EXECUTIVE SUMMARY

WATERSHED EVALUATION OF STONY BROOK

May 29, 2009

MMI #1581-04-1

Prepared for:

Town of Darien
2 Renshaw Road
Darien, Connecticut 06820

Prepared by:

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INTRODUCTION

The Town of Darien selected Milone & MacBroom, Inc. (MMI) in September 2008 to evaluate flooding conditions along several watercourses within the community. The 4.1 square mile Stony Brook watershed was selected as the first watershed for study because resident complaints of flooding have been most vehement there. (Figure ES-1 depicts this watershed.) This report presents the work completed by MMI in the evaluation of Stony Brook and recommendations for mitigation where possible.

Land use in the watershed varies but is approximately 75% residential. The southern end of the watershed (south of Interstate 95) becomes more heavily developed. Report Section 2 provides a detailed description of the watershed.

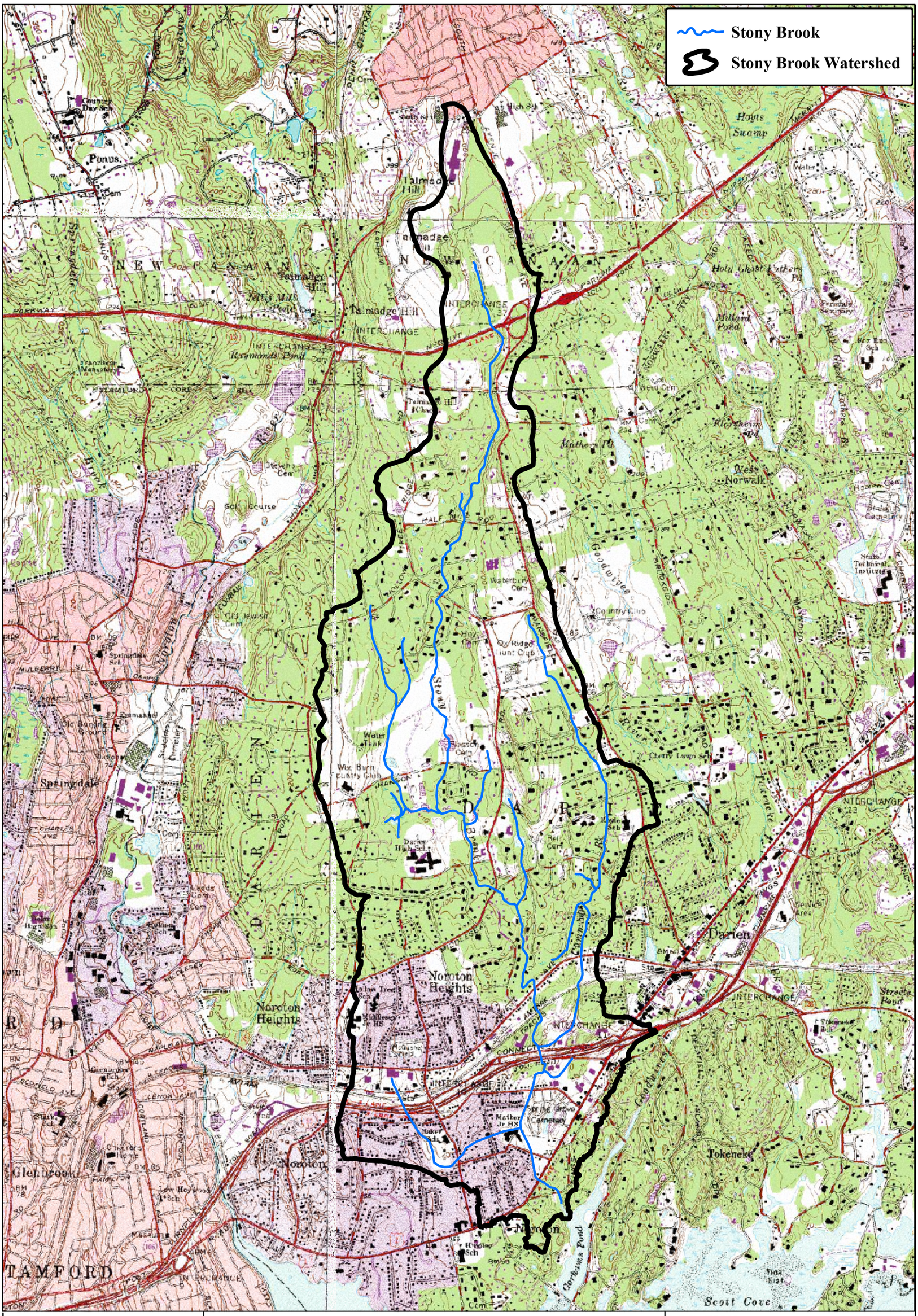
SUMMARY OF FLOODING CONCERNS

The following areas were reported by the town staff and residents as having flooding problems:

- ✓ Route 1
- ✓ Renshaw Road
- ✓ Hecker Avenue
- ✓ Middlesex Avenue/Holly Lane
- ✓ Hanson Road

While the watershed extends north of Hanson Road into New Canaan, extensive flooding has not been reported upstream of Hanson Road, likely due to the larger lot sizes observed in the upper watershed.

MMI staff walked the entire length of the channel from Gorham's Pond to Waveny Park. A detailed assessment of the channel was completed, and the flood prone areas were observed.



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STONY BROOK WATERSHED DRAINAGE EVALUATION

LOCATION: Darien & New Canaan, CT

MMI#: 1581-04
MXD: H:\Watershed_Fig 2-1.mxd
SOURCE: Town of Darien

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WATERSHED MAP

Map By: GJC
Date: December 2008
Scale: 1"= 2,000'

SHEET: Figure ES-1

WATERSHED HYDROLOGY

