Norwood, Massachusetts

Meadow Brook Drainage Study

Prepared By:
FAY, SPOFFORD & THORNDIKE, LLC.
5 Burlington Woods
Burlington, MA 01803

August 2004

FAY, SPOFFORD & THORNDIKE, LLC
Engineers • Planners • Scientists • Landscape Architects • Surveyors

CELEBRATING 90 YEARS

Now, more than ever...

August 3, 2004

Mr. John J. Carroll
General Manager
Town of Norwood
566 Washington Street
Norwood, MA 02062

Subject: Meadow Brook Drainage Study

Dear Mr. Carroll:

We are pleased to submit the Meadow Brook Drainage Study in accordance with our agreement with the Town of Norwood. This study serves as an update to the original Drainage Report for the Meadow Brook Watershed, which we prepared and dated October 1980.

Key elements of the study included: revision and update of hydrological parameters in the watershed, computerized state of the art dynamic hydraulic modeling of the drainage system, and development of alternative solutions.

Throughout the course of this study there have been numerous progress meetings with Town staff and officials to review technical findings and steer the direction of the study to its logical conclusion. The results of the study offer the Town of Norwood the planning flexibility to undertake improvements as it sees fit in consideration of financial factors.

FST is proud to have been of service to you and the Town on this project and wish to express our appreciation to your staff for their cooperation and professional participation. A special thanks to Mark Ryan and the Engineering Department and to Joe Welch and Gary Shorer of the Department of Public Works for their support and timely responses to requests for information and technical input.

As always we are available at anytime to answer any question you may have or to present the findings of the report to Town officials.

Very truly yours,

FAY, SPOFFORD & THORNDIKE

Emile J. Hanwey, P.E.
President

Laeyeng Hui, P.E.
Project Manager

EJH/ray
JN-064
Enclosure

5 Burlington Woods
Burlington, MA 01803
T: 800.835.8666 | T: 781.221.1000
F: 781.229.1115 | www.fstinc.com

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 The Study Area and Existing Storm Drain Facilities

Study Area
(See Figure 1)
The Meadow Brook watershed is located just north of the Neponset River and west of Route 95 lying entirely within Norwood's municipal boundaries. The watershed includes approximately 1.5 square miles (967 acres) of Norwood's land area, of which 36% is impervious. The watershed has an average slope of approximately 2 to 3 percent with elevations ranging from 200 feet (Norwood Town Datum) to 50 feet.

Existing land use throughout the watershed includes both residential and commercial development. Single and multi-family homes are located throughout the project area while retail and business development buildings are mainly found along Route 1, Washington Street, Lenox Street (Commuter Rail), and in the Town Center (Nahatan Street and Broadway).

Existing Storm Drain Facilities
(See Appendix A)
The existing Meadow Brook storm drain facilities convey stormwater runoff originating within the study area to the Neponset River. This system consists of pipes that range from 8- to 60-inches in diameter, box culverts, open channels and appurtenant structures. The system is complicated by drain pipes that travel cross country and are located under residential properties and commercial buildings.

To facilitate this study, the Meadow Brook watershed was delineated into three smaller drainage basins referred to as the Northern Feeder, Southern Feeder, and Meadow Brook subwatersheds. These subwatersheds and their respective collection systems are illustrated in Appendix A and briefly described below:

There are approximately 330 acres tributary to the Northern Feeder subwatershed collection system. This area includes the Nahatan Street (Prospect Street to Monroe Street) and Downtown areas, Day Street, Vernon Street, Broadway, and the Police/Fire Station property/campus. Beginning at the Shaw's/Star supermarket property on Nahatan Street, the main branch of the Northern Feeder runs cross country under residential and commercial properties to Murphy's Field located south of Lenox Avenue where it meets the Meadow Brook collection system. Along this cross-country branch, the Northern Feeder accepts stormwater from several smaller drainage systems located between Central Street and Monroe Street.

TOWN OF NORWOOD
DRAINAGE STUDY

FIGURE 1.
PROJECT LOCUS MAP

FAY, SPOFFORD & THORNDIKE

SCALE : 1" = 3000'

The Southern Feeder collection system conveys runoff collected from 260 acres of tributary area that include Winter Street, Nichols Street, Walpole Street, Washington Street, Elliot Street, and Walnut Avenue. This system consists of pipes of various sizes and approximately 1,000 LF of open channel that is located parallel to the MBTA/Commuter railroad tracks. Similar to the Northern Feeder, the main branch of the Southern Feeder runs cross-country from the southern end of the open channel to Murphy's field where it meets the Meadow Brook collection system.

The Meadow Brook subwatershed encompasses approximately 377 acres bordered by Dean Street, Pleasant Street, Nahatan Street and Neponset Street. The main branch of this collection system begins at Murphy's Field, where it accepts flow from the Northern and Southern Feeder and extends 3,840 LF to the Neponset River. The last 3,220 LF of this main branch is open channel that also collects flow from roadways including Sunnyside Road, Pellana Road, Sixth Street, U.S. Route 1 (Boston Providence Turnpike), and the Westview Drive Area.

2.0 Methodology

U.S. EPA SWMM

The U.S. EPA Storm Water Management Model (SWMM) was used to perform the hydrologic and hydraulic analysis for the Meadow Brook drainage system. SWMM is a dynamic model with the ability to route storm flows through complex systems such as weirs, orifices, closed pipes, and open channels. This application considers backwater effects, surcharged conditions, free surface flow conditions, as well as flow reversal conditions. Additionally, it has the ability to determine peak flow rates for various rainfall conditions and intensities and can compute both the volume and duration of flooding.

In terms of structure, the SWMM program is comprised of "Blocks" which utilize input data to simulate rainfall events, predict volume and rates of runoff, and route the storm flows through a piping network. For this project, the RUNOFF Block and the EXTRAN Block are used to perform system analyses.

The RUNOFF Block performs the hydrologic calculations of the model. It uses precipitation data and catchment characteristics to generate hydrographs at each identified inlet location or "node" location. Catchment characteristics are parameters describing the drainage area and all hydrologic conditions of each catchment. These hydrologic parameters include total tributary area, surface slope, percent impervious area, width (shape factor), depression storage, infiltration rate, and Manning"n" value for pervious and impervious area.

The EXTRAN Block provides the hydraulic analysis portion of the model. It contains all the data necessary to describe the structural and hydraulic characteristics of the storm drain network.

Piping data such as size, length, shape, initial flow (base flow), invert elevation, rim elevation, downstream pipe, and upstream pipe are used to define the hydraulic elements of the system. Open channel data are provided as a function of elevation, and channel geometries are defined by top width, bottom width and channel depth. Known or anticipated storage areas are entered as volumes and surfaces areas as a function of elevation. Within the EXTRAN Block, hydrographs calculated within the RUNOFF Block are routed through the system to evaluate the system's performance.

Design Criteria

Within the RUNOFF Block of SWMM, precipitation is converted into peak stormwater runoff rates and presented as a hydrograph, which depicts runoff rates as a function of time. Depending on the runoff distribution - i.e., the timing of the rainfall and more specifically the amount of rainfall that falls within any given amount of time - the shape, magnitude and duration of the hydrograph will vary.

For purposes of design and analyses, engineers generally use a standard rainfall distribution pattern developed by the U.S. Department of Agriculture, Natural Resources Conservation Services (NRCS), formerly known as the U.S. Soil Conservation Service or SCS. For the New England coastal area, this rainfall distribution pattern is referred to as an SCS Type III storm event. The design of a Type III storm incorporates a high intensity, short duration rainfall peak near the mid point of the storm, representative of a sudden downpour typical of an extreme thunderstorm.

New storm drain facilities being designed in accordance with current engineering standards are generally sized to accommodate the estimated peak runoff rates associated with a 10-year Type III storm. The existing Meadow Brook drainage system was analyzed under the 10-year Type III storm to establish whether the system was able to perform effectively in accordance with current standards. Additionally, Type III storms having a 2-year and 5-year return period were used to determine at what level system deficiencies became apparent. As a conservative measure, the timing of the various Type III storms used in this hydraulic analysis was adjusted such that the peak, in terms of precipitation, was coincident with the high tail water of the Neponset River.

Since the 10-year Type-III storm is a synthetic event, the metered storm of June 13, 1998 was used to confirm the hydraulic conditions of the existing system (*See Figure 2*). As can be seen by a comparison of the 10-Year, Type III data to the June 1998 data, the 10-Year Type III storm

Figure 2.
Comparison of 10-Yr Type III Storm and 6-13-98 Metered Storm

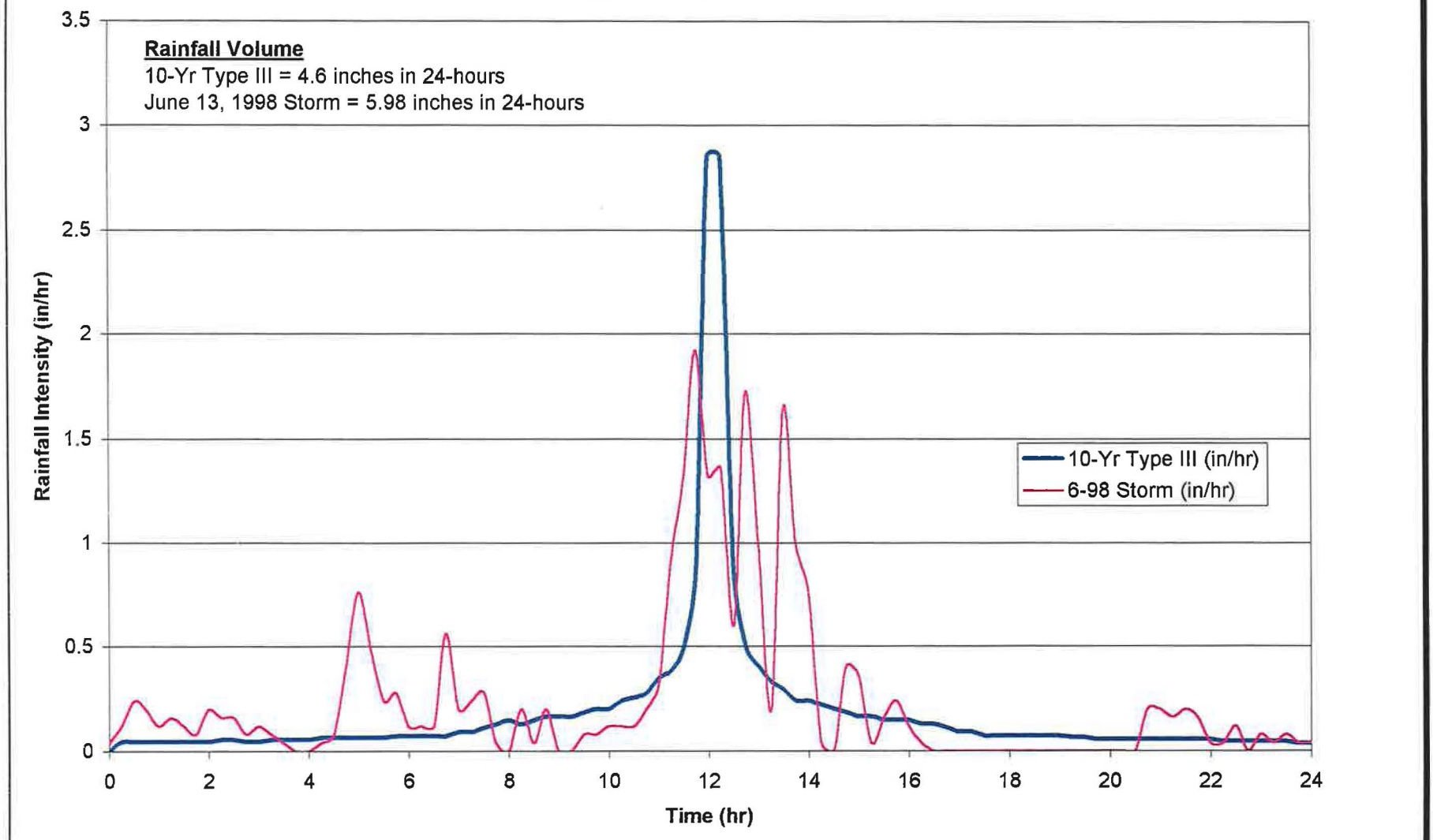


Fig 02 - Storm comp.xls

6/15/04

generates a much higher peak flow than the June 13, 1998 metered storm. A higher peak flow will produce more areas of flooding where the existing system lacks sufficient capacity. In contrast, the June 1998 metered storm generates a lower peak flow that results is less flooding areas but generates an overall greater volume of storm water, therefore, causing areas that flood to have a greater flooding volume and flood for a longer duration. It should be noted that the June 1998 storm has a 24-hour volume equivalent to that of 50-Year, Type III storm with a peak 1-hour flow rate of the 2-Year, Type III storm.

Within Section 4.0 of this report, an analysis of all four events passing through the existing Meadow Brook drainage system is presented. The analyses of system improvements presented in Section 5.0 are based on the 10-year, Type III storm.

Data Collection

The limits of the overall Meadow Brook watershed area were defined using topographic maps and plans of the existing municipal storm drain facilities that were provided by the Town. The watershed area was then further delineated into smaller subcatchment areas for this analysis. Each of these subcatchment areas discharge flows to the Meadow Brook drainage network at various locations.

For each subcatchment area, site specific hydrological parameters such as area, slope, width, and impervious area were calculated. Project wide geographic parameters such as infiltration, pervious depression storage, impervious depression storage, and Manning "n" values (for pervious and impervious area) were estimated based on field investigations and on similar projects of similar land use. All data were then used as input in the RUNOFF Block for generating hydrographs for each subcatchment area.

Input data for the EXTRAN Block were developed from record information supplemented by field investigation. Pipe sizes and lengths, for the most part, were obtained from the Town's Master Drain Map dated April 1979 while invert and rim elevations were obtained through field surveys. Cross sectional areas of open channels were taken from the design drawings developed by Fay, Spofford & Thorndike in 1984 for the Department of Environmental Management Division of Waterways Contract No. 3017.

As stated previously, the Meadow Brook drainage system discharges storm water to the Neponset River. Information collected from the USGS gauging station located along the Neponset River at Pleasant Street was used to establish the downstream conditions needed to perform the hydraulic analyses for this study. Because this station is located upstream of where the Meadow Brook discharges to the Neponset River it was necessary to adjust the gauge readings to reflect conditions at the Meadow Brook confluence with the Neponset River.

SWMM Node Locations

(See Appendix A and Table 2-1)

The SWMM network is laid out based on the locations of existing piping systems and the identified points of stormwater inflow to the system. The nodes were placed on reaches where there is a change in pipe characteristics or where tributary flow is introduced. Additional nodes were added at critical reaches to identify hydraulic impacts of possible relief alternatives, as presented in Section 5.0. A plan of the SWMM network developed for the Meadow Brook system has been included in Appendix A.

The Meadow Brook drainage system is presented as three subsystems that correspond with the subcatchment areas described in Section 1.0. Nodes 1700 to 3600 define the Northern Feeder system, nodes 4990 to 7600 define the Southern Feeder storm drainage system and nodes 100 to 1600 define the Lower Reach/Meadow Brook system. A summary of the node locations has been included in Table 2-1.

Table 2-1 Location of SWMM Nodes

Meadow Brook

NODE	LOCATION
100	Intersection of Neponset River and Meadow Brook
200	Dean Street
300	Easement of Dean Street (behind apartment complex)
350	Easement West of Westview Drive
400	Westview Drive at Elda Drive
450	Edgehill Road
600	Meadow Brook at Route 1
700	Route 1 South of Norwood Exit
800	Route 1 South of Norwood Exit
900	Route 1 South of Norwood Exit
1000	Cross Street at West Border Road
1100	Meadow Brook at Sixth Street
1200	Meadow Brook at Pellana Road
1250	Pleasant Street at Redwood Drive
1300	Gay Street at Sixth Street
1400	Meadow Brook near Audubon Road
1500	Meadow Brook near Sunnyside Road
1550	Sunnyside Road at Cross Street
1590	Pleasant Street. at Gay Street
1600	"Y" under Muphy's Field

Northern Feeder

NODE	LOCATION
1700	Easement at Hennessey Field
1750	At Cross Street
1800	Easement between Cross Street and Plimpton Street
1820	Lenox Street at Plimpton Street
1850	At Andrews Street
1900	Broadway at Guild Street
2000	Shaw's Parking Lot
2050	Shaw's Parking Lot
2100	Shaw's Parking Lot
2120	Shaw's Parking Lot at Nahatan Street
2150	Nahatan Street in front of Police/Fire Station
2200	Behind Police/Fire Station, downstream of detention pond
2300	Behind Police/Fire Station, upstream of detention pond
2400	Railroad Road at Monroe Street
2500	Nahatan Street at Lenox Street
2590	Lenox Street, South of Nahatan Street
2600	Nahatan Street at Broadway

Northern Feeder (continued)

NODE	LOCATION
2650	Nahatan Street, south of Central Street
2700	Broadway at Cottage Street
2750	Cottage Street
2800	Central Street at Vernon Street
2900	Cottage Street, east of Washington Street
3000	Cottage Street at Washington Street
3100	Washington Street, north of Cottage Street
3150	Easement off Washington Street, Cottage Street, and Nahatan Street
3170	Washington Street, south of Railroad Avenue
3200	Easement off Washington Street, Cottage Street, and Nahatan Street
3290	Easement off Washington Street, Cottage Street, and Nahatan Street
3300	Maple Street, 100-ft west of Nahatan Street
3380	Maple Street, 150-ft east of Cottage Street
3390	Wheelock Avenue
3400	Prospect Avenue at Nichols Street
3500	At Fulton Street
3600	Prospect Street at Nahatan Street

Southern Feeder

NODE	LOCATION
4990	At Hillside Avenue
5000	Willow Street at Lenox Street
5100	Willow Street at Lenox Street
5200	Downstream of open channel, parallel to RR tracks
5300	Upstream of open channel, parallel to RR tracks
5400	Hoyle Street, 275-ft east of Washington Street
5500	Hoyle Street at Washington Street
5700	Washington Street, 200-ft south of South Street
5750	Easement off Winter Street and Walpole Street
5800	Walpole Street at Bond Street
5900	Walpole Street at Winter Street
6000	Winter Street at Nichols Street
6100	Nichols Street, 100-ft south of Vernon Street
7000	Easement north of Lenox Street, parallel to RR tracks
7100	Easement north of Lenox Street, parallel to RR tracks
7200	Easement near Washington Street at Walnut Avenue
7300	Walnut Avenue at Elkway
7400	Easement in Athletic Field south of Elkway
7500	Walpole Street, 250-ft north of Elliot Street
7600	Elliot Street at Crescent Avenue

3.0 Existing System Capacities /System Deficiencies

(Appendix B and Figure 3 through 6)

Appendix B of this report includes a summary of the calculated hydraulic capacity for each reach of the modelled existing facilities and a summary of the calculated peak stormwater runoff rates tributary to each reach of the system for the selected four storm events presented in Section 2.0. An evaluation of existing system capacities versus the computed peak runoff rates is presented as a percentage of system capacity for each storm event analyzed. Where the indicated percentage exceeds 100%, the existing system capacity is inadequate to carry the computed peak flow rate. Figures 3 through 6 provide a graphical representation of system inadequacies for the 2-year, 5-year, 10-year, and the June 1998 storm, respectively.

