch
8	112	0.017	Circular
10	79	0.017	Circular
12	1,665	0.017	Circular
18	460	0.017	Circular
24	2,305	0.014–0.017	Circular

Reduced Flow Area From Pipe Collapse From 36” to 10”	60	0.017	Circular
	Total 5,500 FT		

Existing Calibration Model Hydrologic Data

Hydrologic data was collected for thirty tributary subareas and distributed throughout the system via inlet catch basin or manholes. The total tributary area for the Riverdale Area Tributary to the Bridge Street outfall is approximately 62 acres. The collected tributary Hydrologic Data (Sub Area, Percent Impervious, Sub Area Width, and Sub Area Slope) are presented below in Table 3- Calibrated Hydrologic Data.

Table 3 Calibration Hydrologic Data

Subcatchment Inlet	Width (ft)	Area (ac)	Percent Impervious	Slope ft/ft	Surface "n" Impervious (1)	Surface "n" Pervious (1)
CB671	325.00	1.09	38	0.0004	0.014	0.03
CB661	194.60	1.61	38	0.08	0.014	0.03
CB660	89.80	0.45	38	0.031	0.014	0.03
CB656	406.69	4.06	38	0.039	0.014	0.03
OSS-128	8125.00	21.90	38	0.036	0.014	0.03
CB1317	192.93	1.97	38	0.098	0.014	0.03
CB654	256.78	2.65	38	0.039	0.014	0.03
CB657	362.46	1.42	38	0.06	0.014	0.03
CB658	43.34	0.39	60	0.034	0.014	0.03
CB659	217.77	1.85	38	0.038	0.014	0.03
DMH1337	99.79	0.69	38	0.056	0.014	0.03
CB664	90.00	1.61	38	0.039	0.014	0.03
CB662	152.81	0.63	38	0.024	0.014	0.03
CB662	267.67	1.16	38	0.001	0.014	0.03
CB663	118.94	0.81	38	0.102	0.014	0.03
CB2217	255.24	2.39	38	0.122	0.014	0.03
DMH1338	110.22	0.77	38	0.04	0.014	0.03
CB666	124.11	0.95	38	0.021	0.014	0.03
CB665	154.91	1.69	38	0.04	0.014	0.03
DMH1340	129.04	0.45	38	0.059	0.014	0.03
CB667	315.00	3.02	38	0.028	0.014	0.03
CB669	136.75	1.57	38	0.019	0.014	0.03
CB668	60.00	0.61	38	0.026	0.014	0.03
CB670	10.00	0.06	100	0.004	0.014	0.03
CB2628	193.00	1.72	38	0.004	0.014	0.03
CB676	213.00	2.20	38	0.012	0.014	0.03

Subcatchment Inlet	Width (ft)	Area (ac)	Percent Impervious	Slope ft/ft	Surface "n" Impervious (1)	Surface "n" Pervious (1)
CB673	278.00	1.41	38	0.037	0.014	0.03
CB675	143.00	0.43	38	0.077	0.014	0.03
CB2467	300.00	1.55	38	0.008	0.014	0.03
CB655	103.11	0.39	38	0.12	0.014	0.03

(1) XPSWMM Land Cover Values

Model Results Phase 1 and Phase 2

The objective of the Phase 1 and Phase 2 modeling efforts was to determine which of the factors below contribute to the flooding in the low-lying area on Violet Ave.

1. The storm drain conveyance system is undersized and no longer has the carrying capacity to convey storm runoff flow tributary to the system. (Flows may have increased from the original design due to land development)

2. The conveyance system is adequately sized to handle tributary storm runoff flow but has limiting obstructions. (Debris, Collapsed Pipes, Utility Conflicts Reducing Flow Area)

3. The tail water elevation in the Charles River is preventing the local drainage from draining.

The following Hydrologic/Hydraulic model scenarios were developed during Phase 1 and Phase 2 to identify system deficiencies and causes of the flooding:

1. Scenario 1 – July 23, 2013 System Conditions – July 23, 2013 Rain Event (Calibration Model).

2. Scenario 2 – July 28, 2014 System Conditions – July 28, 2014 Rain Event (Calibration Model). Reflects System Improvements By Town of Dedham Engineering In May 2014. Partial Cleaning and Replaced Collapsed Pipe.

3. Scenario 3 – August 13, 2014 System Conditions – August 13, 2014 Rain Event (Calibration Model). Reflects System Improvements By Town of Dedham Engineering In May 2014. Partial Cleaning and Replaced Collapsed Pipe.

4. Scenario 4 – Existing System Conditions – July 23, 2013 Rain Event (Evaluation Model). Reflects System Improvements By Town of Dedham Engineering In May 2014. Partial Cleaning and Replaced Collapsed Pipe.

5. Scenario 5 – Proposed System Conditions Cleaning – July 23, 2013 Rain Event (Evaluation Model). Reflects System Improvements By Town of Dedham Engineering In May 2014. Replaced Collapsed Pipe and Proposed Full system Cleaning

The contributing factors to flooding in the Violet Ave drainage system are:

1. The storm drain conveyance system has limiting obstructions such as sediment buildup, back pitched pipes flowing in the wrong direction, and a collapsed pipe.

2. The storm drain conveyance system is undersized.

The flooded volume at Violet Ave for the July 23, 2013 storm event was reduced with downstream system improvements of sediment removal and replacement of the collapsed pipe but it was not eliminated. See Table 4A & 4B – Violet Ave Flooded Volumes below.

Table 4A - Violet Ave Flooded Volumes Phase1 & Phase 2 Evaluation Models July 23, 2013 Rain Event (1 Year – 1 Hour Event)

Storm Event	Model Flooded Volume (CF)	Description
Scenario 1	33,300	July 23, 2013 System Conditions – July 23, 2013 Rain Event
Scenario 4	8,600	May 2014 Existing System Conditions Partial Cleaning & Collapsed Pipe Repair – July 23, 2013 Rain Event
Scenario 5	4,500	Proposed System Conditions Full Cleaning & Collapsed Pipe Repair – July 23, 2013 Rain Event

The storm drain conveyance system is undersized downstream of DMH321 on the property of 76 Violet Ave and has limiting capacity in the following pipe sections on Figure 4 – Undersized Storm Drains:

1. Conduit C-DMH321 Cross-Country Violet Ave to Kiely Rd.

2. Conduit C-DMH1342 Cross-Country Violet Ave to Kiely Rd.

3. Conduit C-CB667 Kiely Rd.

4. Conduit C-DMH124 Zoar Ave.

5. Conduit C-DMH877Zoar Ave to Bridge St.

Model Conclusions Phase 1 and Phase 2

The removal of downstream obstructions does not eliminate the flooding at DMH321 in the area of 76 Violet Avenue. The undersized storm drains downstream of DMH321 in the area of 76 Violet Ave will require replacement to eliminate flooding for a 1 Year frequency storm or greater.