A model of the watershed was developed for the purposes of estimating peak flood flows during various flood events. The results of this model were compared to available data from the United States Geological Survey and the Federal Emergency Management Agency (FEMA). Table ES-1 summarizes the hydrologic analysis for existing conditions within the watershed using two different rainfall values.

TABLE ES-1
Predicted Peak Flows From HMS Modeling

Watershed Location	Darien High School Access Road	West Avenue	Renshaw Road	Confluence with Gorham's Pond
Watershed Area (sq. mi.)	1.8	2.5	3.8	4.1
Storm Frequency / Rainfall Source				
50%				
TP-40 (cfs)	310	570	679	669
UConn (cfs)	367	639	784	764
10%				
TP-40 (cfs)	713	1,243	1,462	1,450
UConn (cfs)	769	1,335	1,571	1,558
2%				
TP-40 (cfs)	1,115	1,930	2,248	2,238
UConn (cfs)	1,440	2,550	2,938	2,930
1%				
TP-40 (cfs)	1,350	2,380	2,741	2,737
UConn (cfs)	1,833	3,307	3,824	3,832

While we believe that the UConn data reflects more current rainfall data, the hydraulic analysis in the following sections is based on the flow rates generated with the TP-40 rainfall. Use of the UConn data would result in all improvements being oversized. For example, a 30-foot wide bridge might be sufficient to pass a 1% storm based on the TP-40 data, but at the same location a 40-foot wide structure might be needed to pass the 1% storm based on the UConn flows. While some overdesign is prudent and acceptable, the financial implications for the town are potentially significant.

WATERSHED HYDRAULICS

MMI developed a hydraulic model of the Stony Brook channel to evaluate existing flood conditions. This model was then used to evaluate the effectiveness of potential improvements. The model was developed using the HEC-RAS software program. In establishing a floodplain for Stony Brook, FEMA developed a model of this channel. MMI started with that model. MMI field surveyed some 80 additional cross sections in an effort to add structures that FEMA had missed and/or verify bridge dimensions presented by FEMA. The topography of the floodplain was also updated based on the one-foot topographic mapping the town recently procured from Sewall of Old Town, Maine. Results of this model were compared to the data presented by FEMA in the town's Flood Insurance Study.