As seen from the summary of data presented, system deficiencies occur throughout the project area during each of the storm events. Any occurrence of flooding identified along a street is the result of water ponding on the ground when surface runoff is unable to enter a catch basin or when water bubbles up from any catch basin or manhole because the drainage capacity has been exceeded. Flooding identified along an open channel is the result of flow overtopping the banks of the brook.

The topography at the upper reaches of the system is much higher than at the lower reach, as a result local flooding that occurs at the upper reach (Nodes 7600, 6000, 3600) will eventually gutter flow to the lower reach of the system. The hydraulic model also over-predicts the flooding conditions at these locations since it assumes that all the upstream flow is capable of discharging into the last node in the system. As such, deficiencies identified along the upper reaches of the system are not considered as significant as those located along the lower reaches. This report will focus on flooding that occurs at the lower reaches of the system and results in hazardous conditions.

As seen from Figures 5 and 6, there are extensive segments of the existing facilities that are unable to accommodate the peak flow of the June 1998 metered storm and the 10-year Type III design storm. Relief alternatives will be discussed for Norwood's downtown area (Nahatan Street, Broadway, Cottage Street, and Vernon St), the area downstream of the 4'x8' box culvert at Shaw's/Star Market (Rock Street, Andrews Street, and Plimpton Avenue), the box culverts from Murphy Field to Meadow Brook, the Pellana Road area, and the unimproved section of Meadow Brook.

N

LEGEND

EXISTING STORM DRAIN

EXISTING OPEN CHANNEL

PROPOSED SWMM NODES

PROJECT LIMIT (DRAINAGE BOUNDARY)

FI = FIELD INVESTIGATION

RD = RECORD DRAWINGS

INDICATE SURFACE FLOODING

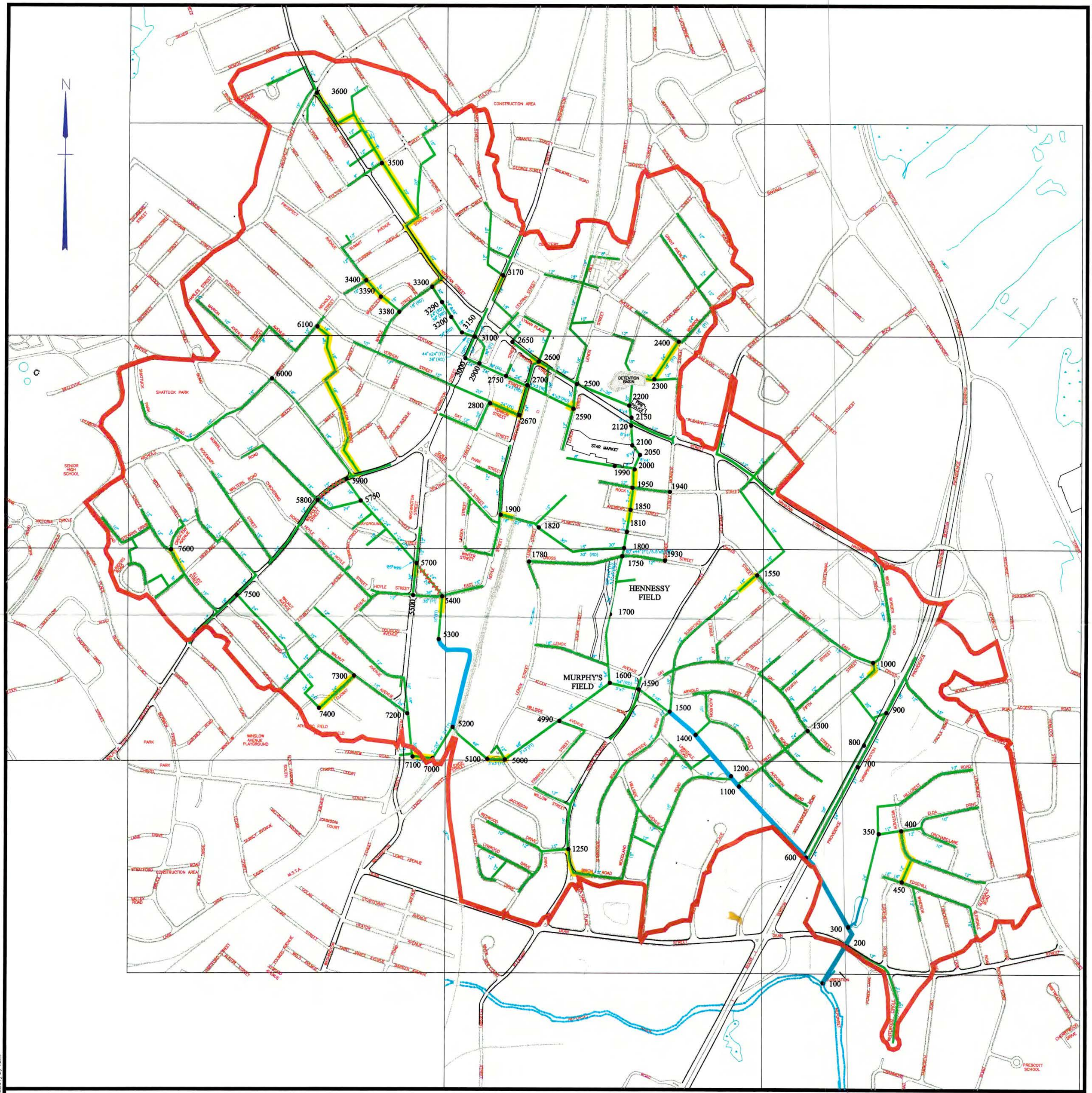
FAY, SPOFFORD & THORNDIKE

TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 3.
SWMM ANALYSIS - 2 YEAR TYPE III STORM
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

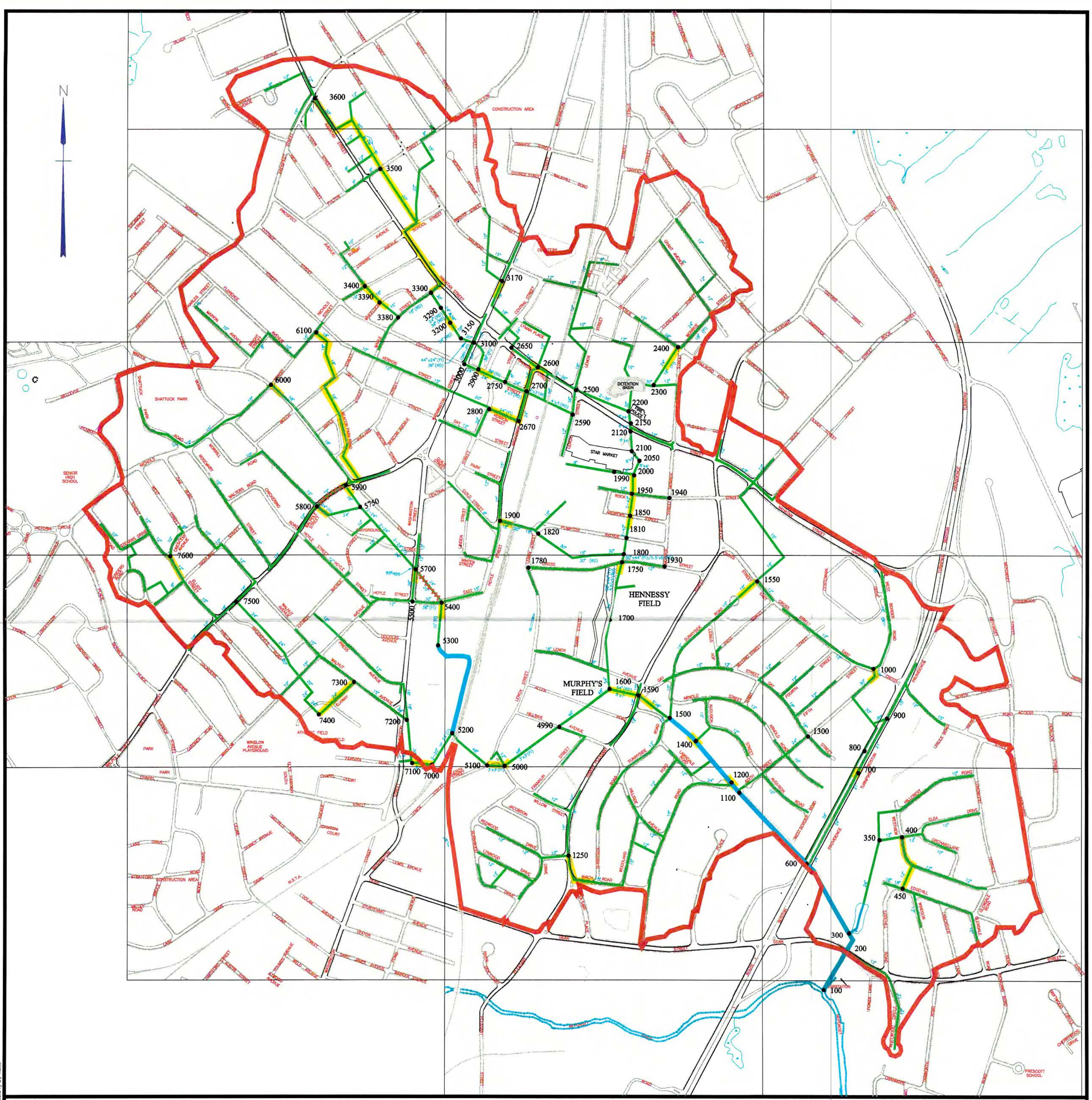
TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 4.
SWMM ANALYSIS - 5 YEAR TYPE III STORM
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\JN-064\Project\Flooding.dwg 09/27/04 16:57 [85.34] By hul_



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

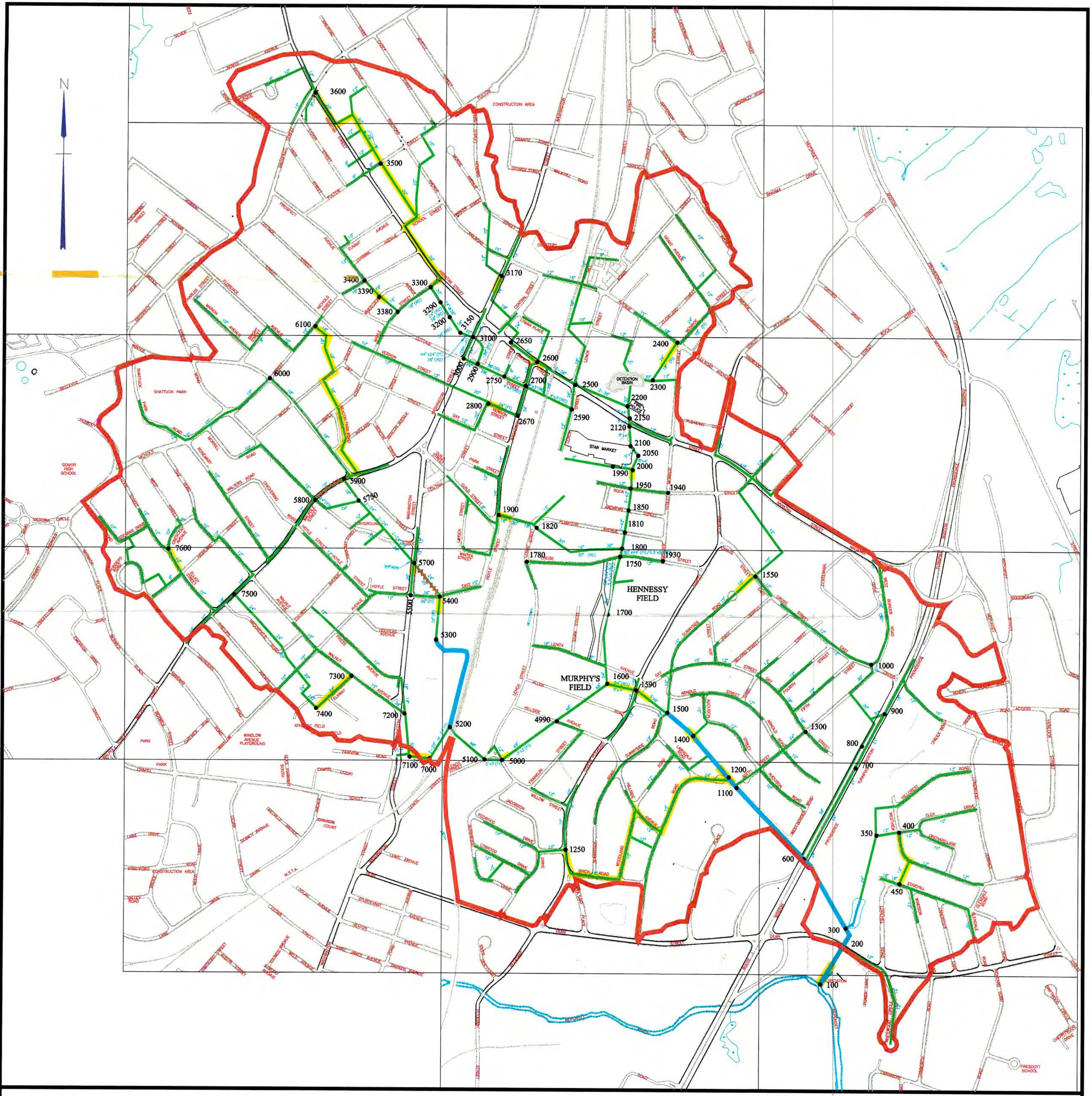
TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 5.
SWMM ANALYSIS - 10 YEAR TYPE III STORM
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\JN-064\Project\Flooding.dwg 09/27/04 16:57 [85,34] By hui_l



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 6.
SWMM ANALYSIS - JUNE 1998 STORM EVENT
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\AN-064\Project\Flooding.dwg 06/27/04 16:57 [85.34] By hul_l

4.0 Analysis of System Improvements

System Relief Alternatives

Relief alternatives will be discussed for Norwood's downtown area (Nahatan Street, Broadway, Cottage Street, and Vernon Street), the area downstream of the 4'x8' box culvert at Shaw's/Star Market (Rock Street, Andrews Street, and Plimpton Avenue), the box culverts from Murphy Field to Meadow Brook, the Pellana Road area, and the unimproved section of Meadow Brook.

In order to improve the performance of the Meadow Brook drainage system, relief alternatives were investigated at each location of identified system deficiency. As a conservative measure, it is assumed all upstream reaches have been relieved and that the flow entering the system has been maximized. System relief follows a step-by-step process. Relief alternatives will be based on the 10-Year Type III design storm.

Improvements to Meadow Brook

(*See Figure 7*)

The Meadow Brook overtops its banks at various locations upstream of Node 1100 during the design storm. This section of the Brook is overgrown with dense vegetation and the banks and channel bedding are in poor condition. Currently, the Brook has a capacity of approximately 133 cfs to 172 cfs, significantly less than the 1,300 cfs produced by the design storm. According to the SWMM analysis, this section of the Brook will flood for 2.5 hours with a flooding volume of 1.87 Ac-ft. under the 10-year Type III storm event conditions.

The downstream section of this Brook, Sixth Street (Node 1100) to the Neponset River, was dredged, shaped and stabilized by the U.S. Corps of Engineers in August 1994. This work was a direct result of recommendations made in a Design Contract for the Department of Environmental Management, Division of Waterways (Contract No. 3107) completed in 1984. Field investigations have confirmed that the upstream 1,000 feet of the Meadow Brook, from Node 1500 to Node 1100, would require similar improvements in order to maximize its capacity.