The impacts of the tailwater elevation at the Bridge Street outfall to the Charles River does not contribute to the flooding for the storm events analyzed in Phase 1 and Phase 2.

Under Phase 3 – Design Model Analysis we analyzed potential alternatives to alleviate the flooding.

Model Results Phase 3 Design Model Analysis

The objective of the Phase 3 modeling efforts was to evaluate potential improvement alternatives to alleviate the flooding at Violet Ave caused by insufficient system capacity. The design model analysis was performed for the 10-Year 24 Hour storm design storm. There is a misconception that a 10-Year storm event classification will occur once every 10 years. A 10 year storm classification means that there is a 10% chance that a 10 year storm classification will occur in any given year. It is likely that the 10-Year 24 Hour design storm was utilized for local drainage system in this neighborhood as it was the required design for that period of time.

The design storms evaluated for the project included both SCS – 24 Hour Events from Technical paper 40 (TP 40) and RR93-5 – 24 Hour events from the Northeast Regional Climate Center, Cornell University Report. The latter is as required by the Dedham Drainage Stormwater Standards.

The following Hydrologic/Hydraulic model scenarios were developed during Phase 3 to identify potential system improvements:

1. Scenario 6 – 10 Year 24 Hour Event – Existing System August 2014, Partial cleaning and collapse pipe replacement.

2. Scenario 7 – 10 Year 24 Hour Event – Attenuate 100% Of Flow Upstream At DMHOSS-128 Volk Rd. Cul-De-Sac – Including System Improvements By Town of Dedham Engineering In May 2014. Replaced Collapsed Pipe and Proposed Full system cleaning.

3. Scenario 8 – 10 Year 24 Hour Event – Raise DMH321 Rim Elevation To Increase Hydraulic Grade Line Freeboard Including System Improvements By Town of Dedham Engineering In May 2014. Replaced Collapsed Pipe and Proposed Full system cleaning.
4. Scenario 9 – 10 Year 24 Hour Event – Reroute upstream flow around Violet Ave low-lying area via a new drain on Hillcrest to Bridge St to increase capacity. Including System Improvements By Town of Dedham Engineering In May 2014. Replaced Collapsed Pipe and Proposed Full system cleaning. Figure 5 – Proposed Alternative 3, Attached

5. Scenario 10 – 10 Year 24 Hour Event – Increase system capacity from DMH321 to Bridge St outfall. Figure 6 – Proposed Alternative 4, Attached

6. Scenario 11 – 10 Year 24 Hour Event – Replace residential properties with neighborhood detention pond on Violet Ave. Including System Improvements By

Town of Dedham Engineering In May 2014. Replaced Collapsed Pipe and Proposed Full system cleaning. Figure 7 – Proposed Alternative 5, Attached

Table 4B - Violet Ave Flooded Volumes Phase 3 Design Model Evaluation 10 Year – 24 Hour Rain Event (SCS TP40 & RR93-5 Rainfall)

Storm Event	Model Flooded Volume (CF)	Flooding At Violet Ave Eliminated	Scenario Description
Scenario 6	30,621	NO – Base Model	August 2014 Existing System Conditions
Scenario 7 Alternative 1	16,869	NO – 55 % Reduction	Attenuate 100% Of Flow Upstream At DMHOSS-128 Volk Rd. Cul-De-Sac
Scenario 8 Alternative 2	11,883	NO – 39 % Reduction, Flooding Moved To Violet Ave St Drainage & Downstream Property	Raise DMH321 Rim Elevation To Increase Hydraulic Grade Line Freeboard
Scenario 9 Alternative 3 Figure 5 Attached	0	YES	Reroute upstream flow around Violet Ave low-lying area via a new 24 Inch drain on Hillcrest to Bridge St. With CB relocation on Violet Ave.
Scenario 10 Alternative 4 Figure 6 Attached	0	YES	Increase system capacity from DMH321 to Bridge St outfall. With CB Improvements at Zoar Ave and Bridge Street
Scenario 11 Alternative 5 Figure 7 Attached	0	YES	Purchase Property – Install Detention Pond

The 10 year 24 Hour storm event model also generated flooding in the upstream neighborhood of Volk Road. Alternatives 3A and 4A are presented for comparison consideration for potential upstream improvements and their impact of moving flow downstream. If such upstream improvements were constructed, the need for additional capacity downstream would also be required and accounted for in our analysis.
Alternative 3A requires the upstream installation of approximately 1000 feet of 36 inch drain and the increase of downstream improvements to 36 inch from the 24 inch presented in Alternative 3.

Alternative 4A requires the upstream installation of approximately 1000 feet of 36 inch drain and the increase of downstream improvements to 48 inch from the 42 inch presented in Alternative 4.

Alternative Cost Analysis

We have generated the probable cost for the three alternatives that eliminated the flooding of Violet Ave for the 10 year storm event. (Alternatives 3, 4, & 5) See Table 5.

Table 5 – Alternative Estimated Costs
10 Year – 24 Hour Rain Event (SCS TP40 & RR93-5 Rainfall)

Storm Event	Estimated Design & Construction Cost ($)	Flooding At Violet Ave Eliminated	Scenario Description
Scenario 9 Alternative 3 Figure 5 Attached	1.9 M	YES	Reroute upstream flow around Violet Ave low-lying area via a new 24 Inch drain on Hillcrest to Bridge St. With CB relocation on Violet Ave.
Scenario 10 Alternative 4 Figure 6 Attached	1.7 M	YES	Increase system capacity from DMH321 to Bridge St outfall. With CB Improvements at Zoar Ave and Bridge Street. (48 Inch RCP)
Scenario 11 Alternative 5 Figure 7 Attached	3.8 M	YES	Purchase Property – Install Detention Pond
Scenario 12 Alternative 3A Figure 8 Attached	3.5 M	YES & Volk Rd	Reroute upstream flow around Violet Ave low-lying area via a new 36 Inch drain on Hillcrest to Bridge St
Scenario 13 Alternative 4A Figure 9 Attached	3.2 M	YES & Volk Rd	Increase system capacity from DMH321 to Bridge St outfall.