POTENTIAL FLOOD MITIGATION

Using the hydrology and hydraulic models, MMI evaluated potential mitigation opportunities. Hydrologic mitigation would decrease the downstream flows, which reduces the impact of undersized structures. Hydraulic mitigation evaluates modifications to the channel and the structures that exist along the channel in an effort to reduce flood heights.

Hydrologic mitigation that was evaluated included the use of 305 and 309 Middlesex Avenue for flood storage, and flood storage on Cummings Brook north of I-95. Neither alternative proved effective at reducing downstream flows.

Some 30 alternatives and combinations of alternatives were evaluated for hydraulic improvements. Table ES-2 summarizes the alternatives that were evaluated, and a description of each alternative is presented in Section 5 of the report. The channel was subdivided into three reaches for the purposes of this evaluation. Such subdivision is not always possible, but in the case of Stony Brook these areas are hydraulically isolated from each other, meaning that improvements in one location will not affect change in the other reaches. The most effective combination of alternatives in each reach is as follows:

Lower Reach: Gorham's Pond to Interstate 95

A total of 23 alternatives was evaluated for this channel reach. In discussing mitigation here, it is important to note two natural features that constrict flow. The first is the bedrock valley wall downstream of Old Kings Highway, and the second is a bedrock outcrop in the channel between Old Kings Highway and Route 1. Even if all modeled improvements are executed, some flooding will remain because of these.

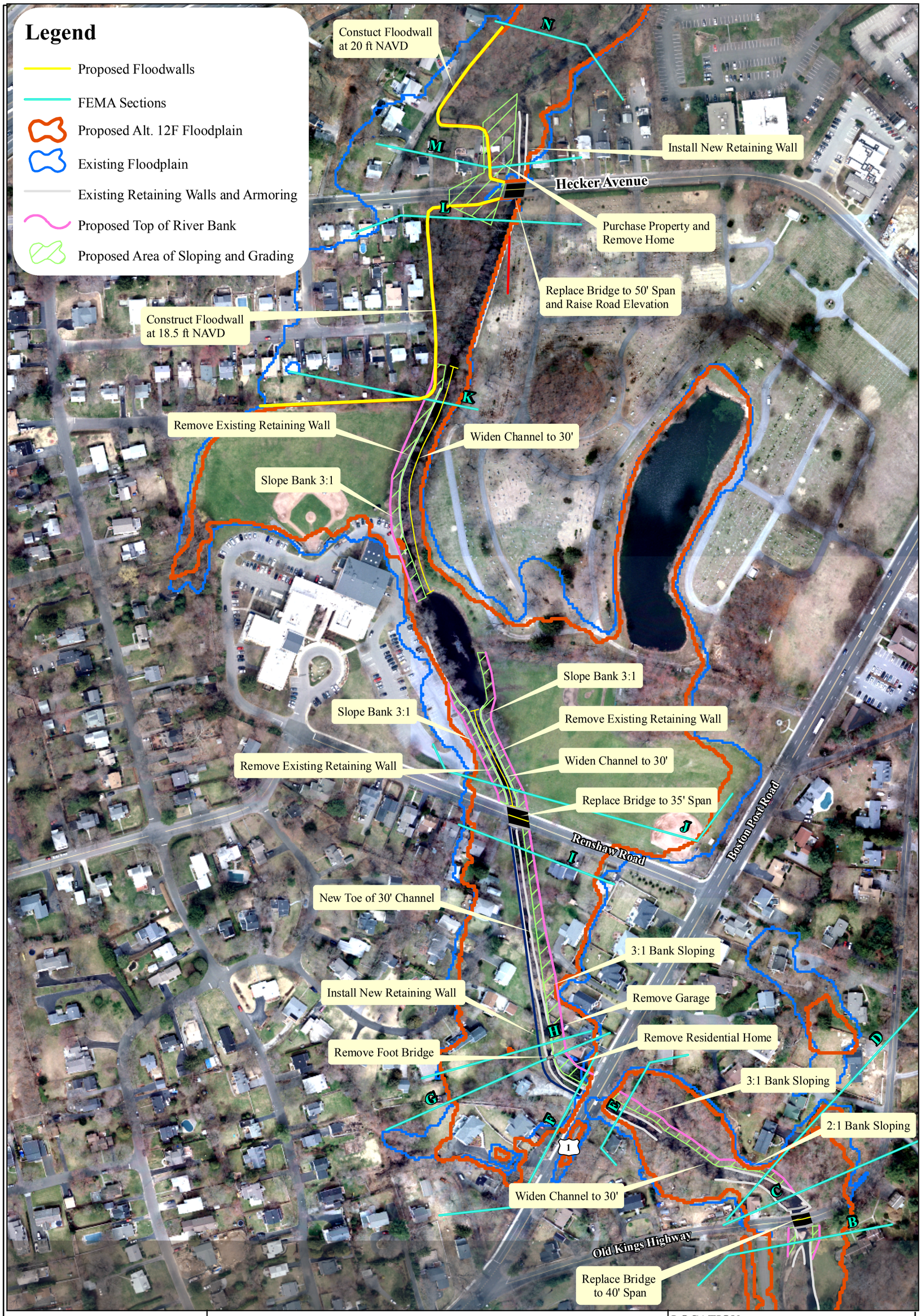
The final combination of alternatives modeled for this reach includes:

- Replacement of Old Kings Highway bridge
- Channel widening from Old Kings Highway to Route 1
- Removal of the private footbridge
- Removal of the left (when facing downstream) concrete wall between Renshaw Road and Route 1 to widen the channel
- Replacement of the Renshaw Road bridge
- Remove the left wall upstream of Renshaw Road
- Replace Hecker Avenue bridge
- Installation of a floodwall from Town Hall Park to upstream of Hecker Avenue

Table ES-3 presents these results, and Figure ES-2 depicts these graphically. It must be noted that the replacement of the Hecker Avenue bridge requires the removal of a home on the upstream right side (looking downstream) of the bridge.

TABLE ES-2
Summary of Alternatives for Hydraulic Improvements

Alternative No.	Location	Description
1	Channel Gorham's Pond to Old King's Highway	Widen channel at natural bedrock constriction
2	Channel Gorham's Pond to Old King's Highway	Remove island from channel
3A	Old King's Highway	Replace Old King's Highway Bridge
3B	Old King's Highway	3A + Removal of Sediments Downstream of Bridge
4A	Channel from Old King's Highway to Boston Post Road	Remove Bedrock Vane and Widen Channel from Old King's Highway to Route 1
4B	Channel from Old King's Highway to Boston Post Road	4A + Removal of Sediments Upstream of Rock Vane
5	Channel from Old King's Highway to Boston Post Road	Widen Channel between Old King's Highway and Boston Post Road (no removal of bedrock or bed lowering)
6A	Boston Post Road	Widen Channel Adjacent to Boston Post Road Bridge
6B	Boston Post Road	3B+5+6A
7	Channel from Boston Post Rd to Renshaw Rd	Removed pedestrian bridge
8A	Channel from Boston Post Rd to Renshaw Rd	Construct Concrete Channel
8B	Channel from Boston Post Rd to Renshaw Rd	Construct Compound Channel
8C	Channel from Boston Post Rd to Renshaw Rd	6B+7+8B
9A	Renshaw Road	Replace Renshaw Road Bridge
9B	Renshaw Road	9A+8C
10	Channel through Town Hall Park	9B + Remove retaining walls and widen channel
11	Channel between Town Hall Park and Hecker Avenue	Create Floodbench on Right
12A	Hecker Avenue	Install Levee Upstream to Protect Hecker Avenue
12B	Hecker Avenue	12A + Replace Hecker Avenue Bridge
12C	Hecker Avenue	12B + Widen Upstream Approach Channel
12D	Hecker Avenue	12C + 10
12E	Hecker Avenue	12D + Remove Home and Replace Hecker Avenue Bridge
12F	Hecker Avenue	12E + Floodwall between Town Hall Park and Hecker Avenue
reserved numbers 13 and 14 for future lower section alternatives		
15	Railroad Bridge	Add additional culvert
16A	Channel Between Railroad and West Avenue	15 + Widen channel
16B	Channel Between Railroad and West Avenue	16A + Bed lowering
17 A	West Avenue	Replace West Avenue Bridge
17 B	West Avenue	15 + 17A
17C	West Avenue	16A + 17A
18A	Channel Upstream of West Avenue	17B + Widen Channel
18B	Channel Upstream of West Avenue	18A + 17C
reserved numbers 19 thru 25 for future middle section alternatives		
25	Channel from West Avenue to Middlesex Road	Restore Rip-Rap section between West Avenue and Dams