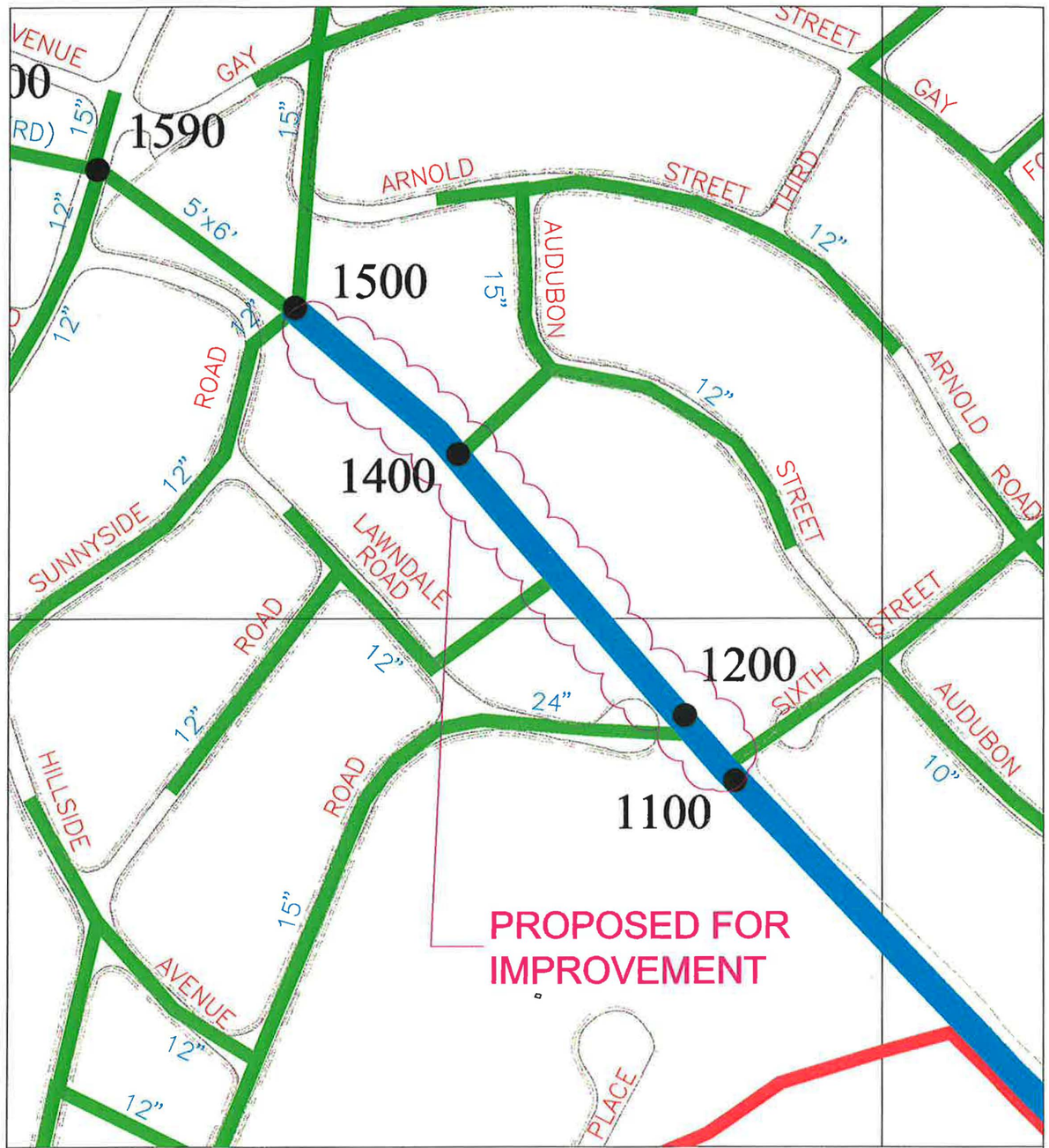
Improvement Summary:

Cost	*Proposed Improvement*
$790,000	• *1,000-ft of Brook improvement*

Willow Street Outfall

(*See Figure 8*)

Another option for relieving the Meadow Brook would be to redirect the flow from the Southern Feeder directly to the Neponset River via a new outfall located west of the Meadow Brook's



LEGEND

EXISTING STORM DRAIN
EXISTING OPEN CHANNEL
PROPOSED SWMM NODES
PROJECT LIMIT (DRAINAGE BOUNDARY)
FI = FIELD INVESTIGATION
RD = RECORD DRAWINGS

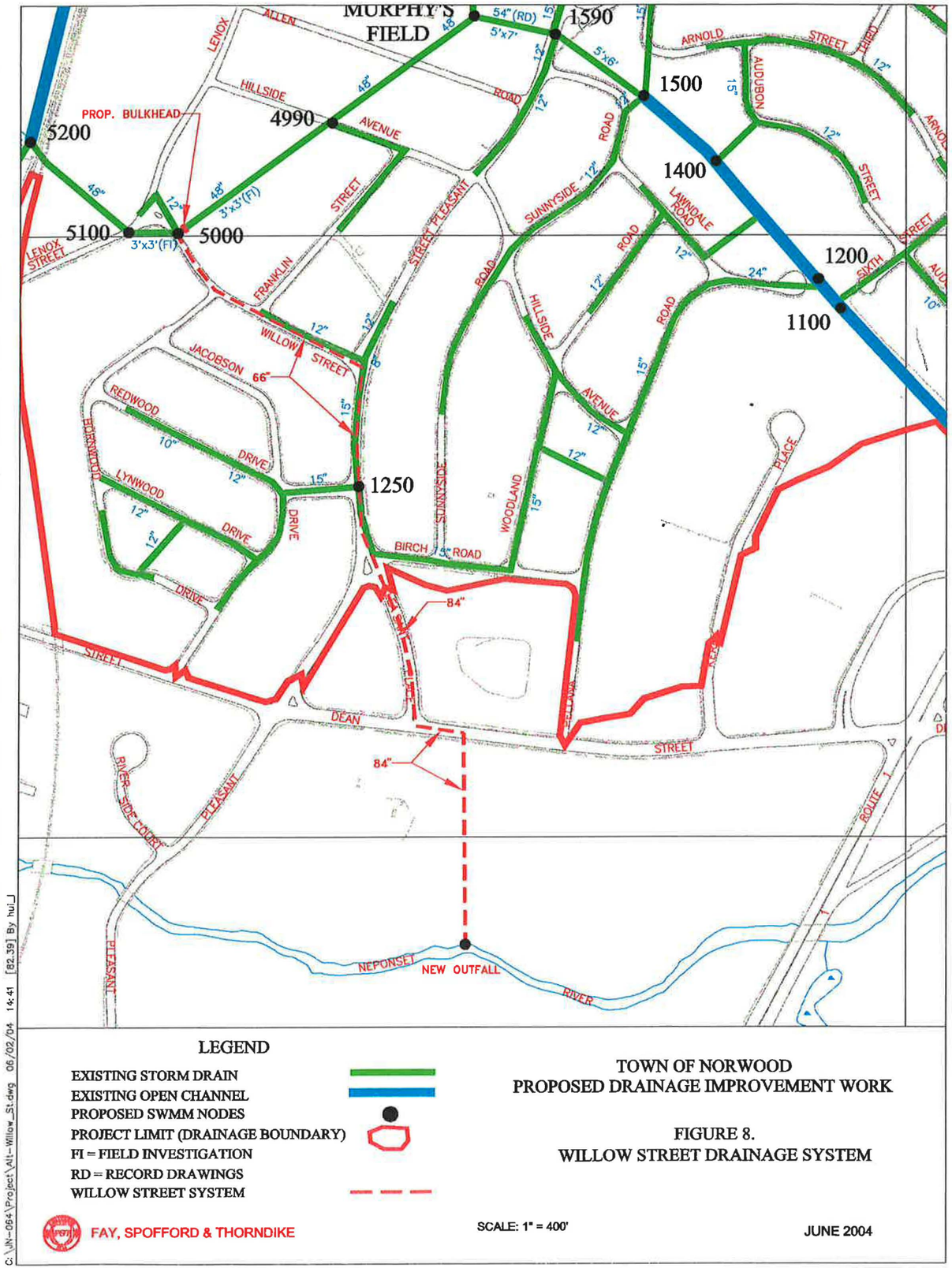
TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 7.
PROPOSED LIMIT OF BROOK IMPROVEMENT

FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 200'

JUNE 2004



TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 8.
WILLOW STREET DRAINAGE SYSTEM

C:\JN-064\Project\Alt-Willow_St.dwg 06/02/04 14:41 [82.39] By hui_J

confluence with the Neponset River. A new 66-inch storm drain would pick up flow from the Southern Feeder at the intersection of Lenox Street and Willow Street. The proposed drain would then extend southeastward along Willow Street towards Pleasant Street. The 66-inch pipe would then continue southward along Pleasant Street, picking up additional flow from the Lynwood Drive-Redwood Drive neighborhood prior to crossing over to Pleasant Place. The additional flow would require that the storm drain be increased to an 84-inch pipe at Node 1250. The Lynwood Drive-Redwood Drive neighborhood drainage system is currently tributary to the Pellana Road outfall at Meadow Brook, redirecting this flow would maximize the benefit of this alternative by also providing relief to the Pellana Road drainage system.

From Pleasant Place, the 84-inch pipe would continue eastward less than 200 feet along Dean Street before taking a southerly route cross country towards the Neponset River, where it will discharge approximately1000 feet east of Pleasant Street. Constructing this new outfall would require the placement of 1,200 linear feet of 66-inch and 1,700 linear feet of 84-inch pipe at an estimated cost of $1.38 million (2004 dollars). Hydraulic model results indicate that providing this outfall would only marginally improve the hydraulic conditions of the Meadow Brook, therefore, resulting in its cost outweighing the benefit it would provide. As such, no further analyses were performed for this alternative.

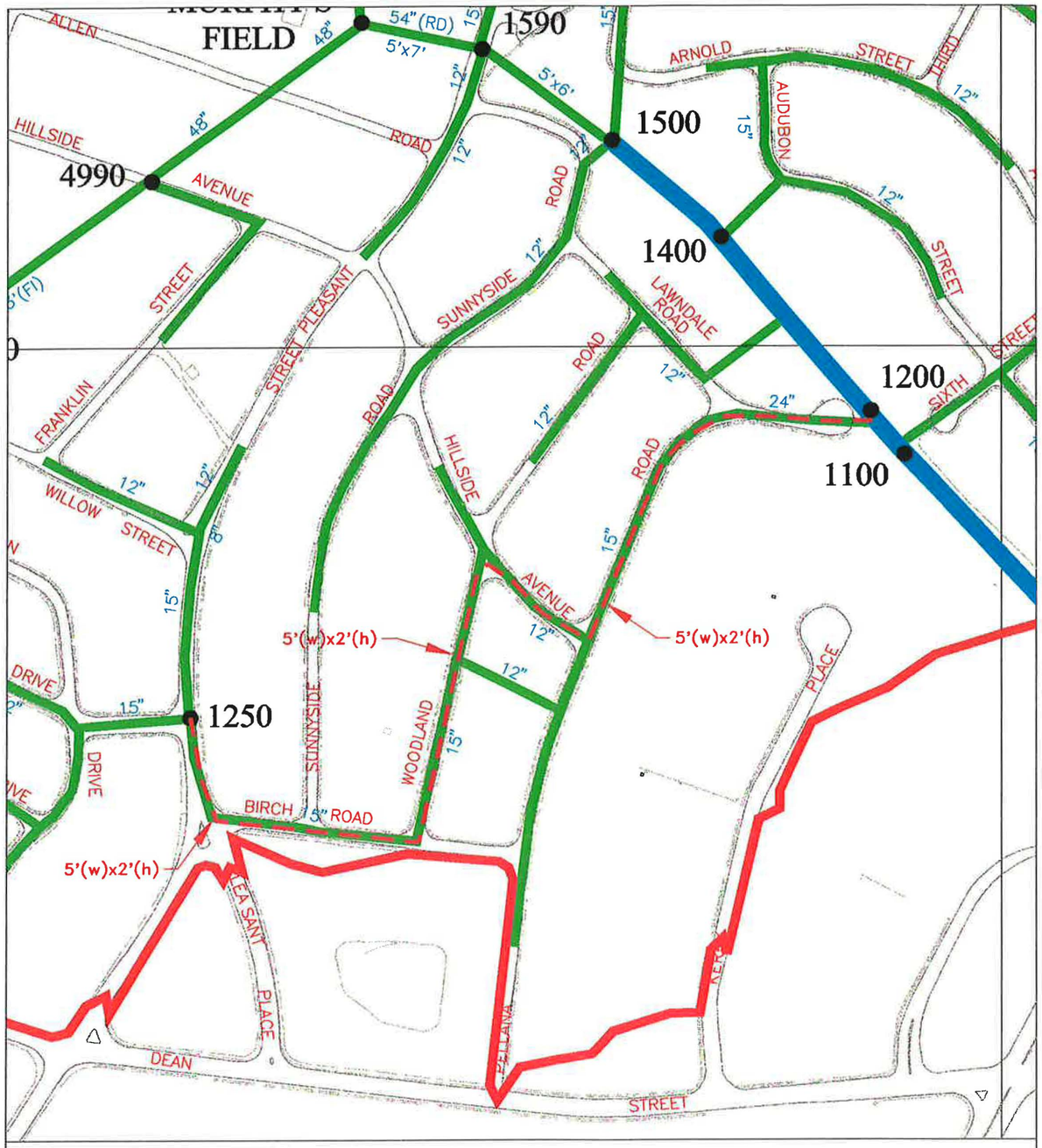
Improvement Summary:

Cost	*Proposed Improvement*
$1,380,000	• *1,200-ft of 66" drain pipe* • *1,700-ft of 84" drain pipe*

Pellana Road Neighborhood Relief

(*See Figure 9*)

The Pellana Road tributary area encompasses a total of 74.75 acres that contribute approximately 68.6 cfs of flow to the Meadow Brook. The storm drainage system in this neighborhood consists mainly of 15-inch diameter storm drain pipe with an estimated capacity of 3.4 cfs. This system discharges to the unimproved portion of Meadow Brook via a 24-inch outfall pipe located at the invert of the brook. Backwater flow is introduced into the system during times when there is significant flow in the brook. In addition to the backwater effects, the topography in the neighborhood is moderately flat resulting in the drainage system not having a sufficient amount of hydraulic head required to pass the storm flow. This condition results in severe flooding in the area of Birch Road and Pleasant Street, which according to the hydraulic model, will flood for over 10 hours with a flooding volume of 3.1 acre-feet during the design storm.



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD RECORD DRAWINGS
- PROPOSED STORM DRAIN

FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 300'

TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 9.
PELLANA ROAD IMPROVMENT

JUNE 2004

The flooding problems in the Pellana Road neighborhood would be relieved by replacing the existing 15-inch and 24-inch storm drain along Pleasant Street, Birch Road, Woodland Road, Hillside Avenue and Pellana Road (Node 1250 to Node 1100) with approximately 2,600 linear feet of 42-inch pipe with a minimum slope of 0.0036 feet/feet. The system is restricted by insufficient ground cover, therefore, an equivalent 5'(w) x 2'(h) box culvert placed along the same alignment is proposed to replace the 42-inch pipe. Further investigation is required prior to final design in order to confirm these findings.

Improvement Summary:

Cost	*Proposed Improvement*
$1,740,000	• *2,635-ft of 5'x2' replacement*

Box Culverts from Murphy Field to Meadow Brook

(*See Figure 10*)

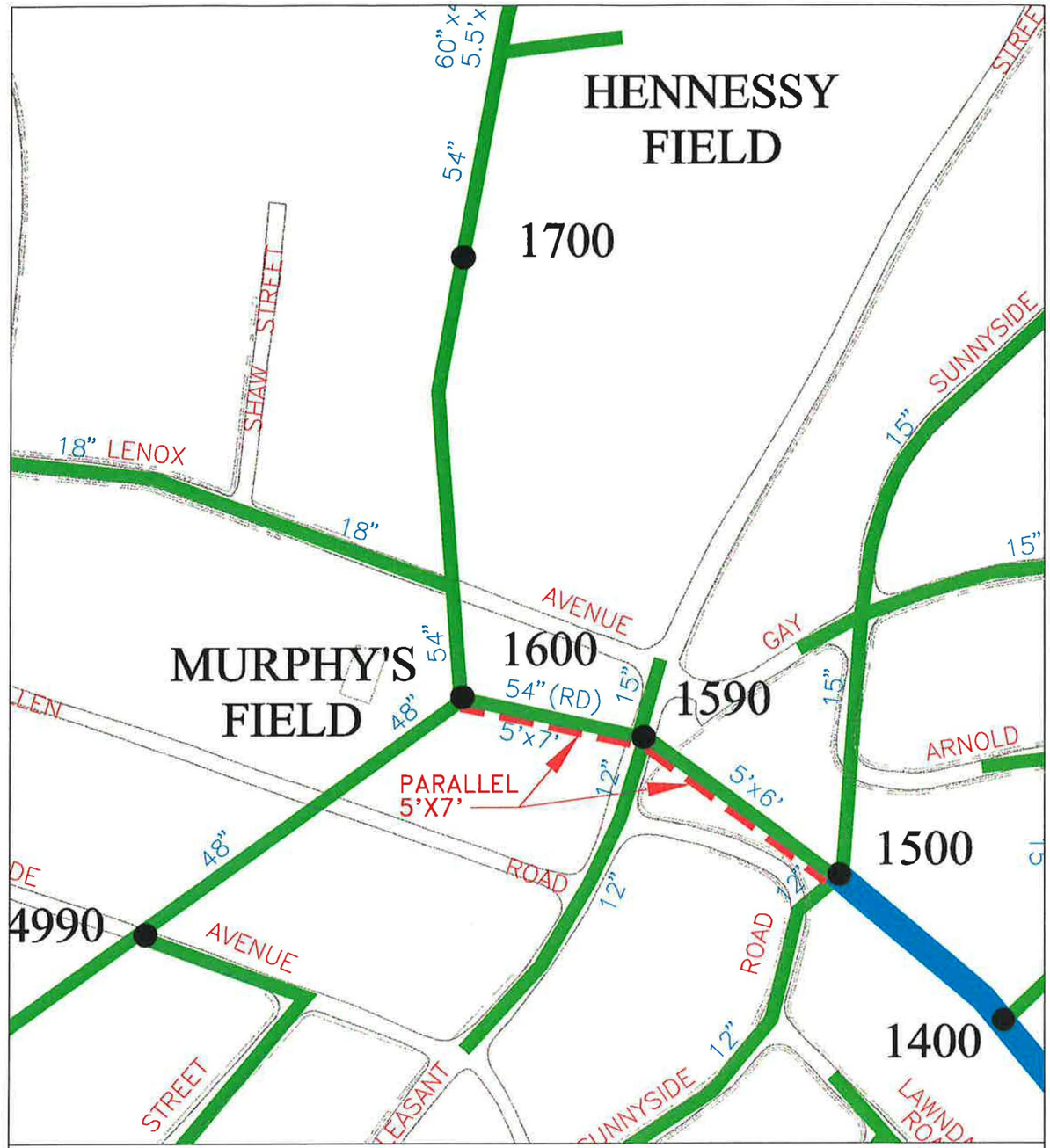
The box culvert from Murphy Field to the upstream end of Meadow Brook is comprised of two sections, the upstream 270 feet of 5'x7' box culvert and the downstream 350 feet of 5'x6' box culvert. The 5'x7' and 5'x6' box culverts have a capacity of 471 cfs and 383 cfs, respectively. Hydraulic analysis conducted under the 10-Year Type III design storm conditions has identified the occurrence of flooding at Murphy Field where the Northern Reach and the Southern Reach meet the upstream portion of the culvert. The tributary combined peak is approximately 1,200 cfs. Flooding at the upstream portion of the culvert is a direct result of the 5'x7' and the 5'x6' culverts insufficient capacity to pass the peak flow of the design storm. Providing additional capacity at the existing culverts would relieve the occurrence of flooding at Murphy Field. It is recommended that 620 linear feet of 5'x7' box culvert at a slope of 0.011 feet/feet be laid parallel to the existing box culverts in order to provide an additional 541.5 cfs at this location.