Permit Review

Pipes and open channels that carry stream flow, as differentiated from pure storm runoff, fall under the jurisdiction of the Massachusetts Department of Environmental Protection (MassDEP) (under the Massachusetts Wetlands Protection Act and 401

Water Quality Certification regulations) and the U.S. Army Corps of Engineers (USACE) jurisdiction.

The Wetlands Protection Act identifies general performance standards that are expected to be met for the protection of Inland Bank and Land Under Water. Presumptions are made that any proposed activity that would remove, fill, dredge or alter a Bank or Land Under Water is required to file a Notice of Intent to the local conservation commission and MassDEP regional office.

Conclusions and Recommendations

The hydraulic model analysis performed under Phase 3 – Design Model Analysis developed three viable alternatives for providing flooding relief for the Violet Ave area.

The analysis and evaluations were conducted to provide 10 year storm frequency protection for the area for both the SCS TP40 and RR93-5 rainfall data. Alternatives 3 & 4 will alleviate flooding for the Violet Ave area for the 10 Year design storm and high intensity summer time storm events.

Alternative 5 removes flooding from the properties and directs the flow to the proposed detention pond for the 10 Year design storm and high intensity summer time storm events.

Alternative 3 incorporates the installation of a new 24 inch drain on Hillcrest Ave to the existing Bridge St outfall to reduce the flow to the Violet Ave drainage system. The negative impacts of Alternative 3 are:

- The creation of a new utility corridor and increased maintenance demands.
- The potential for moving the flooding problem to other areas of the neighborhood that did not previously flood for storm frequencies greater than the 10 year design storm event.

Alternative 4 incorporates the replacement of the existing Violet Ave to Zoar Ave 24 inch circular and 42 inch arch drain pipes with a new 48 inch RCP drain with more carrying capacity and positive flow conditions for existing and future flows. Alternative 4 is the recommended improvement for its relative low cost differential, continued but reduced maintenance demands, and it directly alleviates the Violet Ave drainage flooding. The positive of Alternative 4 is the utilization of an existing utility corridor that makes for efficient construction. The negatives of Alternative 4 are:

- The lack of slope to the outfall that limits capacity of any size pipe.
- Grading issues to be resolved on private properties.
- Minimal depth of cover available for the new pipe.

Alternative 5 incorporates the installation of a new detention pond through the acquisition of six properties on Violet Ave and Kiely Rd. The detention pond is sized to handle the flow volume from the 10 year storm event and discharging flow downstream to the existing Zoar Ave drain. The negatives of Alternative 5 are:

- The relative project cost for only 10 year storm protection.
- The soil conditions in the area likely would require the detention pond (Dry) to be a retention pond (Wet) that holds water at all times.
- The impacts to the neighborhood ascetics.
- The impact to the neighborhood flooding pattern under a storm event greater than a 10 year frequency.
- Future yearly maintenance cost of $25,000 per year.

We wish to thank you and the members of the Engineering Department staff for their assistance while completing this project. We are available to meet with you at your earliest convenience to discuss this report. Please do not hesitate to contact me at (978) 532-1900 with any questions or comments you may have.

