

Township of River Vale



Hackensack River Flood Reduction Study Update

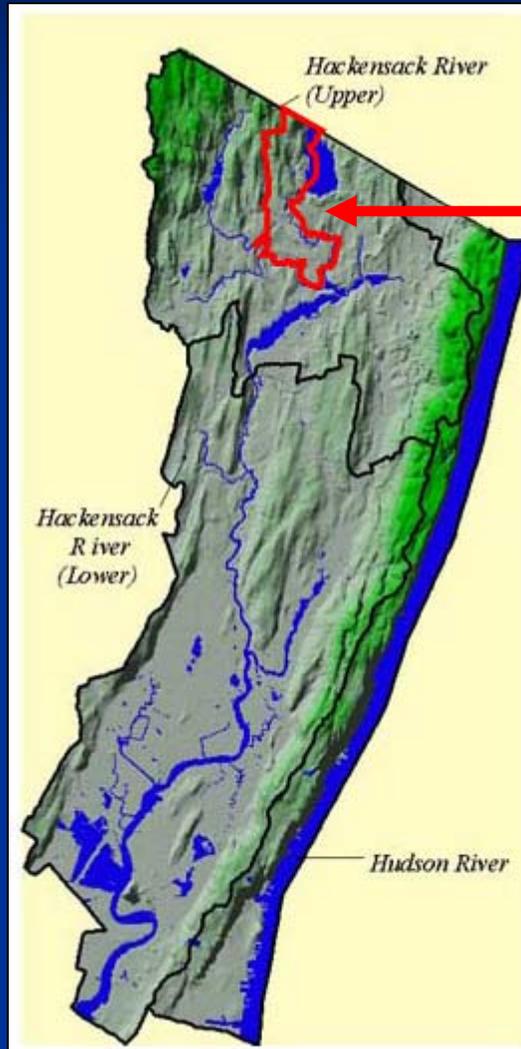
November 11, 2013

Purpose of Study



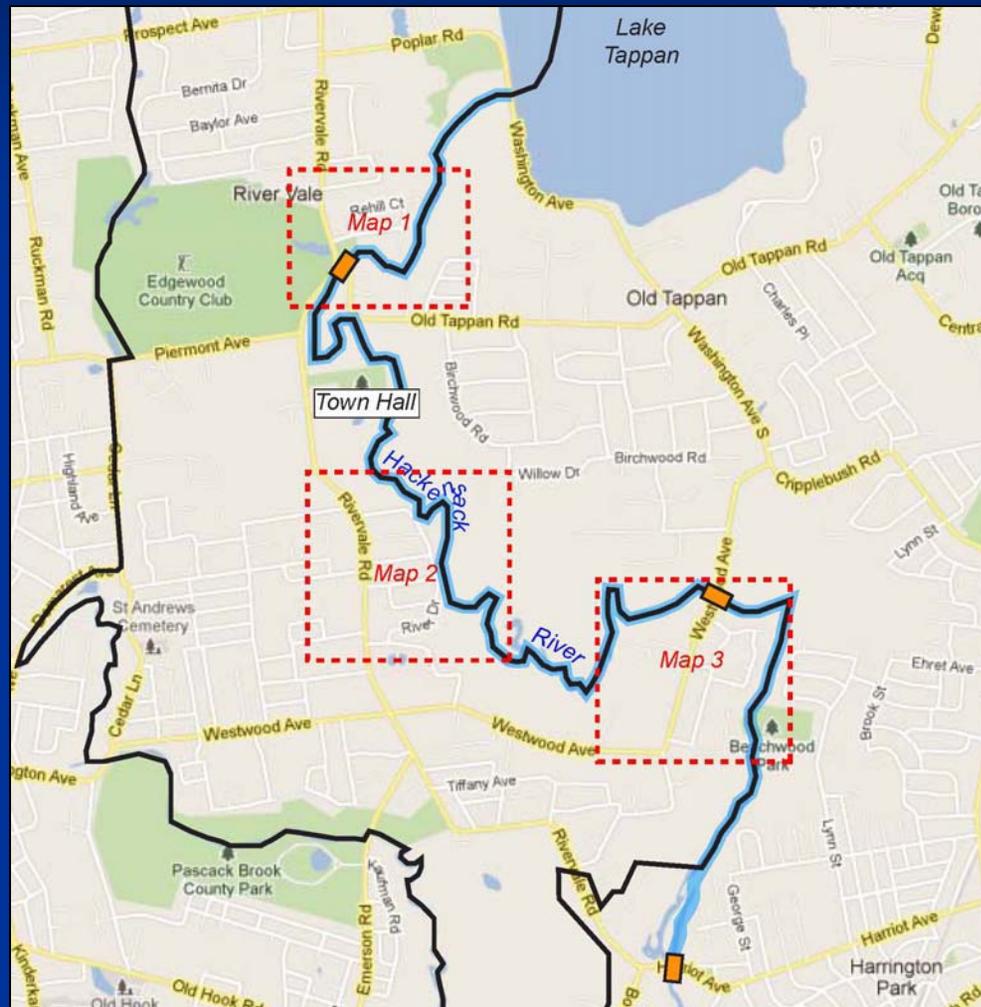
To Analyze Where Frequent Flooding Is Impacting Property and How It Might Be Reduced