Improvement Summary:

Cost	*Proposed Improvement*
$580,000	• *620-ft of 7'x5' parallel*

Northern System from Downtown Area to Murphy Field

At the time this drainage study was implemented, the downtown area was serviced by twin 36-inch storm drains from the Police/Fire Station to the existing 8'x4' box culvert under the parking lot of Shaw's/Star Market (Node 2200 to Node 2050), twin 42-inch storm drains from the 8'x4' culvert to Cross Street (Node 2000 to Node 1800), and a 54-inch drain from Cross Street to Murphy Field where it discharges to the 5'x7' box culvert (Node 1800 to Node1600) (*See Appendix A*).



LEGEND

EXISTING STORM DRAIN
EXISTING OPEN CHANNEL
PROPOSED SWMM NODES
PROPOSED STORM DRAIN
FI = FIELD INVESTIGATION
RD = RECORD DRAWINGS

TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 10.
PROPOSED PARALLEL RELIEF AT BOX CULVERT

FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 200'

JUNE 2004

In 2002, drainage improvements were implemented in conjunction with the new Police/Fire Station and the existing retention basin. The improvements included raising the ground elevation of the Police/Fire Station and regrading the adjoining parking lot. The new Police/Fire Station was constructed at the first floor elevation of 108.5 feet to assure no flooding. While modifications to the parking lot resulted in the elimination of stormwater storage volume from behind the station, the replacement of the twin 36-inch drain pipes from Node 2200 to Node 2050 with 515 linear feet of 8'x4' box conduit provided additional in-system storage and flow capacity.

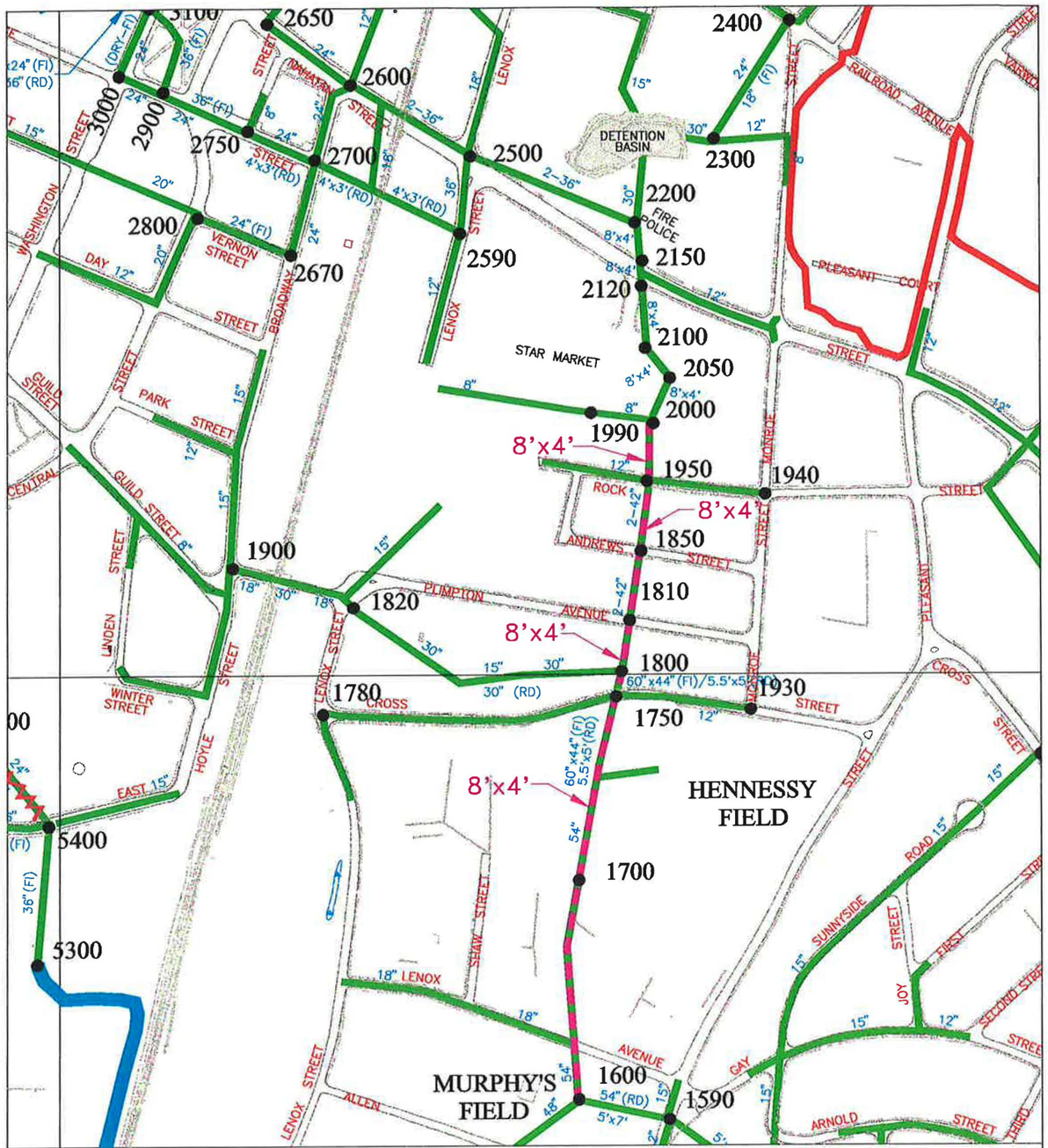
While the impact of drainage improvements at the Police/Fire Station reduced/eliminated the occurrence of site flooding at that location, it also introduced additional stormwater flow to nearby areas under severe storm events. With the raised site of the Police/Fire Station, stormwater in excess of the detention basin and system capacity will sheet flow down to Nahatan Street, and continue to points of lower elevation point in the Shaw's/Star Market parking lot and thence southerly to lower areas of Rock Street, Andrews Street , Plimpton Avenue, Cross Street and finally to Hennessey Field and Murphy Field.

Under design storm conditions, the flow tributary to the Downtown Area is estimated to be 670 cfs. The detention basin located behind the Police/Fire Station is capable of handling a flow of 280 cfs and the remaining 390 cfs is carried through the system. The 8'x4' culvert has a capacity of 411 cfs, the twin 42-inch storm drains have a total capacity of 150 cfs and the 54-inch storm drain has a capacity of 263 cfs. Because the 390 cfs passing through the system exceeds the available capacity of the twin 42-inch and the single 54-inch pipe, some form of relief is required at these locations.

The following paragraphs outline five separate alternatives each intended to relieve the storm drainage system from the downtown area to Murphy Field. Because this area of Norwood is so densely populated, it was important to review several alternatives in order to establish which would provide the most benefit and the least dverse impact to area residents and businesses.

Alternative 1 (See Figure 11)

Alternative 1 proposes the replacement of the twin 42-inch storm drain, Shaw's/Star Market to Cross Street (Node 2000 to Node 1800), and the 54-inch storm drain, Cross Street to Murphy Field (Node 1200 to Node 1600), with approximately 2,045 LF of 8'x4' box



LEGEND

EXISTING STORM DRAIN
EXISTING OPEN CHANNEL
PROPOSED SWMM NODES
PROJECT LIMIT (DRAINAGE BOUNDARY)
FI = FIELD INVESTIGATION
RD = RECORD DRAWINGS
ALTERNATIVE 1

FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 400'

JUNE 2004

TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 11.
ALTERNATIVE 1

culvert. Placement of the 8'x4' culvert is proposed at the same horizontal and vertical alignment as the existing pipes.

Of significant concern is the fact that the work associated with this relief alternative would occur almost entirely within private properties since the existing system is located within the backyards of residential homes on Rock Street, Andrews Street, Plimpton Avenue, Cross Street and Lenox Street. In addition, the proposed box culvert would not improve conditions at Nahatan Street, Day Street, Vernon Street, East Cottage Street, and Broadway. Additional relief would be required to reduce the flooding conditions at these locations. Both the ability to utilize existing easements located along the existing storm drainage alignment and the fact that installation of the 8'x4' culvert would result in the smallest amount of disturbance are advantages to this alternative.

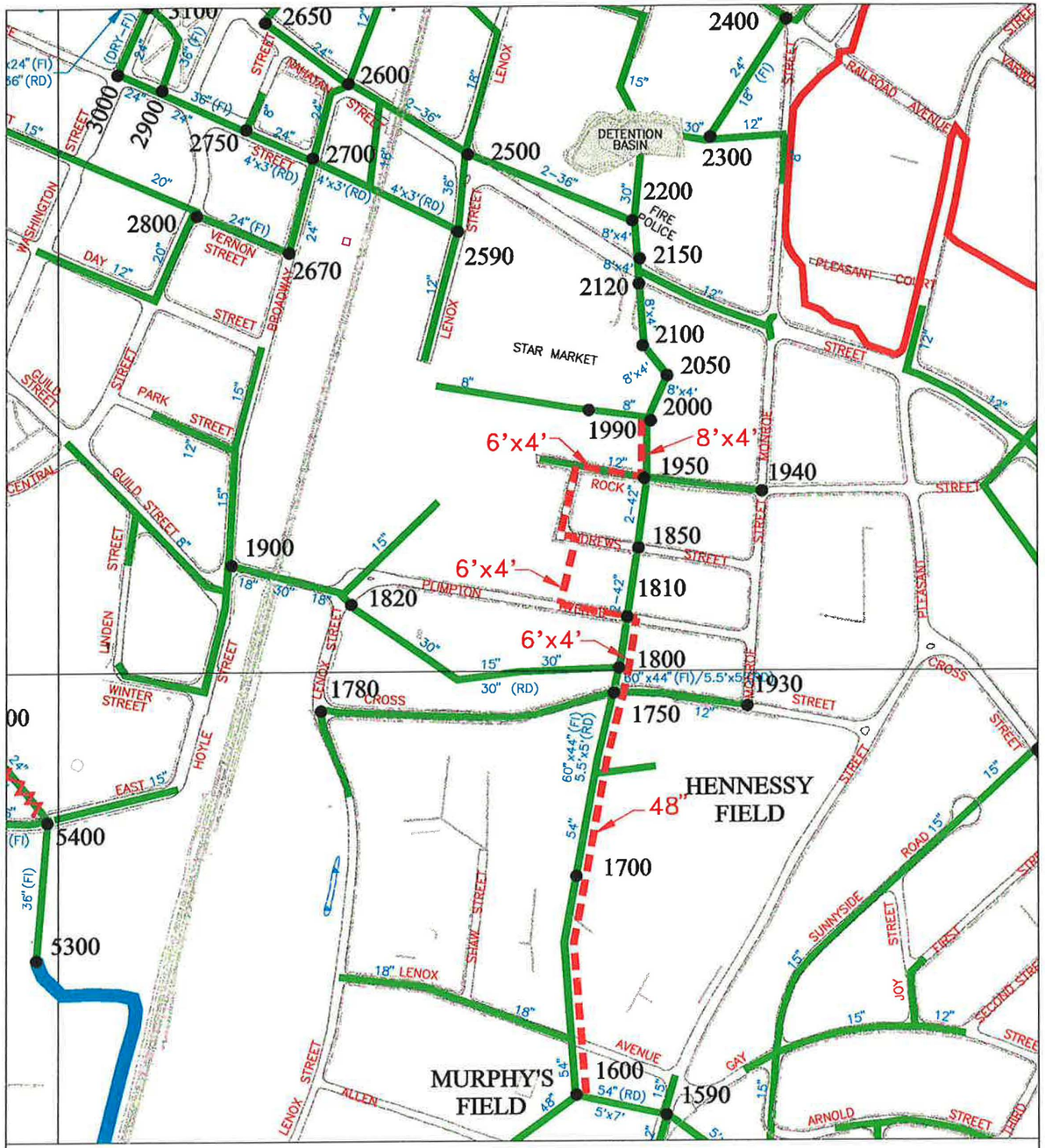
Improvement Summary:

Cost	*Proposed Improvement*
$3,180,000	• *2,045-ft of 8'x4' replacement* • *620-ft of 7'x5' parallel relief* • *1,000-ft of Brook improvement*

Alternative 2 (See Figure 12)

Alternative 2 proposes replacing the existing twin 42-inch drain from Shaw's/Star Market to Rock Street (Node 2000 to 1950) with an 8'x4' box culvert. The existing system would remain in place from Rock Street to Murphy Field, however supplemental relief would be provided. A 6'x4' culvert is proposed to pick up flow from the 8'x4' culvert and run westerly and southerly on Rock Street to Andrews Street. This culvert would then extend cross country under private properties from Andrews Street to Plimpton Avenue where it would then run parallel to the existing twin 42-inch storm drain to Cross Street (Node 1750). At Cross Street the 6'x4' would culvert becomes a 48-inch storm drain that will run parallel to the existing 54-inch storm drain until it reaches Murphy Field.

Similar to Alternative 1, this alternative would not provided relief for the for Nahatan Street, Day Street, Vernon Street, East Cottage Street, and Broadway areas. A new easement would also be required for the placement of the 6'x4' culvert between Andrews Street and Plimpton Avenue. Advantages to this alternative include the use of smaller culvert sizes and the ability to conduct more of the work in public rather than almost entirely within private properties. However, when compared to Alternative 1, Alternative 2 is 440-ft longer and results in a slight decrease in flow capacity.