Very truly yours,

WESTON & SAMPSON

Donald G. Gallucci, PE
Program Manager

cc: Ronald Lawrence, Project Engineer

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FIGURES

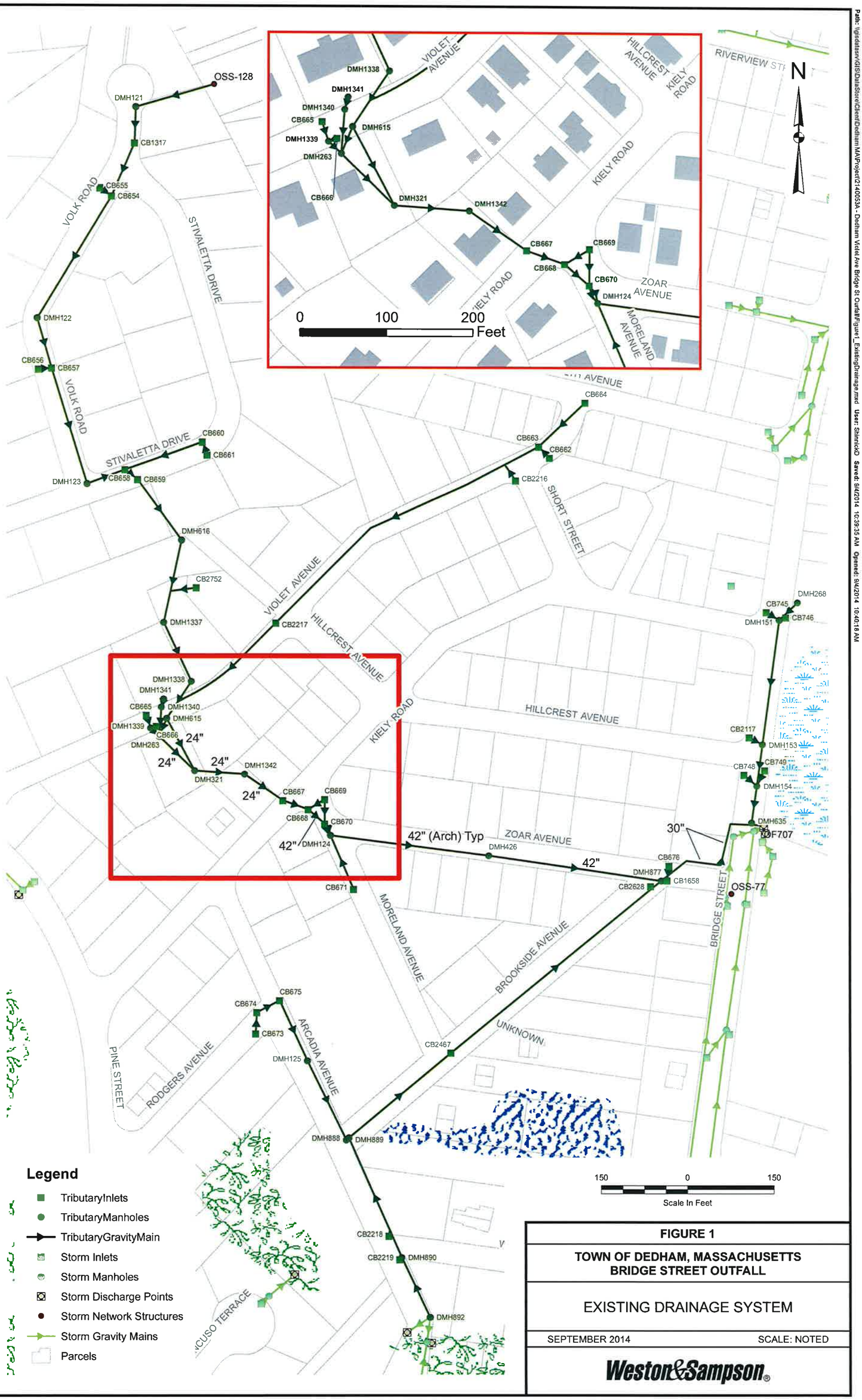

FIGURE 1

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

EXISTING DRAINAGE SYSTEM

SEPTEMBER 2014 SCALE: NOTED

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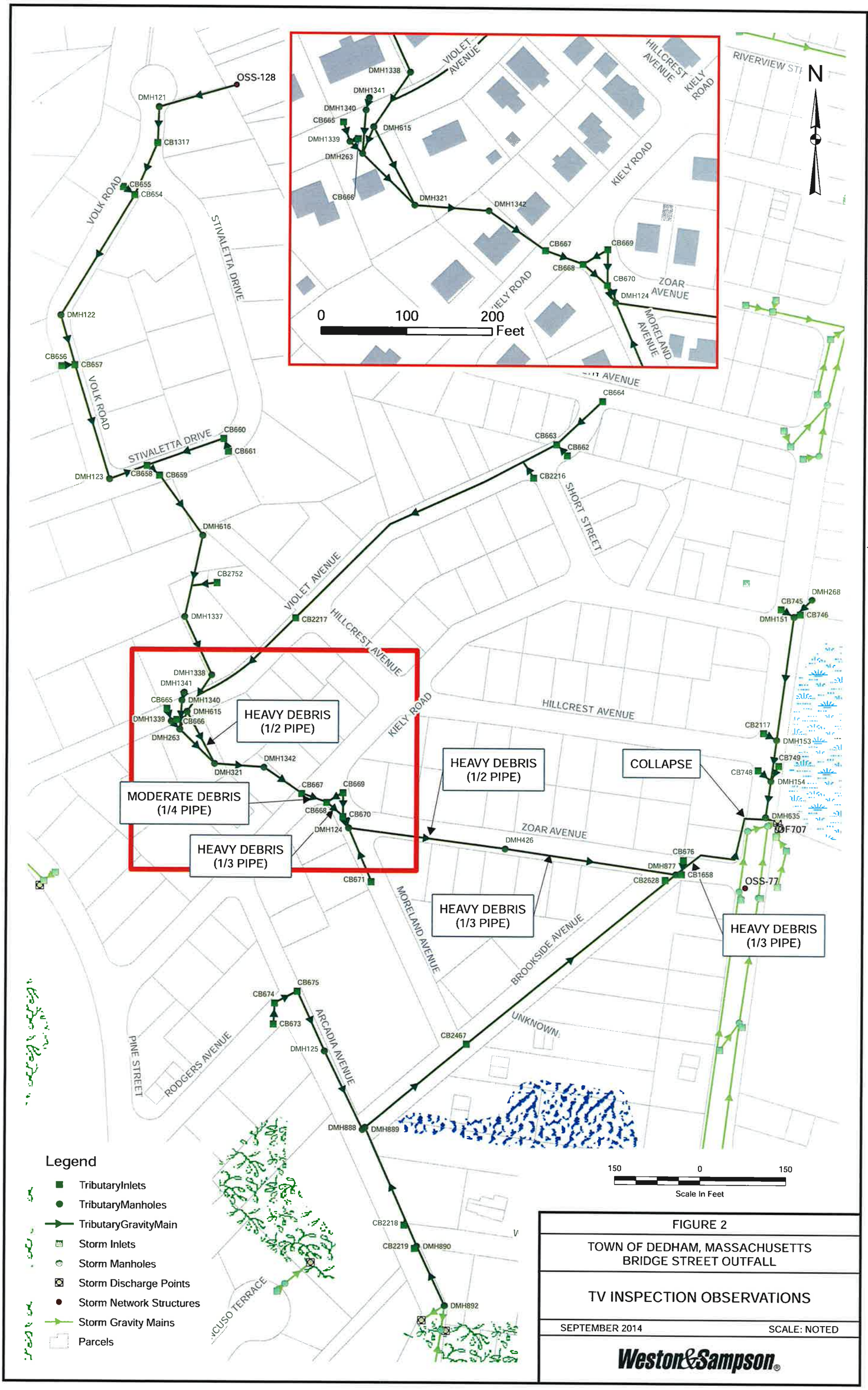