26A	Channel from West Avenue to Middlesex Road	Remove private dams # 1, 2, 3
26B	Channel from West Avenue to Middlesex Road	25+26
27	Private Driveway Bridge	Replace Private Driveway Bridge
28A	Channel downstream of Middlesex Road	Remove accumulated sediment from upstream of Dam #5
28B	Channel downstream of Middlesex Road	Remove Dam # 5 and upstream sediment
28C	Channel downstream of Middlesex Road	28B + 26A +27 + remove sediment upstream of dams and bridge
29A	Middlesex Road	Remove accumulated sediment from upstream
29B	Middlesex Road	29A + 28C
29C	Middlesex Road	29B + Widen Channel Upstream
29D	Middlesex Road	29C + Replaced Middlesex Bridge
30	Hanson Road	Remove Dam #9 and sediments upstream of dam



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STONY BROOK WATERSHED DRAINAGE EVALUATION

LOCATION: Darien, CT

MMI#: 1581-04
MXD: H:\ES-2.mxd
SOURCE: CT DEP

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ALTERNATIVE 12F

Map By: EPB
Date: MAY 2009
Scale: 1"=150'

SHEET: Figure ES-2

TABLE ES-3
Results of Lower Reach Analysis

FEMA Cross Section	Existing Conditions Station	Water Surface Elevation (feet NAVD)		
		Existing Conditions	Proposed Conditions	Difference
A	0	6.4	6.4	0.0
B	632	9.5	9.6	0.1
Old Kings Highway				
C	710	12.0	10.6	-1.5
D	849	11.7	10.2	-1.5
E	1156	14.9	13.1	-1.8
Boston Post Road				
F	1290	14.7	15.5	0.7
Footbridge				
G	1408	17.1	15.9	-1.2
H	1432	17.1	15.9	-1.2
I	1887	17.2	15.9	-1.3
Renshaw Road				
J	2060	17.7	16.4	-1.4
K	3008	18.2	17.2	-1.0
L	3482	18.2	17.5	-0.7
Hecker Avenue				
M	3588	19.8	18.3	-1.5
N	3952	21.1	19.1	-2.0
O	4229	21.3	19.9	-1.3
I-95				
P	4688	39.1	39.1	0.0

Based on the information presented in Table ES-3, the combined improvements provide slightly more than a one foot reduction in water surface elevations during a 1% chance storm event.

Middle Reach: Railroad Bridge to West Avenue

The middle reach is hydraulically isolated from the lower reach by the bedrock cascade upstream of Ledge Road. Because of this abrupt change in channel elevation, improvements made below Ledge Road cannot reduce water surface elevations upstream.

Eight alternatives were evaluated here, starting with replacement of the railroad bridge. Additional alternatives evaluated built upon improvements at the railroad because, without the additional capacity, water surface elevations at West Avenue cannot be decreased. The combination of improvements determined to be most effective for this reach include:

- Provide additional culvert at railroad crossing
- Widen channel from railroad crossing to West Avenue, removing some existing retaining walls
- Replace the West Avenue bridge
- Widen channel upstream of the West Avenue bridge

Figure ES-3 depicts these improvements schematically, and Table ES-4 presents the results. This combination of alternatives provides an estimated 3.5 foot drop in water elevations upstream of West Avenue during a flood event.