LEGEND

EXISTING STORM DRAIN
EXISTING OPEN CHANNEL
PROPOSED SWMM NODES
PROJECT LIMIT (DRAINAGE BOUNDARY)
FI = FIELD INVESTIGATION
RD = RECORD DRAWINGS
ALTERNATIVE 2

FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 400'

TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 12.
ALTERNATIVE 2

JUNE 2004

Improvement Summary:

Cost	*Proposed Improvement*
$3,070,000	• *165-ft of 8'x4' replacement* • *1,010-ft of 6'x4' parallel relief* • *1,310- ft of 48" parallel relief* • *620-ft of 7'x5' parallel relief* • *1,000-ft of Brook improvement*

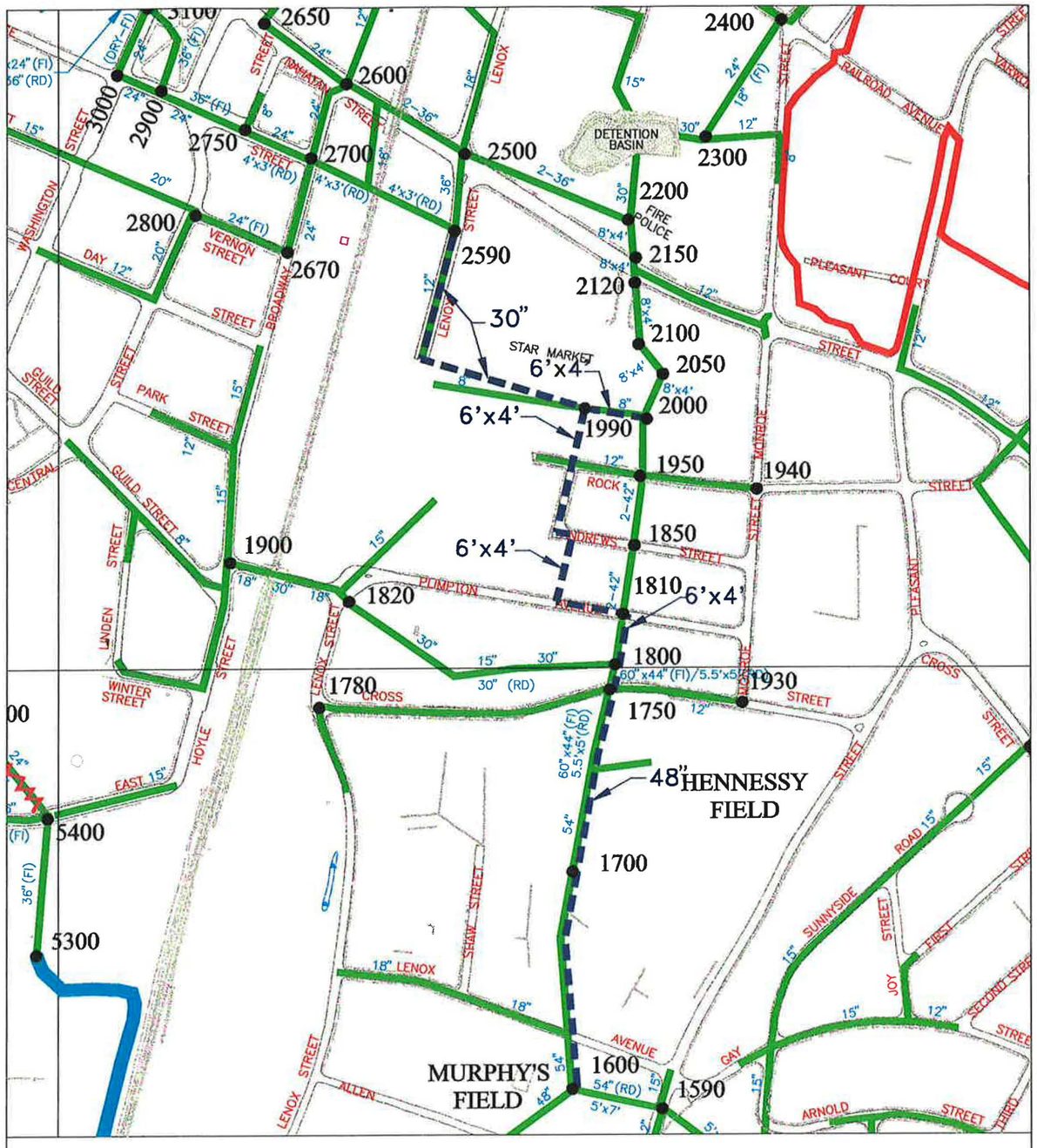
Alternative 3 (See Figure 13)

Alternative 3 is very similar to Alternative 2 with the exception of work proposed upstream of the Shaw's/Star Market area. Under this alternative, the existing system from Shaw's/Star Market to Murphy's Field would remain in place and a relief system would be provided from Shaw's/Star Market to Murphy Field via the same alignment proposed in Alternative 2 (*See Figure 12*). A 6'x4' box culvert is proposed to provide relief from the existing 8'x4' culvert to Cross Street (Node 2000 to Node 1800) and a 48-inch drain is proposed from Cross Street to Murphy Field (Node 1800 to Node 1600). In the area upstream of Shaw's/Star Market, 910-feet of 30-inch connector pipe is proposed from Lenox Street (Node 2590) to the back parking lot of Shaw's/Star Market (Node 1990) in order to convey stormwater runoff collected from the downtown area.

Alternative 3 would require a significant increase in pipe length, approximately 1,300-feet as compared to Alternative 1. Similar to Alternative 2, a new easement would be required for the placement of the 6'x4' culvert between Andrews Street and Plimpton Avenue and work would be conducted within both public streets as well as on private properties. While this alternative does not provided relief for the Day Street, Vernon Street, East Cottage Street, and Broadway areas, it does provide some relief on Nahatan Street at the railroad bridge crossing. Installation of the 30-inch connector pipe would reduce the flooding volume at the railroad bridge by 80% as measured under the 10-year Type III design storm conditions.

Improvement Summary:

Cost	*Proposed Improvement*
$3,330,000	• *910-ft of 30" relief* • *1,200-ft of 6'x4' parallel relief* • *1,230-ft of 48" parallel relief* • *620-ft of 7'x5' parallel relief* • *1,000-ft of Brook Improvement*



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- ALTERNATIVE 3

FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 400'

TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 13.
ALTERNATIVE 3

JUNE 2004

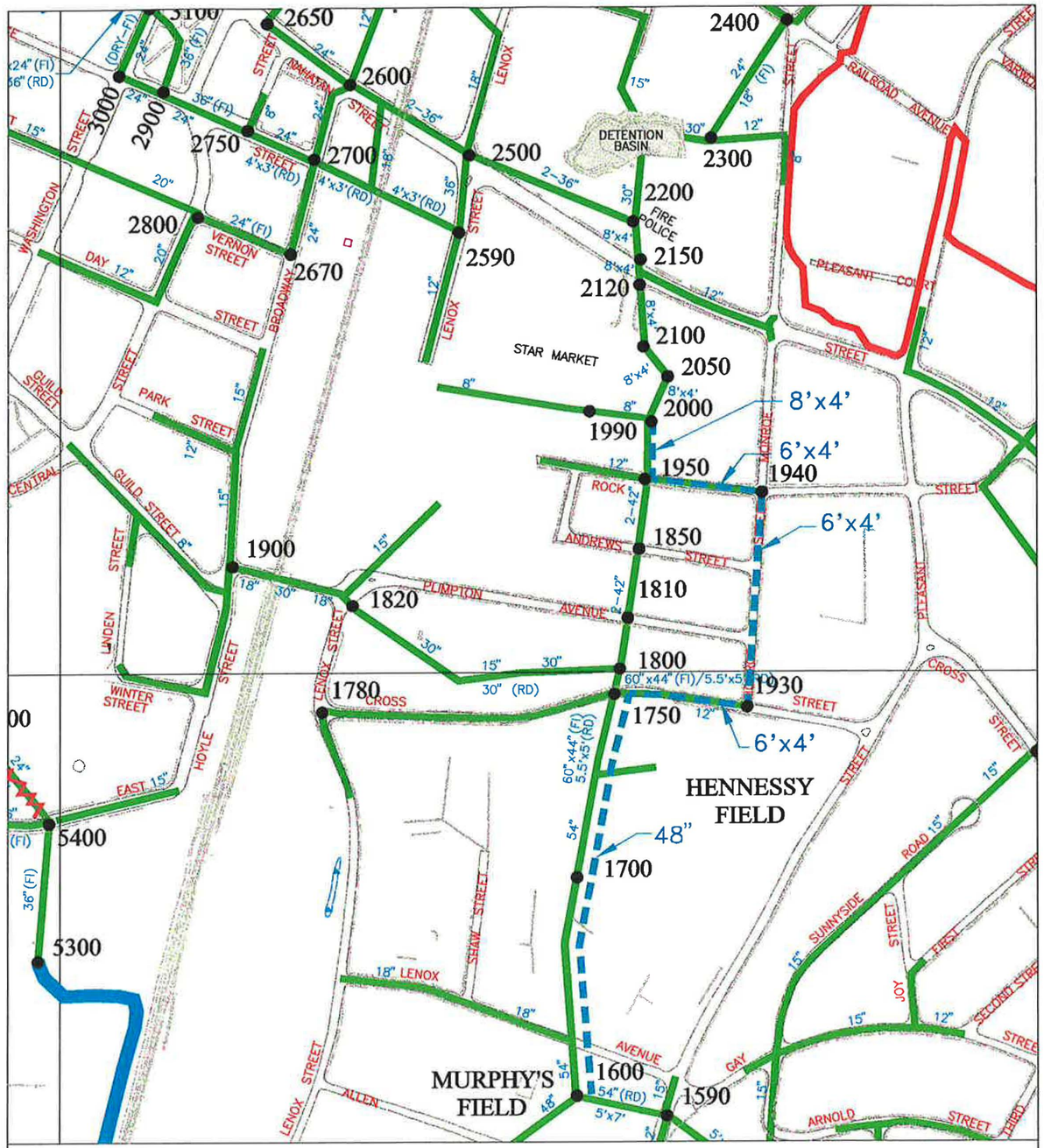
Alternative 4
(See Figure 14)
Alternative 4 is somewhat a mirror image of Alternative 2. It proposes replacing the twin 42-inch drain under the Shaw's/Star Market parking lot with an 8'x4' box culvert. From Rock Street, the existing system is to remain in place and a 6'x4' box culvert will be added for relief. The 6'x4' picks up flow from the proposed 8'x4' at Rock Street then runs easterly to Monroe Street and southerly to Cross Street (Node 1950 to Node 1750). At Cross Street, the drain runs westerly to join with the existing 54-inch storm drain. Similar to Alternative 2, a 48-inch pipe is proposed parallel to the existing 54-inch pipe (Node 1750 to Node 1600).

Alternative 4 would require an increase in pipe length, approximately 370-ft longer as compared to Alternative 2. In addition, this alternative does not provide relief for Nahatan Street, Day Street, Vernon Street, East Cottage Street, and Broadway. The advantage of this alternative is that all work for the 6'x4' box culvert will be performed within public streets with no work being performed on private properties. However, the trench depth of the relief system would be much greater than that required for the previous alternatives since Monroe Street is approximately 10-ft higher than the existing systems. In addition to deep cuts, there is a possibility of encountering ledge along Monroe Street. Sewer profiles indicate the top of ledge on Monroe Street ranges from 2 feet to 8 feet below ground surface. Additional research is required to confirm this detail.

Improvement Summary:

Cost	*Proposed Improvement*
$3,640,000	• *165-ft of 8'x4' replacement* • *1,380-ft of 6'x4' replacement* • *1,230-ft of 48" parallel relief* • *620-ft of 7'x5' parallel relief* • *1,000-ft of Brook Improvement*

Alternative 5
(See Figure 15)
Under this alternative, the existing system from Shaw's/Star Market to Murphy's Field is to remain in place. Modifications to the drainage system are proposed to begin at Broadway where a bulkhead is proposed at the 24-inch pipe connecting East Cottage Street to Nahatan Street (Node 2700 to Node 2600). A new 42-inch pipe, which would replace the existing system on Broadway, is proposed to pick up flow from the existing drainage system at East Cottage Street, run southerly down Broadway to East Vernon Street, then collect flow from Central Street and continue down on Broadway via a 48-inch pipe as it



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- ALTERNATIVE 4

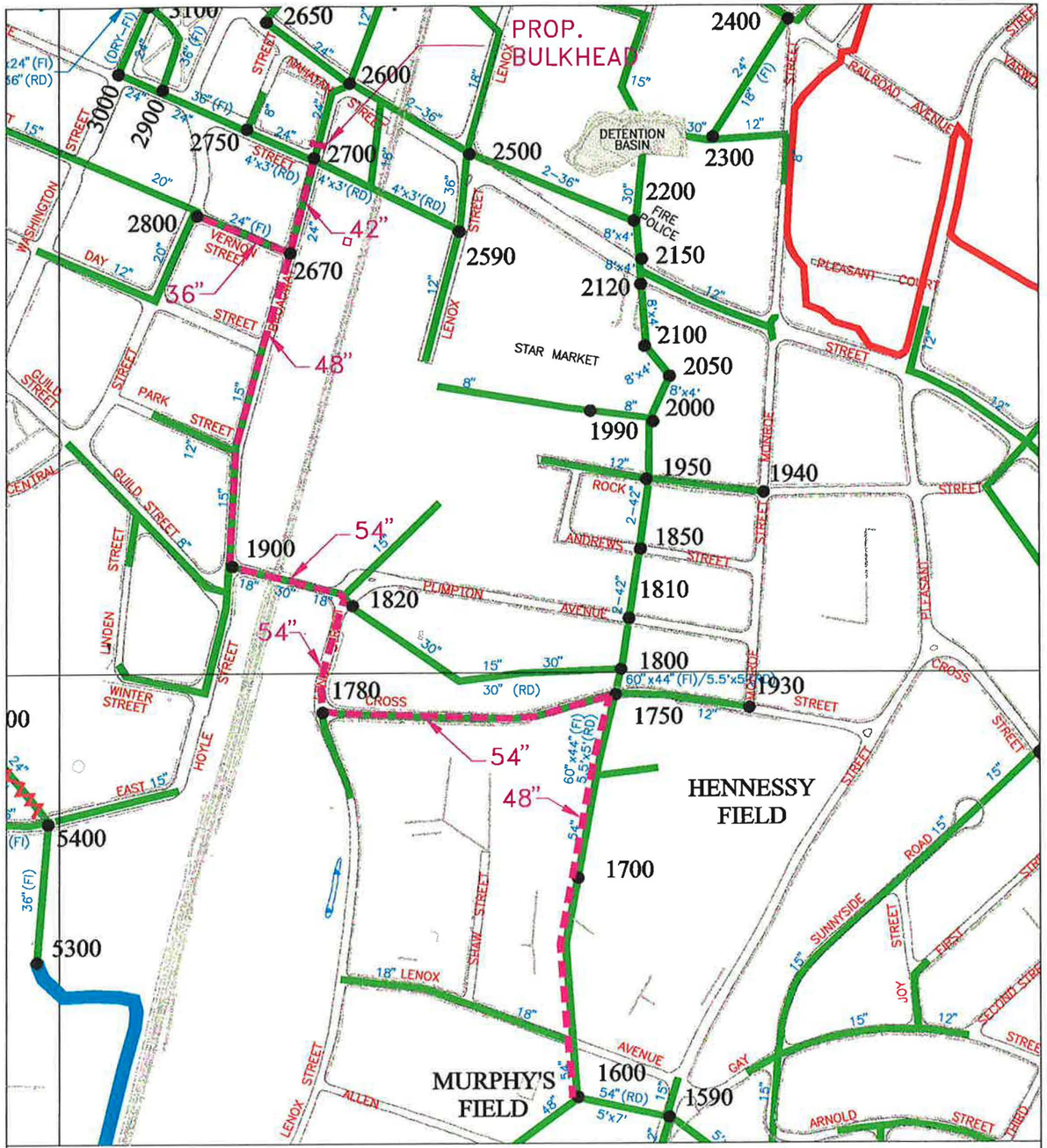
FAY, SPOFFORD & THORNDIKE

SCALE: 1" = 400'

TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 14.
ALTERNATIVE 4

JUNE 2004



TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 15.
ALTERNATIVE 5

collects drainage from the Guild Street, Winter Street and other smaller drainage areas. The existing systems along this alignment will be removed or abandoned. At Guild Street, the pipe size increases from 48-inch to 54-inch and runs easterly under the railroad tracks to the intersection of Plimpton Avenue and Lenox Street (Node 1900 to Node 1820). From this intersection, the proposed 54-inch runs southerly along Lenox Street to Cross Street (Node 1820 to Node 1780) and at Cross Street runs easterly to the upstream section of the existing 54-inch pipe (Node 1780 to 1750). Like the previous alternatives, a parallel 48-inch pipe from Node 1750 to 1600 is proposed to relieve the existing 54-inch.

The most significant disadvantage of this alternative is the extensive length of pipe required, approximately 2,000 feet more pipe as compared to Alternative 1. However, the pipe and culvert sizes are smaller (42-, 48- and 54-inch to 6'x4' box culvert) and all the proposed work is located within public streets. Impacts resulting from this new alignment require that an estimated 900 feet of 6-inch water main on Broadway will be relocated. There are also potential utility conflicts with a 10-inch gas main within Guild Street at the railroad bridge, and sanitary sewer systems in streets.

This alternative allows the upper reaches of Nahatan Street to discharge directly to the 8'x4' box culvert under Shaw's/Star Market and no additional relief is required for the twin 42-inch from the existing 8'x4' to Cross Street. In addition, a proposed bulkhead at the existing 24-inch pipe (Node 2700) will result in a high percentage of the flow being diverted to the proposed system in Broadway thus eliminating flooding at the Nahatan Street railroad crossing under design storm conditions. This alternative results in no additional work being required in the downtown area of Nahatan Street, Day Street, Vernon Street, East Cottage Street, and Broadway.

Improvement Summary:

Cost	*Proposed Improvement*
$4,270,000	• *300-ft of 36" replacement* • *300-ft of 42" replacement* • *960-ft of 48" drain* • *1,240-ft of 54" drain* • *1,230-ft of 48" parallel relief* • *620-ft of 7'x5' parallel relief* • *1,000-ft of Brook Improvement*

Underground Detention Tank at Murphy Field / Detention Pond at Hennessey Field

If relief were provided for the upstream areas as outlined above, the peak flow discharging to Neponset River would increase to approximately 1240 cfs. This represents a 67% increase from the 740 cfs currently being discharged under design storm conditions. The Neponset River Watershed Association (NRWA) strongly objects to any increase in flow rates to the Neponset

River since there is already a significant amount of flooding that occurs in the low lying areas of the watershed during major storm events. The NRWA has requested that when conducting any drainage improvements, communities within the watershed refrain from increasing the flow rates to the Neponset River.

As a result of meetings conducted with the NRWA, two alternatives are proposed to maintain the amount of flow that is it entering the Neponset River while still allowing the Town to provide relief for the upstream flooding areas. The alternatives proposed utilize Murphy Field and Hennessey Field as stormwater storage basins.