FIGURE 2

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

TV INSPECTION OBSERVATIONS

SEPTEMBER 2014 SCALE: NOTED

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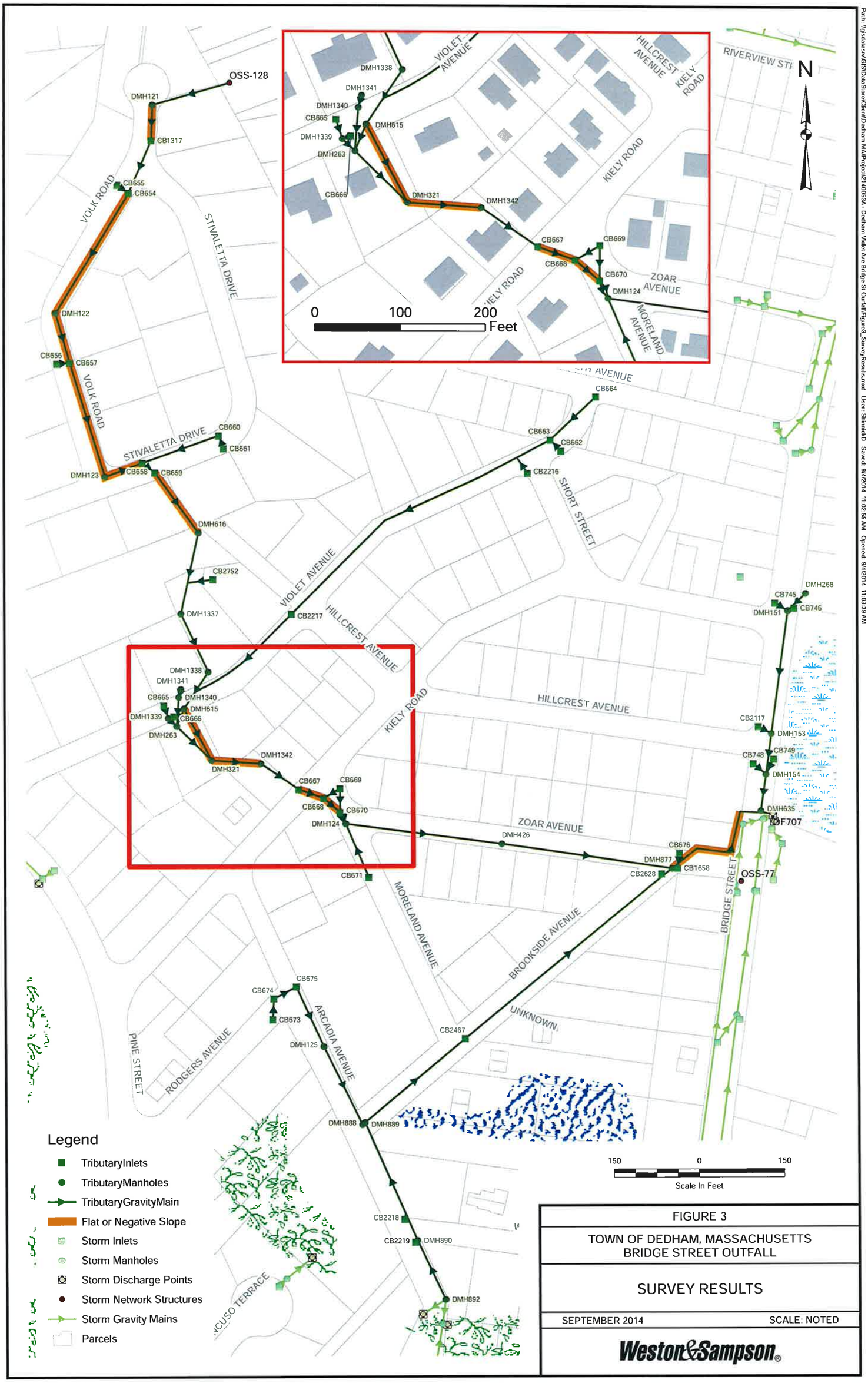