Hackensack River Basin

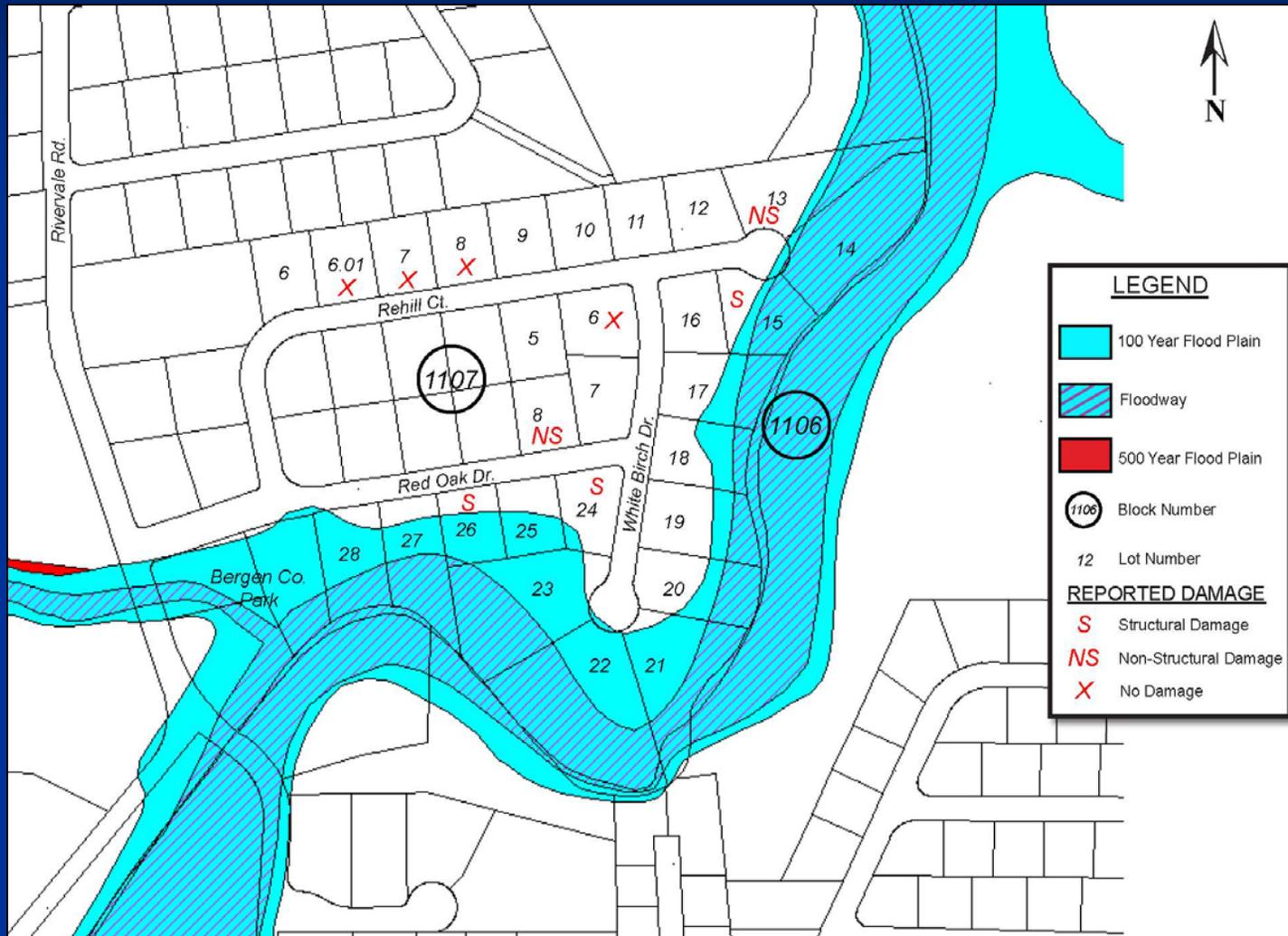


**Township of
River Vale**

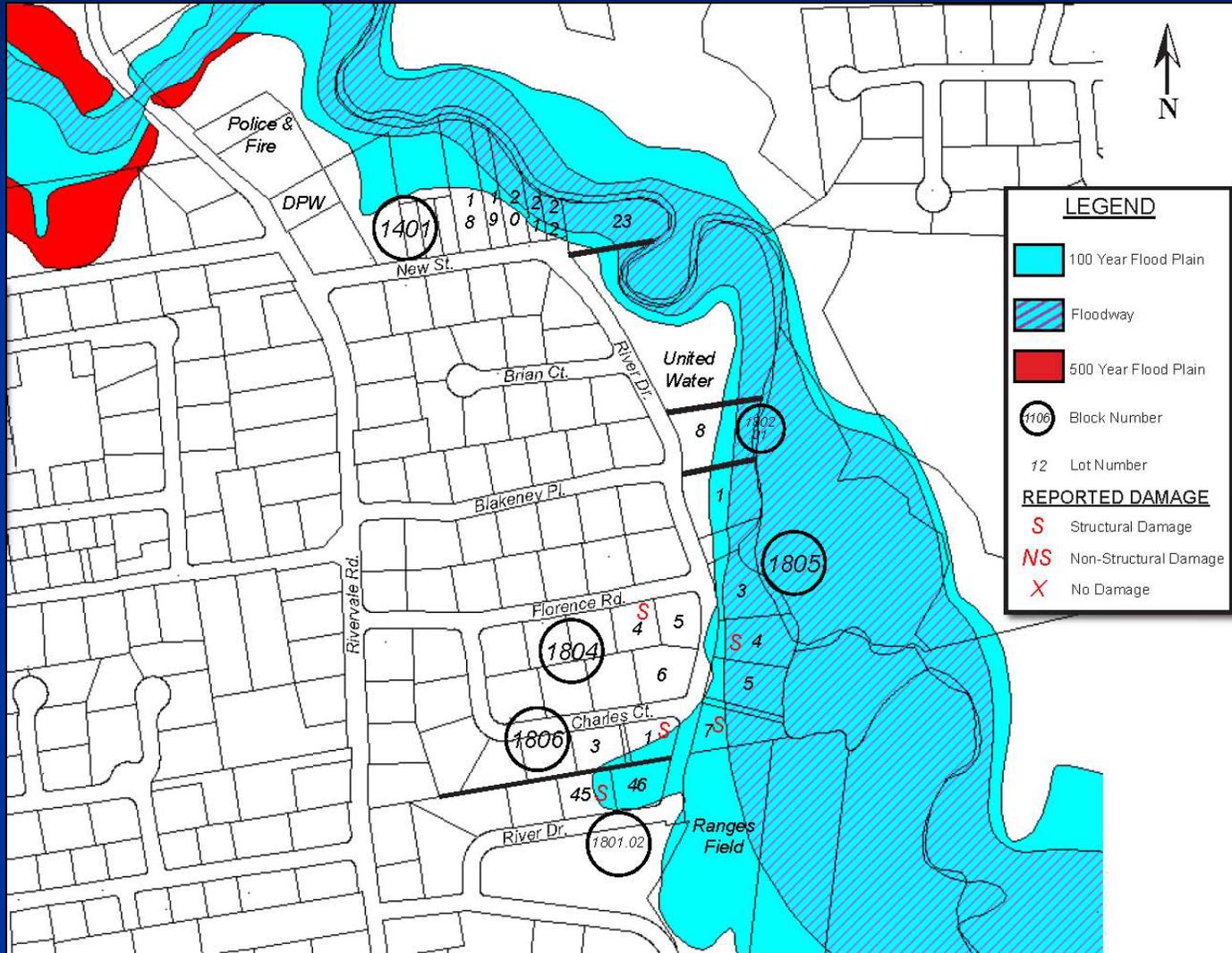
Flood Problem Areas



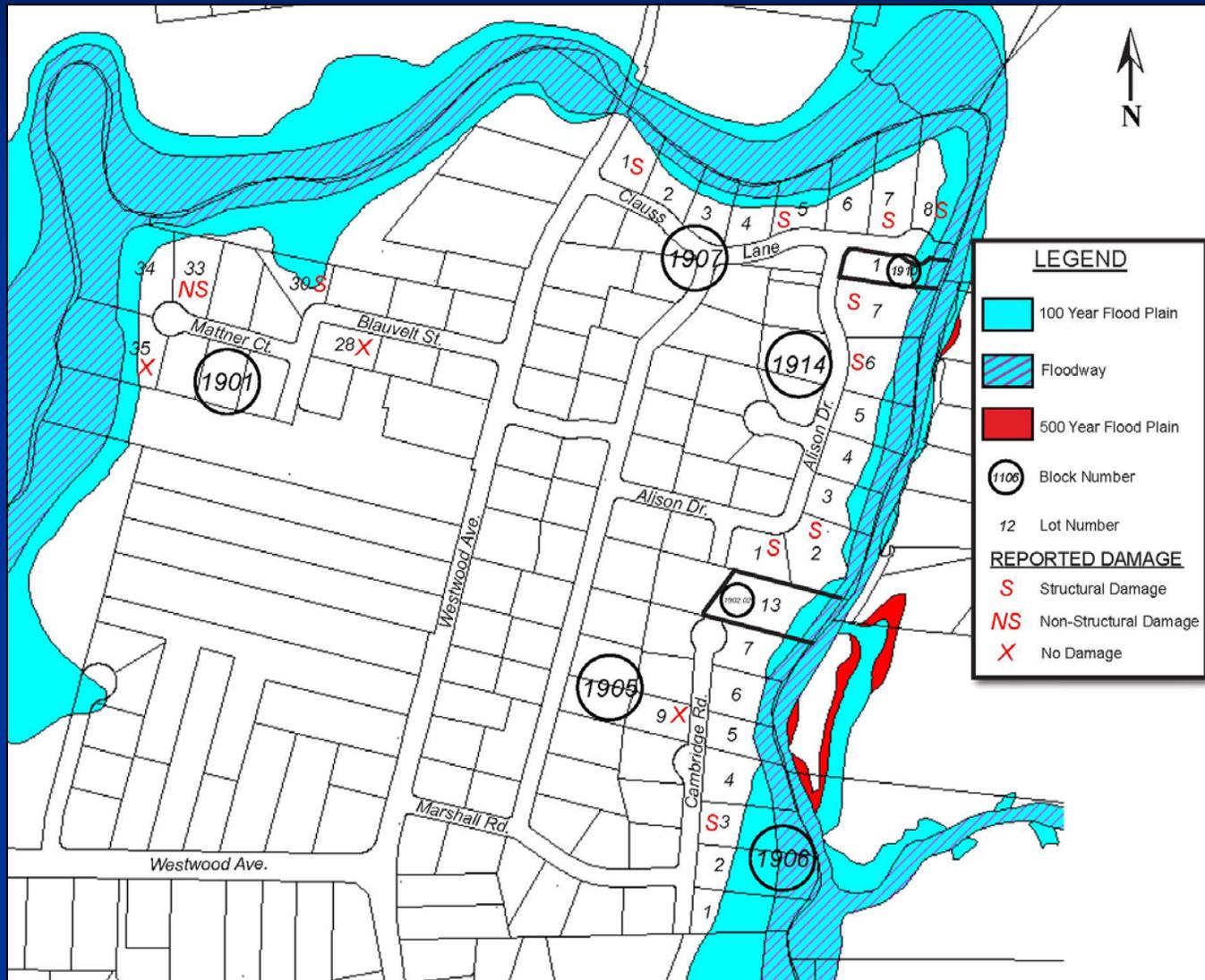
Flood Area 1



Flood Area 2



Flood Area 3



Flood Reduction Study Tasks

- Obtain Available Hackensack River Data
- Interview Officials Regarding Past Flood Events
- Identify 'Flood Threshold' Locations and Frequencies
- Compare and Verify Available Data with Past Events
- Identify and Evaluate Hydraulic Effectiveness of Alternative Flood Reduction Plans and Combinations