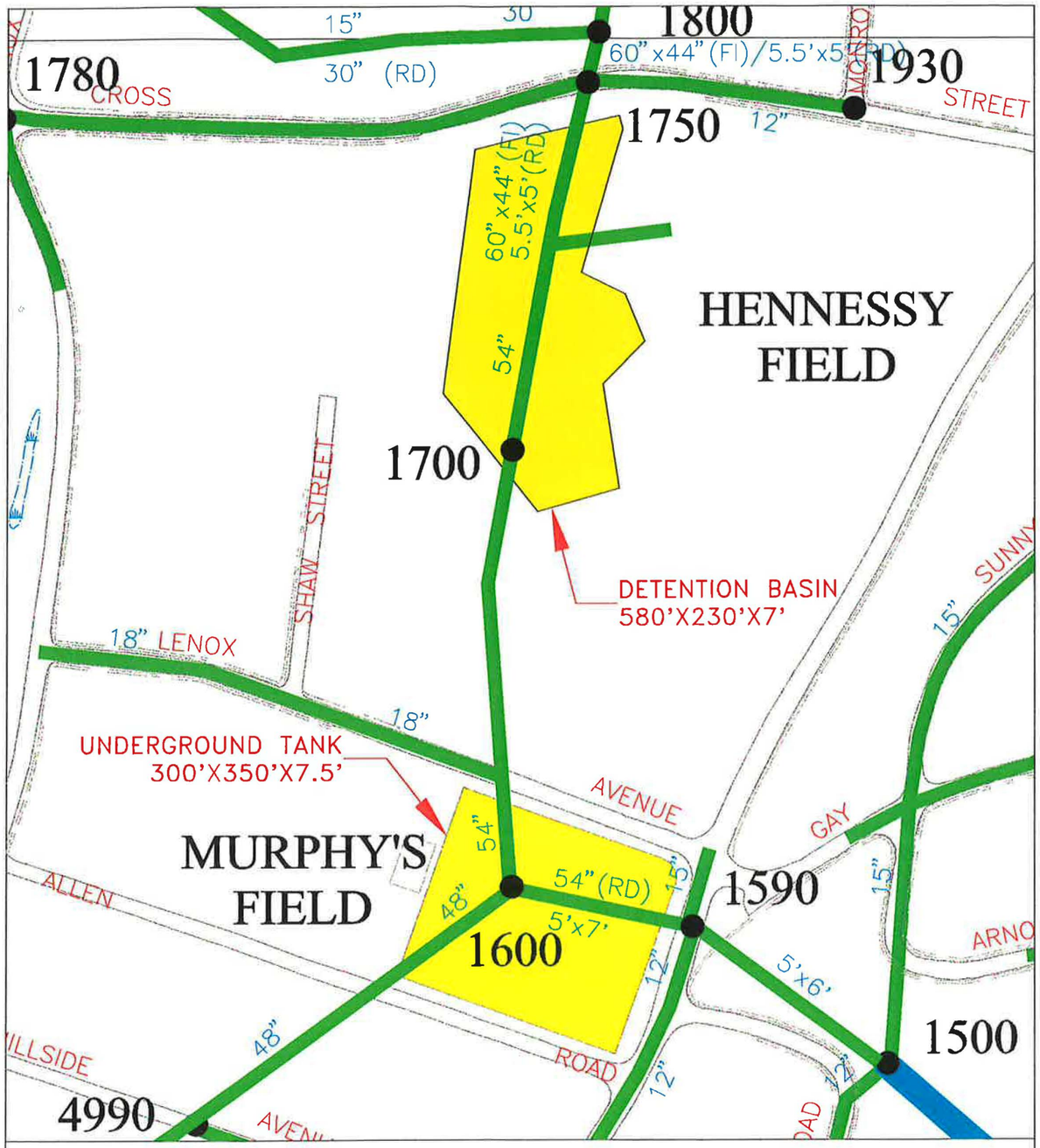
Murphy Field (See Figure 16)
Murphy Field is a municipal park/ball field bordered by Lenox Street, Lenox Avenue, Pleasant Street and Allen Road. In order to maintain the field's existing use, an underground detention tank is conceptualized at this location. In order to maintain the existing discharges to the Neponset River, 32.5 acre-feet (10,600,000 gallons) of storage volume would be required. This amount of storage would required installing a 300'x675'x7' underground storage tank.

Murphy Field cannot accommodate a tank sized to store a volume of 32.5 acre-feet. The western side of the park is considerably higher in elevation than the ball field portion of the park. Because the depth of the storage tank is restricted to 7 feet, the significant change in site elevation reduces the area where the storage tank may be placed. This makes it cost prohibitive to construct a tank of this size. These restrictions result in only enough space for a detention tank equivalent to 300'x350'x7', which would provide a storage volume of 19.7 acre-feet (642,000 gallons).

Providing this level of storage would still result in a 35% (164 cfs) increase in flow to the Neponset River. Additionally, the upstream 1000 feet of the Meadow Brook would need to be improved in conjunction with providing relief to the box culverts located downstream of the proposed tank. The added detention provided at Murphy Field would reduce the amount of relief required at the existing box culvert to a 48-inch pipe, as compared to the 5'x7' box culvert mentioned in the previous sections.

Improvement Summary:

Cost	*Proposed Improvement*
$7,650,000	• *300'(W)x350'(L)x7'(D) = 19.7 ac-ft*



TOWN OF NORWOOD
PROPOSED DRAINAGE IMPROVEMENT WORK

FIGURE 16.
PROPOSED STORAGE BASINS

Hennessey Field (See Figure 16)

Hennessey Field is located to the north of Murphy Field, bordered by Lenox Avenue, Lenox Street, Cross Street and Pleasant Street. The elevations of Pleasant Street and Cross Street are so high that the existing 54-inch drain pipe that extends through Hennessey Field is located within the "valley" of these two hills. Several hundred feet of the 54-inch storm drain will be removed between Cross Street and Lenox Avenue and a detention pond would be constructed in this "valley." This detention pond would convey stormwater discharged from the 54-inch storm drain at Cross Street to the 54-inch drain at Pleasant Street via a flow control structure that would be installed at the downstream end of the pond.

Unlike the Murphy Field storage tank, which will service both the North Feeder and the South Feeder, the Hennessey Field detention basin will only service the North Feeder due to its geographic location. This basin is intended to retain stormwater flow from the North Feeder and allow the peak flow from the South Feeder to pass through Murphy Field. When the peak flow from the South Feeder has passed, a flow control structure would discharge flow to Murphy Field at a desirable rate. (*Note: The peak flow from the South Feeder is approximately 470 cfs. The existing capacity of the 5'x7' culvert is 471 cfs and the capacity of the 5'x6' is 383 cfs.*)

Under the assumption that no additional flow is to be introduced to the Neponset River, an additional storage volume of 32 acre-feet would still be required. It is unlikely that Hennessey Field will have a storage volume of this magnitude. Even if it were able to accommodate 32 acre-feet of storage, the peak flow from the South Feeder would continue to cause flooding at the 5'x6' culvert (2.89 acre-feet for 20-minutes) and at the unimproved section of Meadow Brook (0.73 acre-feet for 50-minutes).

It is estimated that Hennessey Field can accommodate a detention basin that has a volume equal to 21 acre-feet (*See Figure 16*). With this storage volume, there will be a 25% increase in the flow rate to the Neponset River (an additional 115 cfs). Under this scenario, improvements at Meadow Brook in addition to relief for the existing box culverts, in the form of a 48-inch drain, would still be required.

Improvement Summary:

Cost	*Proposed Improvement*
$960,000	• *21 ac-ft*

Restoring Wetland to Gain Additional Storage

(*See Figure 17*)

The proposed work at Murphy Field and Hennessey Field are within the limits of the Town and are both intended to detain additional flow from discharging to Neponset River. It is clear that the desired storage volume cannot be achieved and there would be an increase in flow to the Neponset River. Via discussions with the Neponset River Watershed Association, it is our understanding that the only acceptable means of introducing any additional flow to Neponset River is by increasing the flood volume within the watershed area, i.e., by restoring wetlands.

In the Massachusetts Executive Office of Environmental Affairs, January 2000 Report: Restoring Wetlands of the Neponset River Watershed, seven sites were identified to be within the "receiving area" of the Meadow Brook drainage area. Town officials reviewed this report and determined that none of the seven sites were feasible for the Town to restore. However, the power line area behind Vanderbilt Avenue was previously a wetland. This Town owned land is located south of the Meadow Brook area and is in close proximity to the Neponset River. At the time these power lines were constructed, this area was filled with soil and gravel. These materials must be removed in order to restore this wetland to its original condition. The volume of soil and gravel removed is equivalent to the flooding volume that would be restored. By reviewing local survey data it has been determined that an estimated 17.7 acre-feet can be restored back to its wetland state, significantly less that the 32.5 acre-feet that is required.

PROPOSED AREA OF RESTORATION

VANDERBILT AVENUE

NOTES:
THE TOTAL VOLUME GAIN FOR STORAGE IS APPROXIMATELY 17.7 AC–FT. THIS VOLUME IS BASED ON THE SOIL REMOVED BETWEEN THE ELEVATIONS OF 41.0' TO 45.0'. ELEVATION BELOW 41.0' IS UNDER THE FLOOD PLAIN AND ELEVATION OVER 45.0' IS ABOVE THE FLOOD PLAN.

LEGEND

EXISTING POWERLINE

PROPOSED AREA OF RESTORATION

FAY, SPOFFORD & THORNDIKE

TOWN OF NORWOOD
PROPOSED DRAINAGE MPROVEMENT WORK

FIGURE 17.
TRANSMISSION EASEMENT
VANDERBILT AVENUE

SCALE: 1" = 200'

JUNE 2004

C:\JN-064\Project\Vanderbilt-Alt.dwg 06/14/04 17:35 [40:10] By hul_l

5.0 Cost Estimate

(See Table 5-1)

Section 5.0 presents several alternatives to relieve system deficiencies in the Meadow Brook watershed's storm drainage system. Specifically, the identified improvements are intended to relieve existing flood prone areas and to provide adequate system capacity to accommodate passage of the 10 year, Type III storm event.

The implementation of a system improvement program needs to be based on the cost of the improvements, the benefits realized from the improvements and the availability of funds from within the Town budget. To assist in the development of such a program, a cost benefit summary of the alternative system improvements are summarized in Table 5-1. System improvement priorities are presented in the following section under "Recommendations".

The costs presented in Table 5-1 represent preliminary order of magnitude costs based on average conditions using a linear foot cost basis for the pipe or channel component of each alternative. Roadway and sidewalk repairs, landscaping and surface treatment restorations, control of water during construction and a 30% contingency cost have been incorporated into these costs. However, these estimated construction costs do not include any allowance for potential utility system relocations, police details, traffic management, easement takings, and other construction related permits.

It is important to recognize that the stated costs are preliminary in nature and are intended only to form budgetary estimates for each improvement. Actual costs of construction may vary from the stated costs due to unexpected conditions encountered along the alignment of the improvement, or due to design revisions made during further development of the improvement.

Table 5-1 Cost Benefit Comparison

Location	Improvements	2004 Cost	Benefits	Outstanding Issues
Meadow Brook	- 1,000-ft of Brook improvement	$790,000	- Able to handle flow from North and South Feeder once relieved. - Consistent with downstream section.	- Increase flow rate to Neponset River. - Flooding continues at upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).
Willow Street Outfall	- 1,200-ft of 66" drain pipe - 1,700-ft of 84" drain pipe	$1,380,000	- No flow from South Feeder to Meadow Brook. - Improved hydraulic conditions at "Y".	- Relief required for Meadow Brook once North Feeder is relieved. - Potential conflicts with existing utilities. - Flooding continues at upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).
Pellana Rd	- 2,635-ft of 5'x2' replacement	$1,740,000	- Will be able to handle flow from the Pellana Rd tributary area.	- Increased flow rate to Meadow Brook.
Box Culvert at "Y"	- 620-ft of 7'x5' parallel	$580,000	- Able to handle flow from North and South Feeder once relieved.	- Increased flow rate to Meadow Brook. - Flooding continues at upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).
Alternative 1	- 2,045-ft of 8'x4' replacement - 620-ft of 7'x5' parallel relief - 1,000-ft of Brook improvement	$3,180,000	- Able to handle flow from North and South Feeder once relieved.	- Increased flow rate to Meadow Brook. - Work on private property. - Flooding continues at upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).
Alternative 2	- 165-ft of 8'x4' replacement - 1,010-ft of 6'x4' parallel relief - 1,310- ft of 48" parallel relief - 620-ft of 7'x5' parallel relief - 1,000-ft of Brook improvement	$3,070,000	- Able to handle flow from North and South Feeder once relieved.	- Pipe length 440-ft longer than Alt. 1. - Increased flow rate to Meadow Brook. - Work on private property. - Flooding continues at upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).
Alternative 3	- 910-ft of 30" relief - 1,200-ft of 6'x4' parallel relief - 1,230-ft of 48" parallel relief - 620-ft of 7'x5' parallel relief - 1,000-ft of Brook Improvement	$3,330,000	- Able to handle flow from North and South Feeder once relieved. - Flooding will be reduced by 80% at RR bridge crossing on Nahatan Street.	- Pipe length 1,300-ft longer than Alt. 1. - Increase flow rate to Meadow Brook - Work on private property - Flooding continues at upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).

Location	Improvements	2004 Cost	Benefits	Outstanding Issues
Alternative 4	- 165-ft of 8'x4' replacement - 1,380-ft of 6'x4' replacement - 1,230-ft of 48" parallel relief - 620-ft of 7'x5' parallel relief - 1,000-ft of Brook Improvement	$3,640,000	- Able to handle flow from North and South Feeder once relieved. - No work on private property.	- Pipe length 730-ft longer than Alt. 1. - Increase flow rate to Meadow Brook. - Flooding continues at the upstream locations, particularly downtown area (Nahatan Street, Vernon Street, Day Street).
Alternative 5	- 300-ft of 36" replacement - 300-ft of 42" replacement - 960-ft of 48" drain - 1,240-ft of 54" drain - 1,230-ft of 48" parallel relief - 620-ft of 7'x5' parallel relief - 1,000-ft of Brook Improvement	$4,270,000	- Able to handle flow from North and South Feeder once relieved. - No work on private property. - No additional work in downtown area. - No relief for existing twin-42" system (Node 2000 to Node1800). - No flooding at Nahatan Street, Vernon Street, Day Street.	- Pipe length 2,000-ft longer than Alt. 1 - Increase flow rate to Meadow Brook. - Relocate approx. 900-ft of 6" water main. - Potential relocation of 10" gas main. - Potential conflicts with existing sanitary sewer systems.
Underground Storage Tank at Murphy Field (*Site Restriction*)	- 300'(W)x675'(L)x7'(D) = 32.5 ac-ft	$13,110,000	- No relief at "Y". - No increased flow rate is introduced to Meadow Brook.	- Site Restriction, - Minor flooding at un-improved section of Meadow Brook.
Underground Storage Tank at Murphy Field (*See Table 5-2 for cost summary w/ each alternative*)	- 300'(W)x350'(L)x7'(D) = 19.7 ac-ft	$7,650,000	- No site restriction. - Able to handle flow from North and South Feeder once relieved.	- An increase of approximately 164-cfs to Meadow Brook during peak flow (35% additional flow). - Flooding at box culverts at "Y" - Flooding at un-improved section of Meadow Brook.
Retention Basin at Hennessey Field (*Site Restriction*)	- 32 ac-ft	$1,530,000	- No increased flow rate is introduced to Meadow Brook.	- Site Restriction, - Flooding at box culverts at "Y" - Minor flooding at un-improved section of Meadow Brook.
Retention Basin at Hennessey Field (*See Table 5-3 for cost summary w/ each alternative*)	- 21 ac-ft	$960,000	- No site restriction - Able to handle flow from the North Feeder once relieved.	- An increase of approximately 115-cfs to Meadow Brook during peak flow (25% additional flow). - Flooding at box culverts at "Y" - Flooding at un-improved section of Meadow Brook.

Table 5-2 Combined Cost Table for Underground Detention Tank (19.7 ac-ft) at Murphy Field with Each Drainage Improvement Alternative

Improvement	2004 Cost
Detention Tank w/ Alternative 1	$10,630,000
Detention Tank w/ Alternative 2	$10,520,000
Detention Tank w/ Alternative 3	$10,800,000
Detention Tank w/ Alternative 4	$11,100,000
Detention Tank w/ Alternative 5	$11,720,000

Note: *All combinations include providing a 48-inch relief at "Y".*

Table 5-3 Combined Cost Table for Detention Basin (21 ac-ft) at Hennessy Field with Each Drainage Improvemnet Alternative

Improvement	2004 Cost
Detention Basin w/ Alternative 1	$4,000,000
Detention Basin w/ Alternative 2	$3,900,000
Detention Basin w/ Alternative 3	$4,110,000
Detention Basin w/ Alternative 4	$4,410,000
Detention Basin w/ Alternative 5	$5,040,000

Note: *All combinations include providing a 48-inch relief at "Y".*

6.0 Recommendations

(Appendix C)

System deficiencies have been identified throughout the Meadow Brook drainage network. While the hydraulic analyses indicate the occurrence of flooding in multiple areas, it is important to note that these calculations were performed using the 10-year Type III design storm and that the topography of the area does not have a significant impact on the SWMM model. There are areas in which the model has predicted flooding when in actuality stormwater would simply sheet flow towards the next catch basin and enter the system via gutter flow. Compounded with the recent improvements at the Police/Fire Station and under the Shaw's/Star Market parking lot, it is recommended that the system (especially the flood prone areas) be closely monitored during high intensity storm events in the near future for two reasons: 1) to confirm the model results, and 2) to review the impacts of the recent improvements at the Police/Fire Station and the Shaw's/Star Market.