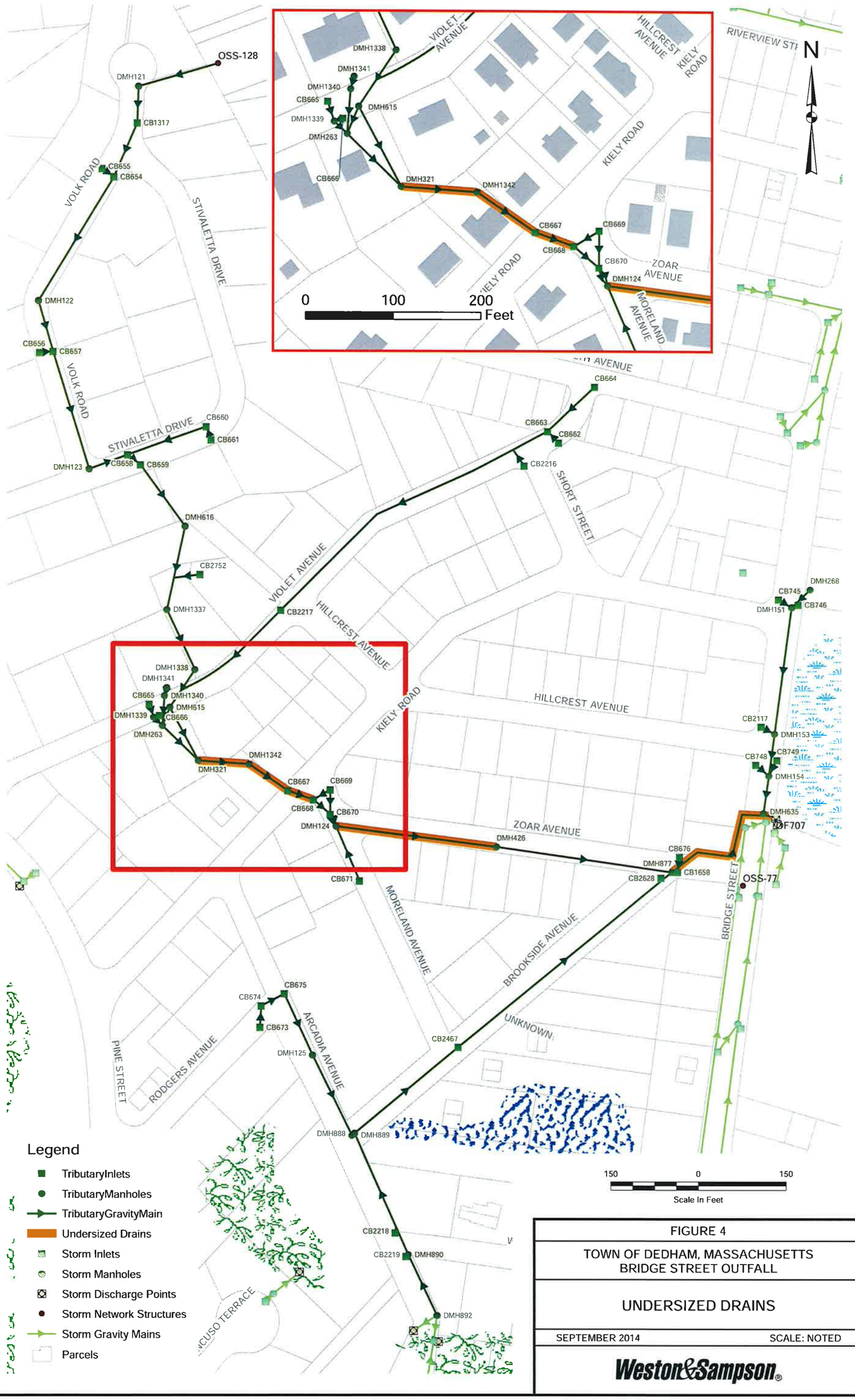

FIGURE 4

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

UNDERSIZED DRAINS

SEPTEMBER 2014 SCALE: NOTED

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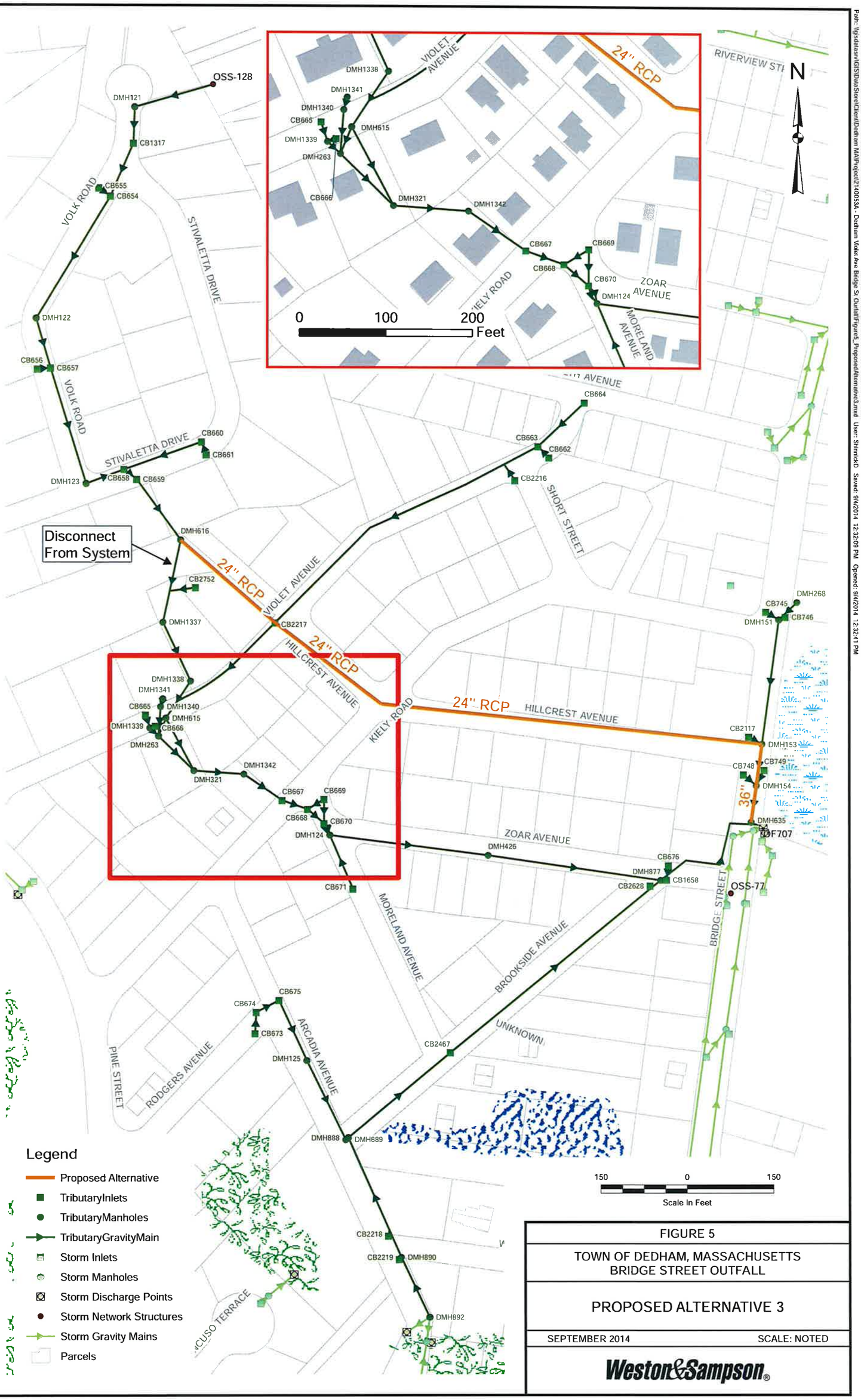