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STONY BROOK WATERSHED DRAINAGE EVALUATION

LOCATION: Darien, CT

MMI#: 1581-04
MXD: H:\Fig 5-14_alt18B.mxd
SOURCE: CT DEP

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ALTERNATIVE 18B

Map By: EPB
Date: MAY 2009
Scale: 1"=150'

SHEET: ES-3

TABLE ES-4
Results of Middle Reach Analysis

FEMA Cross Section	Existing Conditions Station	Water Surface Elevation (feet NAVD)		
		Existing Conditions	Proposed Conditions	Difference
T	5586	65.0	65.0	0.0
Railroad				
U	5733	77.3	73.1	-4.2
V	6177	77.2	73.1	-4.2
West Avenue				
W	6349	77.5	74.0	-3.5
X	7015	77.6	74.4	-3.1
Y	7650	77.6	76.1	-1.5
Dam #1				
Z	8122	83.7	83.7	0.0

Upper Section: West Avenue to Hanson Road

Upstream of West Avenue, most flooding complaints center on the Holly Lane and Hanson Road neighborhoods. Flood mitigation in this area is complicated by the low-lying homes adjacent to the channel and the complex channel system. The series of alternatives focused on methods of lowering water surface elevations in these areas although no alternative was identified that can effectively reduce flood elevations at Hanson Road.

Flooding complaints at Middlesex Road focus on the bridge being undersized. Our analysis revealed that this is not the case, but rather flooding in this area is the result of backwater effects from the downstream dams and bridge. Between West Avenue and Middlesex Road, four dams and one private driveway crossing were identified. The channel has also been constricted in one area. The constrictions and structures serve to raise water surface elevations upstream to Middlesex Road. The final combination of alternatives evaluated here includes the following:

- Removal of Dams 1, 2, 3, and 5
- Replace the private driveway bridge with an adequately sized structure
- Excavate sediments from Dam 2 to just upstream of the Middlesex Road bridge
- Widen channel upstream of the Middlesex Road bridge

It is important to note that replacement of the Middlesex Road bridge does not appreciably change the water surface elevation when compared to implementation of these improvements without replacing the bridge. The replacement of this bridge is therefore not recommended. Table ES-5 summarizes the results of this alternative, and Figure ES-4 presents them schematically.

This reach presents an interesting challenge for the town of Darien in that reducing flooding of private properties upstream of Middlesex Road required improvements on other private properties downstream. Therefore, alleviating flooding in this reach requires that the town make improvements on private property in order to benefit other private property owners. In this case, the town's infrastructure is not the source of flooding. Taxpayers will need to decide if this is appropriate.

TABLE ES-5

Results of Upper Reach Analysis

FEMA Cross Section	Existing Conditions Station	Water Surface Elevation (feet NAVD)		
		Existing Conditions	Proposed Conditions	Difference
Y	7650	77.6	76.1	-1.5
Dam #1				
Z	8122	83.7	83.4	-0.3
Dam #2				
AA	8292	86.4	85.7	-0.7
Dam #3				
AB	8613	90.4	87.8	-2.6
AC	8613	90.4	87.8	-2.6
Driveway Bridge				
AD	8754	92.5	89.5	-2.9
AE	9605	94.2	93.7	-0.5
Middlesex Road				
AF	9719	95.9	95.5	-0.3
AG	10145	97.9	96.1	-1.8
AH	10603	98.5	98.5	0.0
High School Lane				