This report will continue to recommend long term improvements. Based on the findings, the following recommendations are made, in order of priority from highest to lowest (*See Appendix C*).

Priority 1 – Maximize the use of the existing facilities to the fullest extent possible through continued maintenance and repair on a regular basis.

a.) Remove deadwood and debris from the banks of the unimproved section of Meadow Brook.

b.) Keep pipelines, culverts and drainage structures (such as catch basins) clean and free from sediment.

c.) Encourage (or enforce) street sweeping of roadways as well as private parking lots to minimize sediment transfer to existing storm drain inlets.

Priority 2 - Provide relief to segments of the existing facilities identified as being the most deficient or critical to other segments of the existing downstream facilities.

a.) Conduct further investigations leading to the development, design and construction of the improvements proposed for the upstream 1,000 feet of Meadow Brook. Clearing the banks and cleaning the channel bedding will increase the capacity of the system as well as provide additional storage volume. Improvements made to this portion of the brook should be

consistent with the 1994 improvements made to the downstream section and are to be considered routine maintenance activities.

b.) Conduct further investigation along smaller reaches of the system, such as the Pellana Road and other flood prone areas, to determine the severity of flooding and what action should be taken for drainage relief.

c.) Provide a stormwater storage basin and/or a wetland restoration area prior to any relief on the North or South Feeder. If a basin is added, it will capture the additional flow from the North and/or South Feeder. If a wetland is to be restored, the area restored is equivalent to the volume gain for storage.

It is recommended that the Town of Norwood, as part of its master plan to make improvements within the Meadowbrook watershed, designate the area of Hennessey Field (see Appendix D) as the location of a future municipal stormwater detention basin, that any development within the locus shall not encroach on the recommended basin area and, if possible, include the basin construction as part of the development scope of work

d.) Provide parallel relief for the box culverts from Murphy Field to Meadow Brook once the North or South Feeder is relieved. If a detention basin were constructed, a 48-inch drain pipe would be required to provide adequate relief. If no additional storage is provided within the project area, then a 7'x5' box culvert would be required to provide adequate relief.

Priority 3 - Provide relief for the downtown area at Nahatan Street, Vernon Street, Day Street, Broadway, and Guild Street. Of the alternatives presented, the one that provides relief for the downtown area is Alternative 5, as seen in the Cost Benefit Comparison Table. Not only does this alternative relieve the downtown area, it also eliminates work in the Rock Street, Andrews Street, and Plimpton Avenue area. Work will be preformed in public ways and not private properties. With the longer pipe length, there is also the extra benefit of greater storage volume.

Note: SWMM predicted flooding at the upstream reaches of the system. The flooding in this area has been identified as non-critical and recommendations have not been

made for improvements to these facilities. For the time being, it is recommended this area be closely monitored during storm events.

Appendix B. Summary of Existing Conditions and System Capacities

Location		Pipe Size	Number of	Pipe Length	Invert Elevation		Pipe	Rough Coeff	Full Capacity	Peak Runoff for Storm Events (Cummulative) - CFS							
										2-yr (Type III)		5-yr (Type III)		10-yr (Type III)		6/13/98 Metered	
From	To	(in)	Pipes	(ft)	Upst	Dwnst	Slope	n	(cfs)	Qpeak	% of Cap	Qpeak	% of Cap	Qpeak	% of Cap	Qpeak	% of Cap
7600	7500	12	1	990	189.3	162.1	0.0275	0.015	5.12	16	312.7%	21.9	428.0%	26.8	523.8%	17.6	344.0%
7500	7400	24	1	1420	162.1	118.85	0.0305	0.015	34.20	34.8	101.7%	47.6	139.2%	58.2	170.2%	37.9	110.8%
7400	7300	24	1	470	118.85	118.3	0.0012	0.015	6.70	34.8	519.1%	47.6	710.0%	58.2	868.1%	37.9	565.3%
7300	7200	15	1	615	118.3	109.6	0.0141	0.015	6.66	55.6	835.3%	76.3	1146.3%	93.5	1404.7%	61.1	917.9%
7200	7100	30	1	410	109.6	106.2	0.0083	0.015	32.36	55.6	171.8%	76.3	235.8%	93.5	288.9%	61.1	188.8%
7100	7000	20	2	190	106.2	102.5	0.0195	0.015	33.64	84.5	251.2%	114.7	341.0%	139.4	414.4%	87.3	259.5%
7000	5200	20	2	355	102.5	100.4	0.0059	0.015	18.54	84.5	455.8%	114.7	618.7%	139.4	751.9%	87.3	470.9%
6100	5900	18	1	1540	160.3	147.7	0.0082	0.015	8.23	22.7	275.8%	30.9	375.4%	37.7	458.0%	26.2	318.3%
6000	5900	18	1	1240	195.2	147.7	0.0383	0.015	17.81	10	56.1%	14.7	82.5%	18.8	105.5%	16.2	91.0%
5900	5750	18	1	250	147.7	140.6	0.0284	0.015	15.34	63.8	416.0%	87.6	571.2%	107.4	700.3%	74.4	485.1%
5800	5750	24	1	460	148.35	140.6	0.0168	0.015	25.44	85	334.1%	116.6	458.3%	142.9	561.7%	98.3	386.4%
5750	5700	24	2	720	140.6	120.1	0.0285	0.015	66.14	85	128.5%	116.6	176.3%	142.9	216.1%	98.3	148.6%
5700	5500	36	1	370	120.1	116.4	0.0100	0.015	57.78	101.9	176.3%	139.5	241.4%	170.6	295.2%	115.3	199.5%
5500	5400	36	1	275	116.4	111.8	0.0167	0.015	74.74	124.7	166.9%	169.8	227.2%	206.9	276.8%	135.5	181.3%
5400	5300	36	1	415	111.8	108.55	0.0078	0.015	51.14	140.1	274.0%	190.1	371.8%	231.1	451.9%	149.1	291.6%
5300	5200	Open Channel		1075	108.55	100.4	0.0076	0.03	546.7	172.2	31.5%	232.5	42.5%	281.5	51.5%	174.2	31.9%
5200	5100	48	1	450	100.4	73.15	0.0606	0.015	306.24	256.7	83.8%	347.2	113.4%	420.9	137.4%	261.5	85.4%
5100	5000	3x3	1	180	73.15	70.2	0.0164	0.015	94.5	256.7	271.6%	347.2	367.4%	420.9	445.4%	261.5	276.7%
5000	4990	3x3	1	300	70.2	65.7	0.0150	0.015	90.4	288.5	319.1%	388.7	430.0%	469.8	519.7%	285.7	316.0%
4990	1600	48	1	920	65.7	51.8	0.0151	0.015	152.97	288.5	188.6%	388.7	254.1%	469.8	307.1%	285.7	186.8%
3600	3500	20	1	1055	176.3	170.1	0.0059	0.015	9.24	12	129.9%	17.5	189.4%	21.9	237.0%	12.8	138.5%
3500	3300	20	1	1490	170.1	137.6	0.0218	0.015	17.80	36.9	207.3%	51.9	291.6%	64.1	360.1%	41	230.3%
3400	3390	20	1	220	166.4	158.9	0.0341	0.015	22.25	17.9	80.4%	24.4	109.6%	29.6	133.0%	20.2	90.8%
3390	3380	15	1	220	158.9	151.3	0.0345	0.015	10.40	17.9	172.1%	24.4	234.6%	29.6	284.6%	20.2	194.2%
3380	3300	18	1	400	151.3	137.6	0.0343	0.015	16.84	17.9	106.3%	24.4	144.9%	29.6	175.7%	20.2	119.9%
3300	3290	30	1	300	137.6	135.55	0.0068	0.015	29.38	79.1	269.3%	110.0	374.5%	135.3	460.6%	89.8	305.7%
3290	3200	36 & 24	2	350	135.55	130.45	0.0146	0.015	93.5	79.1	84.6%	110.0	117.6%	135.3	144.7%	89.8	96.0%
3200	3150	36	1	175	130.45	127.9	0.0146	0.015	69.75	90.2	129.3%	124.8	178.9%	152.9	219.2%	99.4	142.5%
3150	3100	2 x 3.67	1	130	127.9	126	0.0146	0.015	66.10	90.2	136.5%	124.8	188.8%	152.9	231.3%	99.4	150.4%
3100	2900	36	1	285	126	117.9	0.0284	0.015	97.42	45.1	46.3%	62.4	64.1%	76.45	78.5%	49.7	51.0%
3100	3000	24	1	220	126	122.2	0.0173	0.015	25.76	45.1	175.1%	62.4	242.3%	76.45	296.8%	49.7	192.9%
3000	2900	24	1	140	122.2	117.9	0.0307	0.015	34.35	59.9	174.4%	82.2	239.3%	100.35	292.2%	64	186.3%
2900	2750	36	1	280	117.9	111.5	0.0229	0.015	87.36	105	120.2%	144.6	165.5%	176.8	202.4%	113.7	130.1%
2750	2700	3 x 4	1	220	111.5	110.7	0.0036	0.015	64.50	105	162.8%	144.6	224.2%	176.8	274.1%	113.7	176.3%
2800	2700	24	1	600	111.1	110.7	0.0007	0.015	5.06	32.2	636.3%	42.9	847.7%	51.3	1013.7%	27.7	547.4%
3170	2650	18	1	800	133.9	113.7	0.0253	0.015	14.46	29.1	201.2%	39.3	271.8%	47.5	328.5%	28.3	195.7%
2650	2600	24	1	300	113.7	106.7	0.0233	0.015	29.94	29.1	97.2%	39.3	131.3%	47.5	158.7%	28.3	94.5%
2700	2600	24	2	280	110.7	106.7	0.0143	0.015	46.85	150	320.2%	204.5	436.5%	248.3	530.0%	151.7	323.8%
2600	2500	36	2	415	106.7	104.4	0.0055	0.015	86.04	202.2	235.0%	274.3	318.8%	332.1	386.0%	198.2	230.4%
2700	2590	3 x 4	1	480	110.7	106.4	0.0090	0.015	102.02	202.2	198.2%	274.3	268.9%	332.1	325.5%	198.2	194.3%

Appendix B. Summary of Existing Conditions and System Capacities

Location		Pipe Size (in)	Number of Pipes	Pipe Length (ft)	Invert Elevation		Pipe Slope	Rough Coeff n	Full Capacity (cfs)	Peak Runoff for Storm Events (Cummulative) - CFS							
										2-yr (Type III)		5-yr (Type III)		10-yr (Type III)		6/13/98 Metered	
From	To				Upst	Dwnst				Qpeak	% of Cap	Qpeak	% of Cap	Qpeak	% of Cap	Qpeak	% of Cap
2590	2500	36	1	230	106.4	104.4	0.0087	0.015	53.88	202.2	375.2%	274.3	509.1%	332.1	616.3%	198.2	367.8%
2500	2200	36	2	535	104.4	92	0.0232	0.015	175.95	238.3	135.4%	321.9	183.0%	388.7	220.9%	226.6	128.8%
2400	2300	18	1	440	111.5	93.3	0.0414	0.015	18.51	19.8	107.0%	29.2	157.8%	37.2	201.0%	28.1	151.8%
2300	22000	Detention Basin			93.3	92											
22000	2200	Detention Basin			92	92											
2200	2150	4 x 8	1	115	92	91.85	0.0013	0.012	173.26	296.5	171.1%	402.6	232.4%	487.9	281.6%	289.2	166.9%
2150	2120	4 x 8	1	100	91.85	91.7	0.0015	0.012	186.10	296.5	159.3%	402.6	216.3%	487.9	262.2%	289.2	155.4%
2120	2100	4 x 8	1	190	91.7	90.3	0.0074	0.012	413.37	296.5	71.7%	402.6	97.4%	487.9	118.0%	289.2	70.0%
2100	2050	4 x 8	1	110	90.3	90.3	0.0050	0.012	339.79	296.5	87.3%	402.6	118.5%	487.9	143.6%	289.2	85.1%
2050	2000	4 x 8	1	145	90.3	88.65	0.0114	0.015	411.14	296.5	72.1%	402.6	97.9%	487.9	118.7%	289.2	70.3%
2000	1850	42	2	370	88.65	85.95	0.0073	0.015	148.92	314	210.9%	425.7	285.9%	515.4	346.1%	303.4	203.7%
1850	1800	42	2	365	85.95	82.05	0.0107	0.015	180.20	314	174.3%	425.7	236.2%	515.4	286.0%	303.4	168.4%
1900	1820	18	1	385	99.1	95.95	0.0082	0.015	8.23	31.7	385.1%	41.8	507.8%	49.6	602.5%	24.9	302.5%
1820	1800	30	1	880	95.95	82.05	0.0158	0.015	44.66	31.7	71.0%	41.8	93.6%	49.6	111.1%	24.9	55.8%
1800	1750	3.67 x 5	1	80	82.05	81.2	0.0106	0.015	194.88	411.1	211.0%	554.6	284.6%	669.4	343.5%	385.8	198.0%
1750	1700	54	1	560	81.2	67.8	0.0239	0.015	263.54	411.1	156.0%	554.6	210.4%	669.4	254.0%	385.8	146.4%
1700	1600	54	1	670	67.8	51.8	0.0239	0.015	263.28	411.1	156.1%	554.6	210.7%	669.4	254.3%	385.8	146.5%
1600	1590	5 x 7	1	270	51.8	48.8	0.0111	0.015	471.05	730.9	155.2%	991.8	210.6%	1201.9	255.2%	714.6	151.7%
1590	1500	5 x 6	1	350	48.8	45	0.0109	0.015	382.59	730.9	191.0%	991.8	259.2%	1201.9	314.1%	714.6	186.8%
1550	1500	15	1	1630	93.66	45	0.0299	0.015	9.67	27.3	282.3%	37.1	383.7%	45.1	466.4%	28.2	291.6%
1500	1400	Open Channel		330	45	45	0.0001	0.03	171.7	791.8	461.2%	1,075.3	626.3%	1304.1	759.5%	785.1	457.3%
1400	1200	Open Channel		520	45	44.9	0.0002	0.03	133.1	800.2	601.2%	1,087.5	817.1%	1319.5	991.4%	794.9	597.2%
1250	1200	15	1	2635	54.5	44.9	0.0036	0.015	3.38	38.5	1139.7%	55.0	1628.2%	68.6	2030.8%	42.7	1264.1%
1200	1100	Open Channel		125	44.9	44.29	0.0049	0.03	571.4	876.9	153.5%	1,193.3	208.8%	1448.9	253.6%	873.5	152.9%
1300	1100	24	1	840	57.35	44.29	0.0155	0.015	24.44	12.3	50.3%	17.2	70.4%	21.3	87.2%	15.8	64.7%
1100	600	Open Channel		835	44.29	41.7	0.0031	0.02	2080	897.1	43.1%	1,221.6	58.7%	1483.9	71.3%	898.8	43.2%
1000	800	30	1	970	63.9	58.1	0.0060	0.015	27.48	31.3	113.9%	41.5	151.0%	49.6	180.5%	27.7	100.8%
900	800	30	1	435	69.7	58.1	0.0267	0.015	58.03	9.55	16.5%	12.7	21.9%	15.2	26.2%	8.4	14.5%
900	700	21	1	580	69.7	60.2	0.0164	0.015	17.57	9.55	54.4%	12.7	72.3%	15.2	86.5%	8.4	47.8%
800	600	36	1	1170	58.1	41.7	0.0140	0.015	68.41	49.95	73.0%	66.2	96.8%	79.1	115.6%	43.7	63.9%
700	600	24	1	985	60.2	41.7	0.0188	0.015	26.86	22.75	84.7%	30.2	112.4%	36.1	134.4%	19.8	73.7%
600	300	Open Channel		820	41.7	40.5	0.0015	0.015	1438.4	986.6	68.6%	1,340.6	93.2%	1626.3	113.1%	980.1	68.1%
450	400	12	1	510	64.8	55.75	0.0177	0.015	4.11	17.3	420.7%	24.2	588.6%	30	729.6%	20.3	493.7%
400	350	12	1	210	55.75	52	0.0179	0.015	4.12	39.6	960.1%	56.2	1362.5%	70.1	1699.5%	49.3	1195.2%
350	300	24	1	940	52	40.5	0.0122	0.015	21.68	48.8	225.1%	69.2	319.2%	86.1	397.2%	57.3	264.3%
300	200	Open Channel		170	40.5	39.6	0.0053	0.02	1959.8	1066.6	54.4%	1,451.2	74.0%	1761.8	89.9%	1063.4	54.3%
200	100	8 x 12	1	450	39.6	39	0.0013	0.015	616.33	1072.8	174.1%	1,459.4	236.8%	1771.7	287.5%	1068.7	173.4%

PRIORITY 3
DOWNTOWN AREA

PRIORITY 2C
STORAGE BASIN AND/OR
WETLAND RESTORATION

PRIORITY 2B
PELLANA ROAD /
OTHER FLOOD PRONE AREAS

PRIORITY 2D
BOX CULVERT

PRIORITY 2A
MEADOW BROOK

PRIORITY 1
MAXIMIZE EXISTING FACILITIES THROUGH
MAINTENANCE AND REPAIR ON A REGULAR BASIS

LEGEND

EXISTING STORM DRAIN
EXISTING OPEN CHANNEL
PROPOSED SWMM NODES
PROJECT LIMIT (DRAINAGE BOUNDARY)
FI = FIELD INVESTIGATION
RD = RECORD DRAWINGS
EXISTING STORM DRAIN
(NOT FOUND DURING FIELD INVESTIGATION)