FIGURE 5

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

PROPOSED ALTERNATIVE 3

SEPTEMBER 2014 SCALE: NOTED

Weston&Sampson

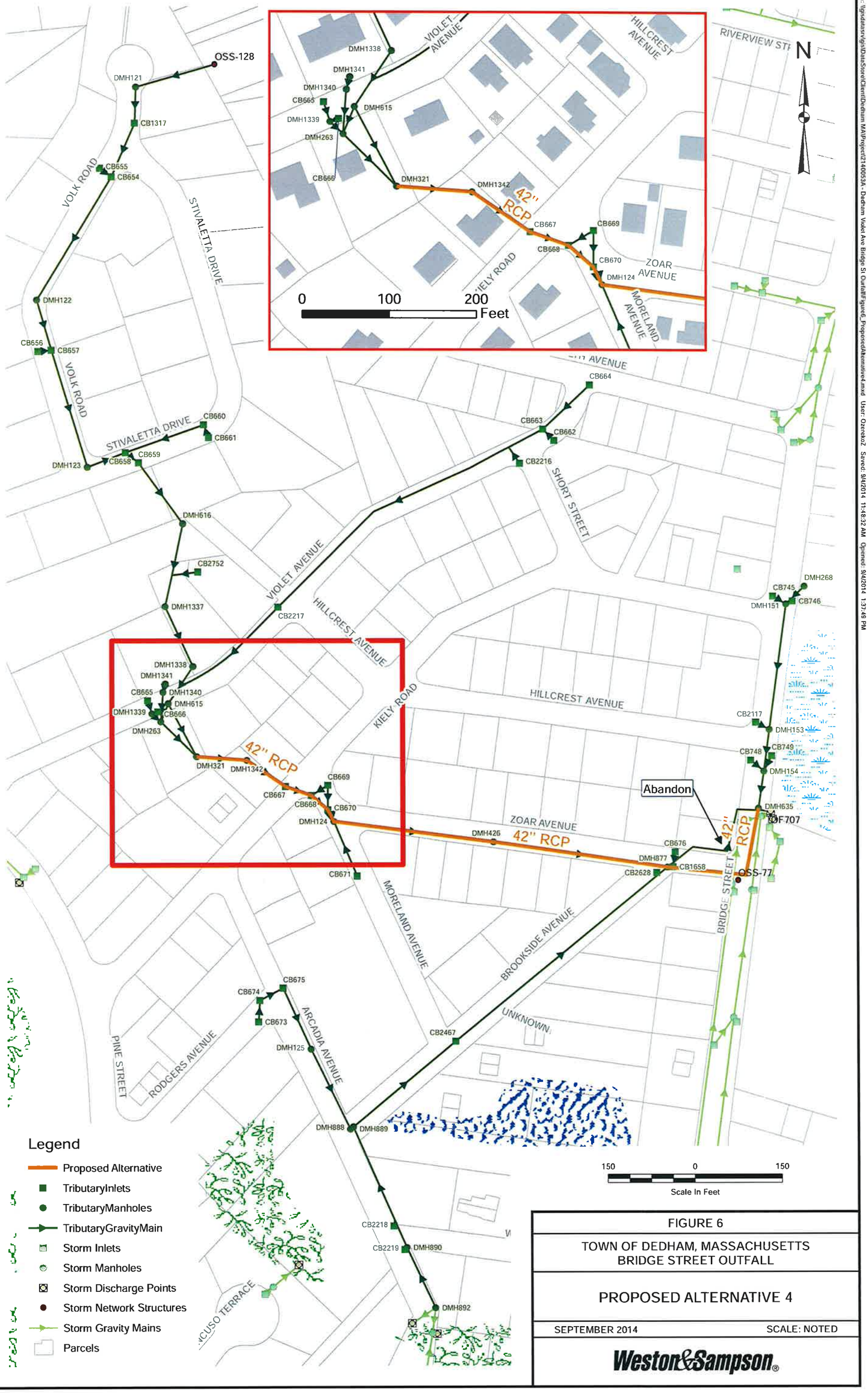

FIGURE 6

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

PROPOSED ALTERNATIVE 4

SEPTEMBER 2014 SCALE: NOTED

Weston&Sampson

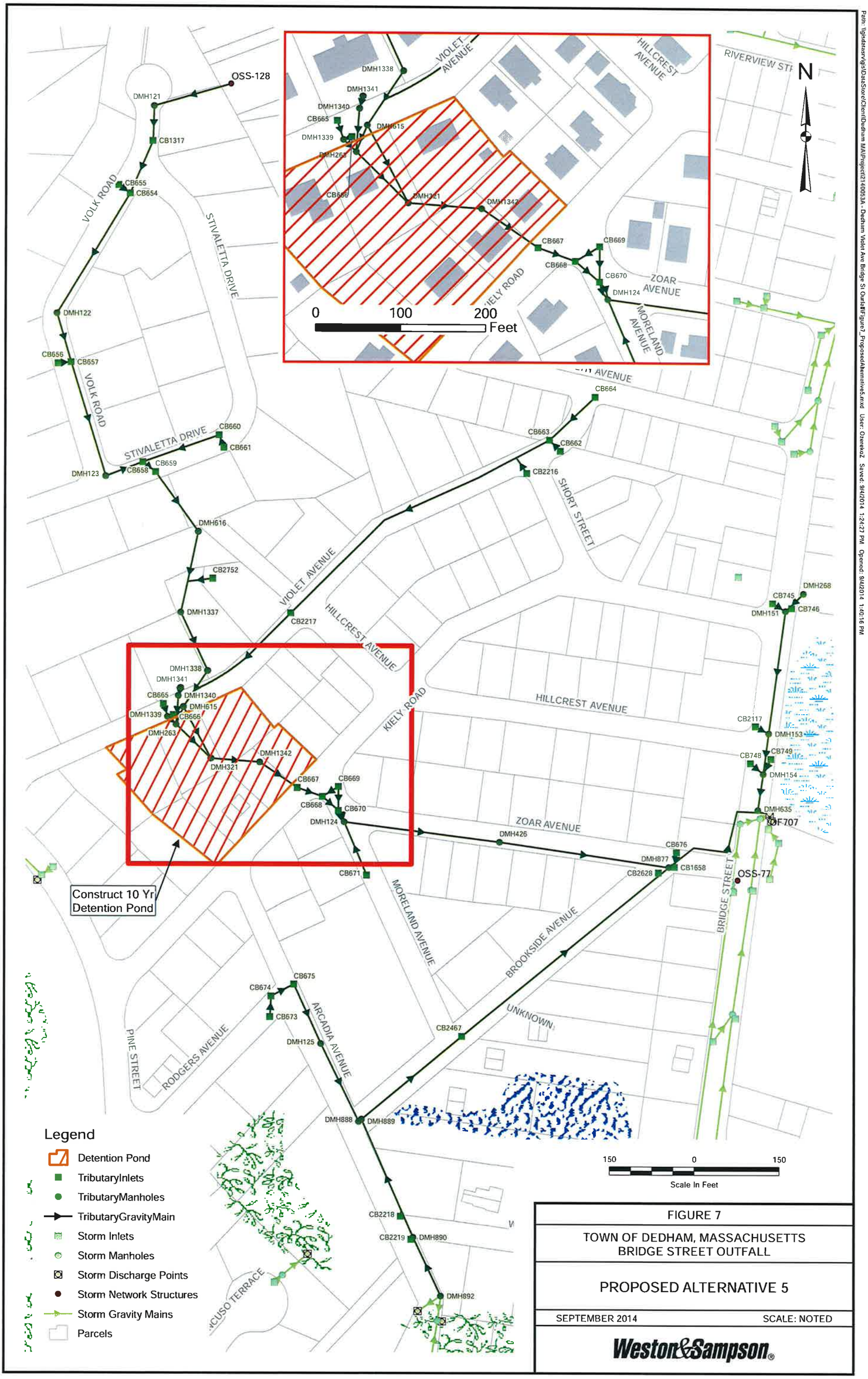

FIGURE 7

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