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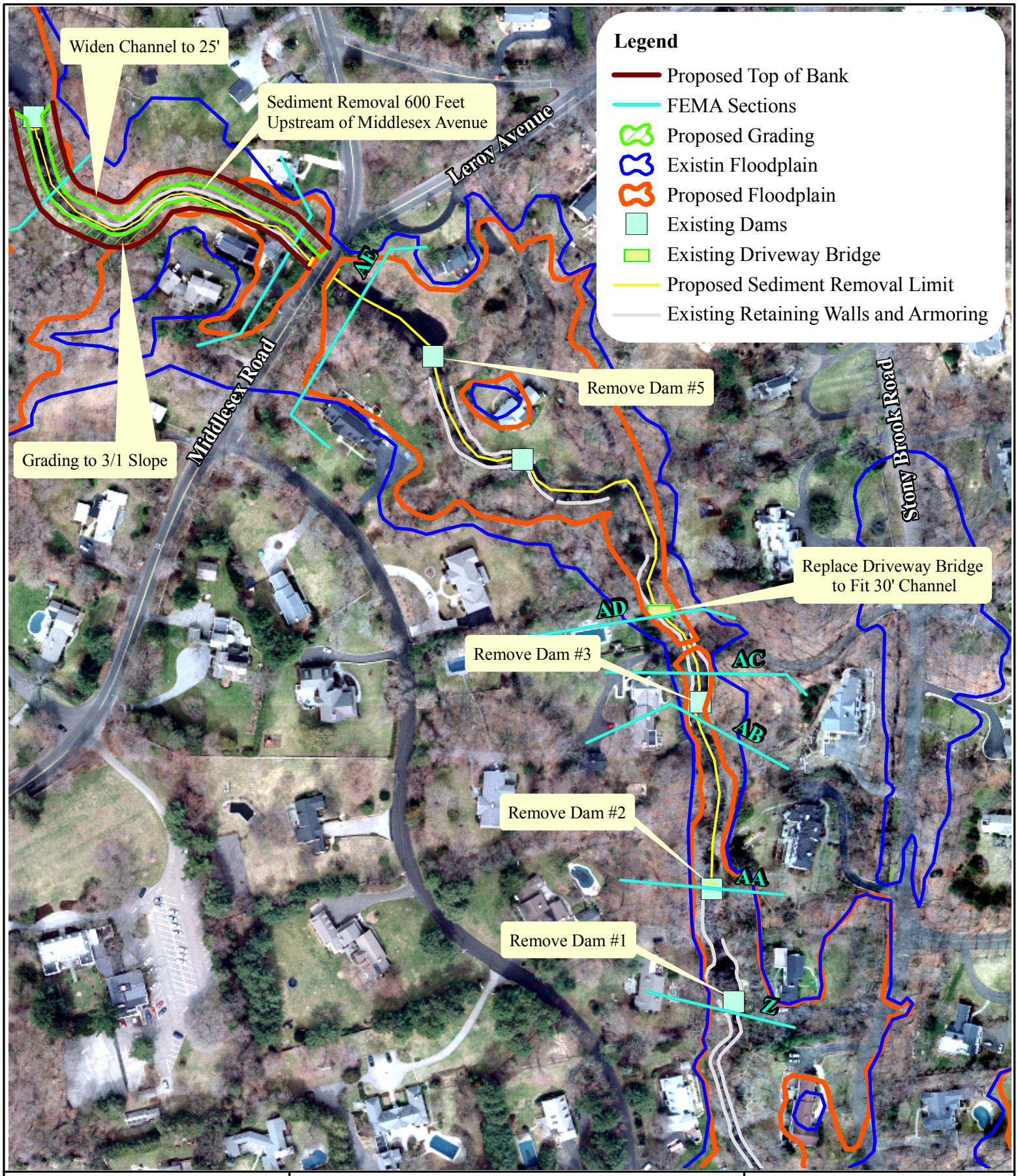

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STONY BROOK WATERSHED DRAINAGE EVALUATION

LOCATION: Darien, CT

MMI#: 1581-04
MXD: H:\Fig 5-16_alt29B.mxd
SOURCE: CT DEP

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ALTERNATIVE 29C

Map By: EPB
Date: MAY 2009
Scale: 1"=200'

SHEET: ES-4