FAY, SPOFFORD & THORNDIKE

APPENDIX C.
TOWN OF NORWOOD

DRAINAGE MAP FOR MEADOW BROOK DRAINAGE STUDY
RECOMMENDATION FOR IMPROVEMENTS

SCALE: 1" = 300'

JUNE 2004

C:\JN-064\Project\App C - Recomm_Imprvmnts.dwg 08/02/04 17:50 [89.33] By hul_

CROSS STREET

1930

12"

60" x44" (FI)
5.5'x5'(RD)

54"

PROPERTY LINE

DETENTION BASIN
580'X230'X7'

1700

HENNESSY
FIELD

SHAW STREET

PLEASANT STREET

LENOX AVENUE

18"

LEGEND

EXISTING STORM DRAIN

PROPOSED SWMM NODES

FI = FIELD INVESTIGATION
RD = RECORD DRAWINGS

APPENDIX D.
TOWN OF NORWOOD

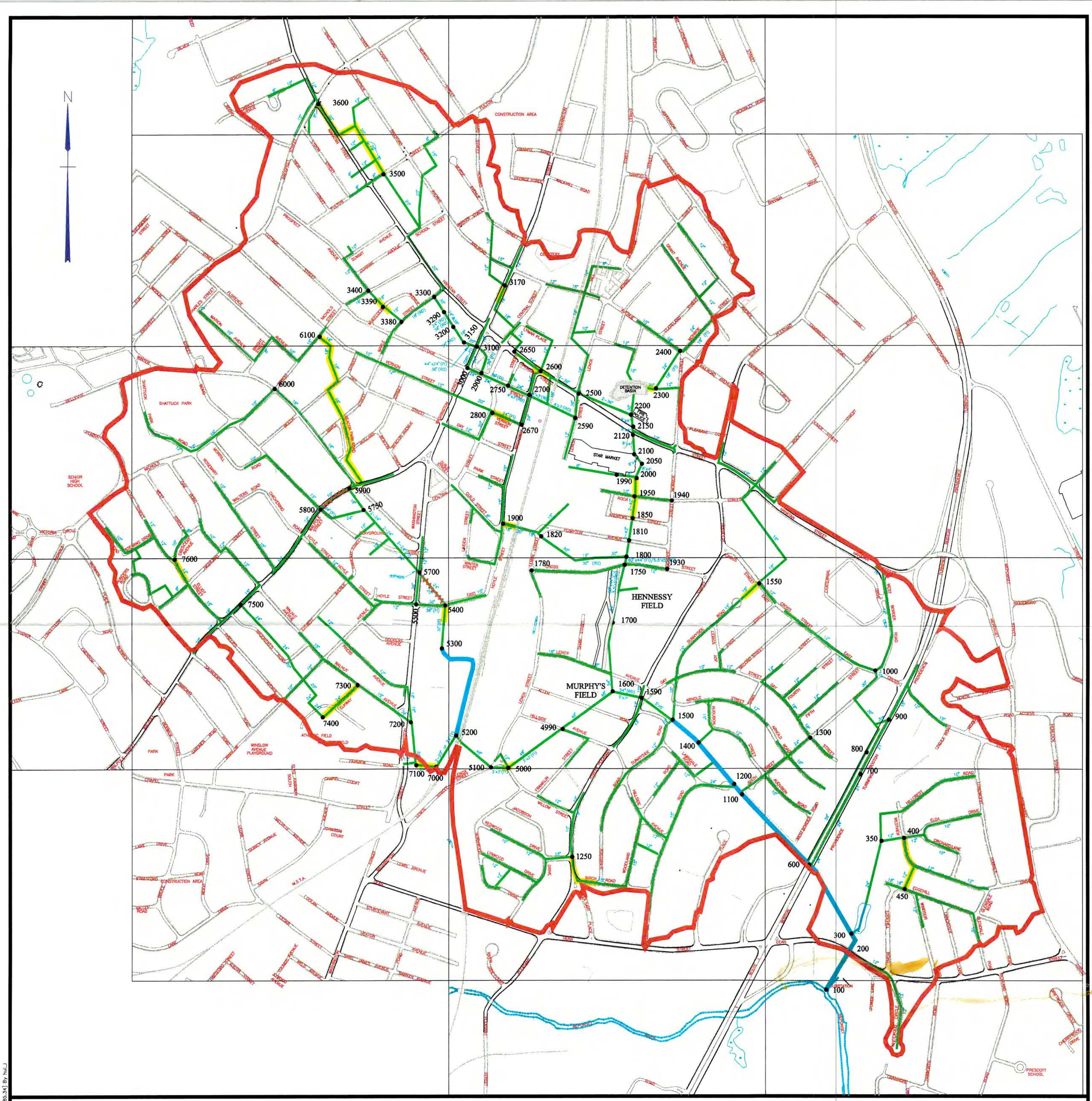
DETENTION BAISN AT HENNESSEY FIELD

SCALE: 1" = 30'

JUNE 2004

FAY, SPOFFORD & THORNDIKE

C:\JN-064\Project\Drainage.dwg 06/22/04 11:02 [77.91] By hui_l



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

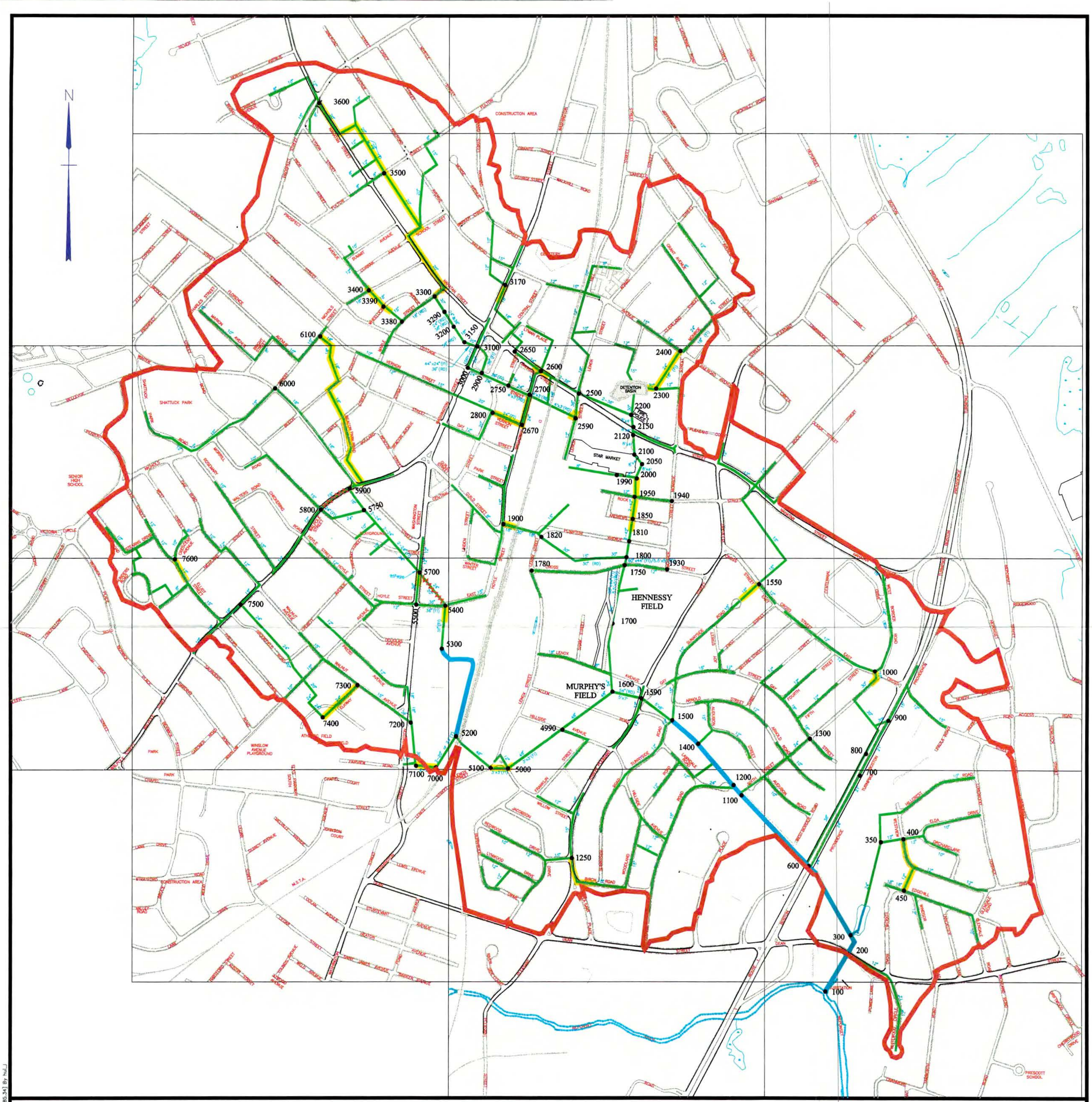
TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 3.
SWMM ANALYSIS - 2 YEAR TYPE III STORM
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\JN-064\Project\Flooding.dwg 09/27/04 16:57 [85.34] By hui_j



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

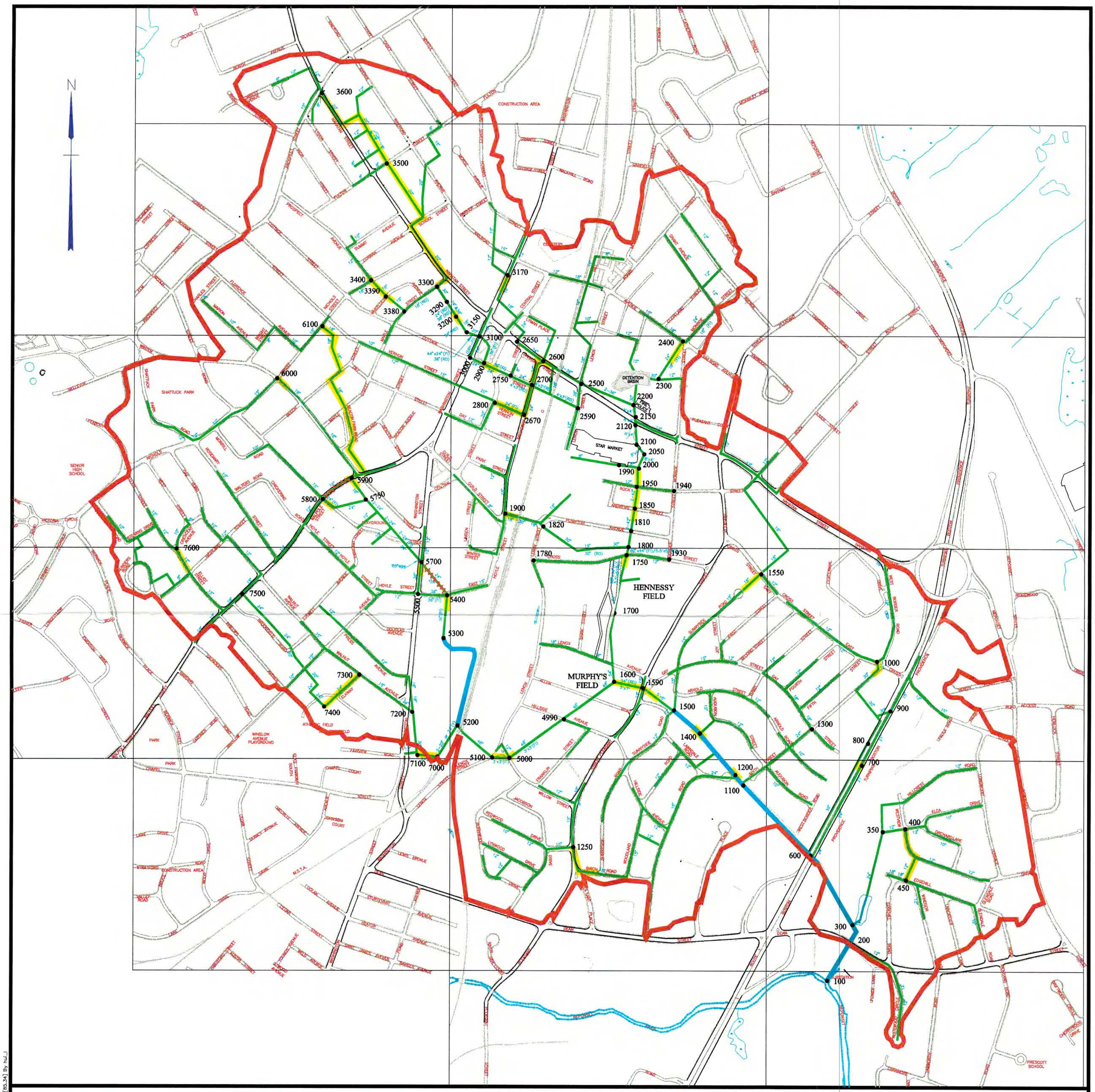
TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 4.
SWMM ANALYSIS - 5 YEAR TYPE III STORM
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\JN-064\Project\Flooding.dwg 09/27/04 16:57 [85,34] By: hui_j



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

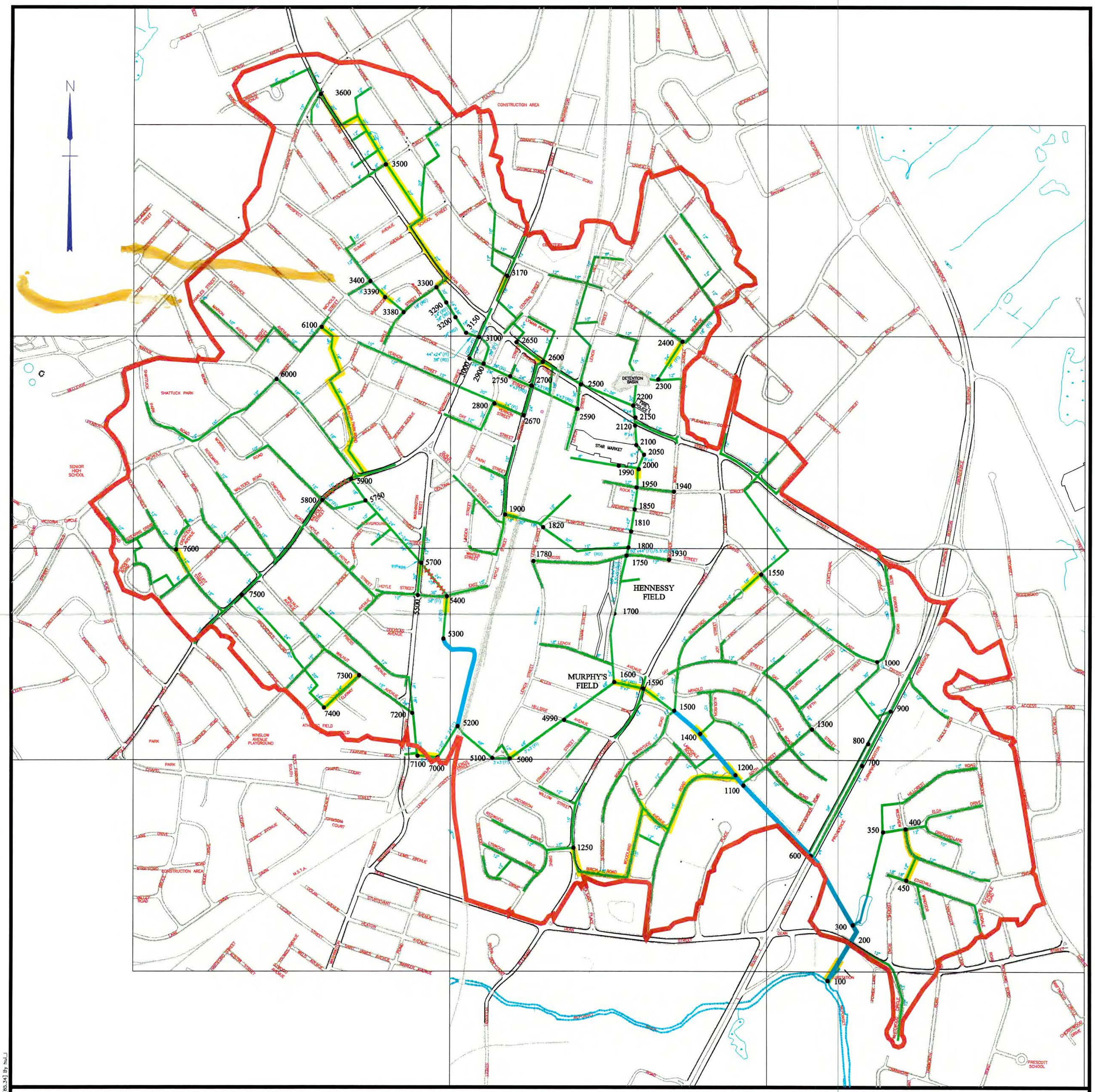
TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 5.
SWMM ANALYSIS - 10 YEAR TYPE III STORM
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\AN-064\Project\Flooding.dwg 09/27/04 16:57 [85.34] By hul_l



LEGEND

- EXISTING STORM DRAIN
- EXISTING OPEN CHANNEL
- PROPOSED SWMM NODES
- PROJECT LIMIT (DRAINAGE BOUNDARY)
- FI = FIELD INVESTIGATION
- RD = RECORD DRAWINGS
- INDICATE SURFACE FLOODING

FAY, SPOFFORD & THORNDIKE

TOWN OF NORWOOD
MEADOW BROOK DRAINAGE MAP

FIGURE 6.
SWMM ANALYSIS - JUNE 1998 STORM EVENT
LIMITS OF FLOODING

SCALE: 1" = 600'

JUNE 2004

C:\JN--064\Project\Flooding.dwg 09/27/04 16:57 [85.34] By hul_l