PROPOSED ALTERNATIVE 5

SEPTEMBER 2014 SCALE: NOTED

Weston&Sampson

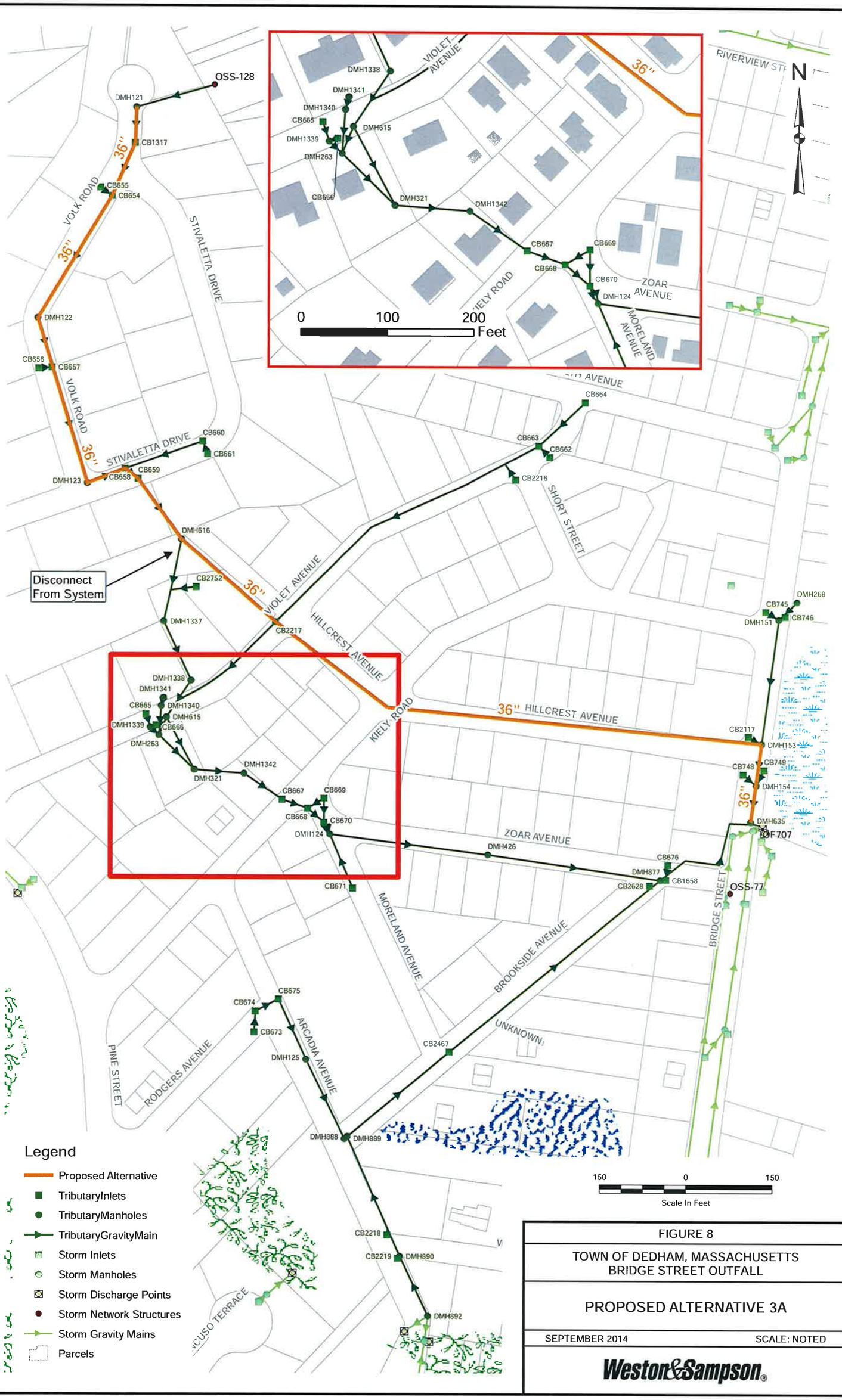

FIGURE 8

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

PROPOSED ALTERNATIVE 3A

SEPTEMBER 2014 SCALE: NOTED

Weston&Sampson

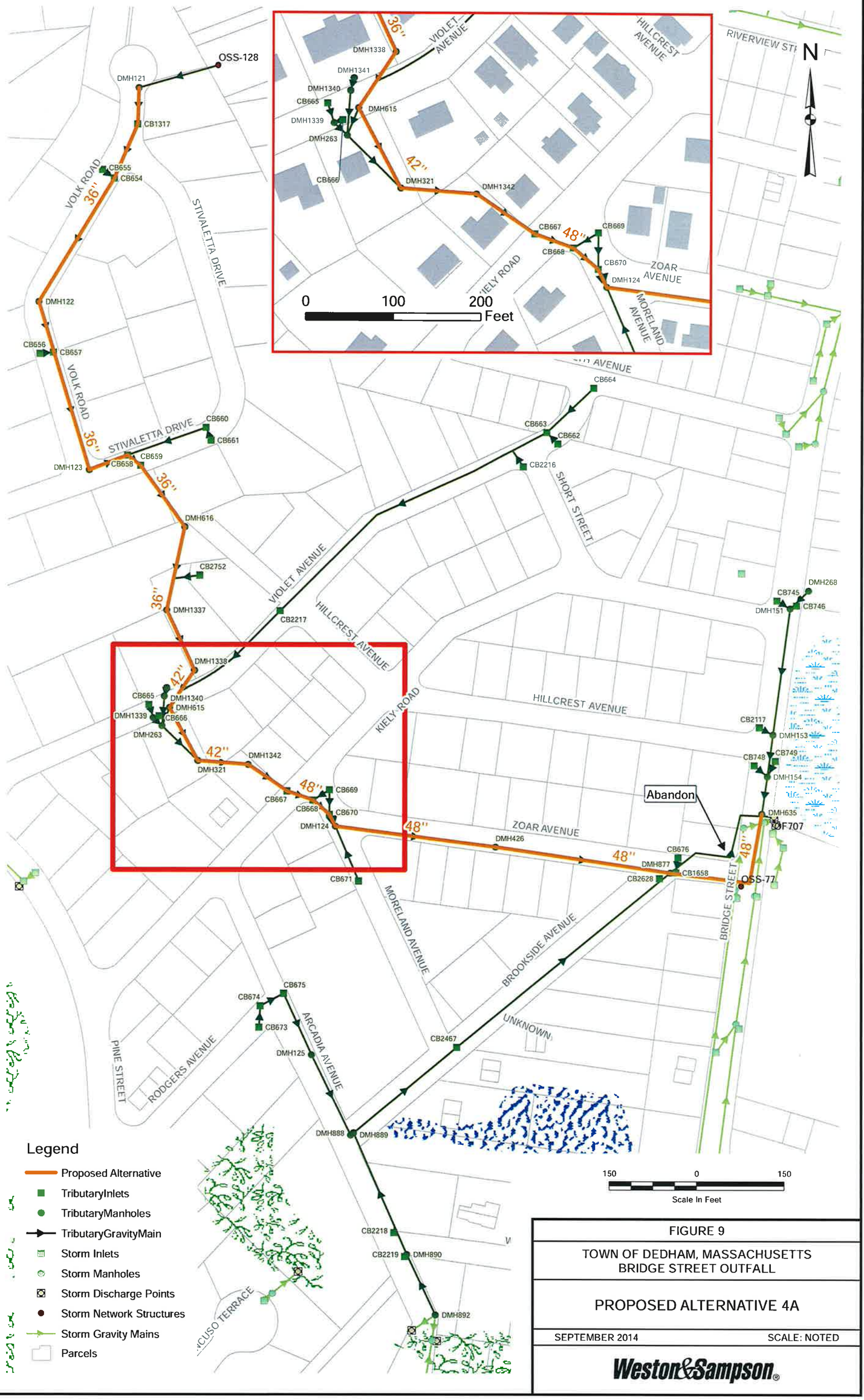

FIGURE 9

TOWN OF DEDHAM, MASSACHUSETTS
BRIDGE STREET OUTFALL

PROPOSED ALTERNATIVE 4A

SEPTEMBER 2014 SCALE: NOTED

Weston&Sampson