- Recommend Effective Plans for Further Consideration and Analysis

Important

- **Study Analyzes Hydraulic Effectiveness of Alternative Flood Reduction Plans**
- **Other Important Plan Aspects Must Also be Addressed, Including:**
 - **Cost, Benefits, and Cost-to-Benefit Ratio**
 - **Upstream and Downstream Impacts**
 - **Environmental Impacts**
 - **Property Acquisition**
 - **Local and State Permits**

Available Data

- **Current NJDEP Delineation of Hackensack River Flood Plains Adopted in 1978**
- **NJDEP Currently Developing New Flood Plain Delineation Using New Discharges, Field Surveys, and Topographic Mapping**
- **Flood Reduction Study Based upon New NJDEP Delineation Data and Computer Models**
- **NJDEP Expects to Release New Delineation Results by January 2014**

Flood Frequency and Probability

Flood 'Frequency' Typically Expressed in Years

$$\text{Annual Flood Probability (\%)} = \frac{100}{\text{Flood Frequency (Years)}}$$

100-Year Flood Annual Probability = $100 / 100 = 1\%$

25-Year Flood Annual Probability = $100 / 25 = 4\%$

10-Year Flood Annual Probability = $100 / 10 = 10\%$

2-Year Flood Annual Probability = $100 / 2 = 50\%$

Updated Flood Threshold Estimates

Flood Area No.	Existing Threshold Rate	Existing Threshold Frequency	Existing Threshold Probability
1	2,500 CFS _±	12 Years _±	8%
2	2,000 CFS _±	7 Years _±	14%
3	1,400 CFS _±	3 Years _±	33%

What Can Be Done?

- **Reduce Water Levels by Increasing Waterway Size and Conveyance. Includes Channels, Bridges, Culverts, and Dams**
- **Reduce Water Levels by Reducing Waterway Flow by Storing 'Excess' Flow**
- **Construct Barriers Between Existing Water Levels and Structures, Roads, and People**
- **Move Structures, Road, and People Away Above Existing Water Levels**

Flood Plans Analyzed

Structural Measures

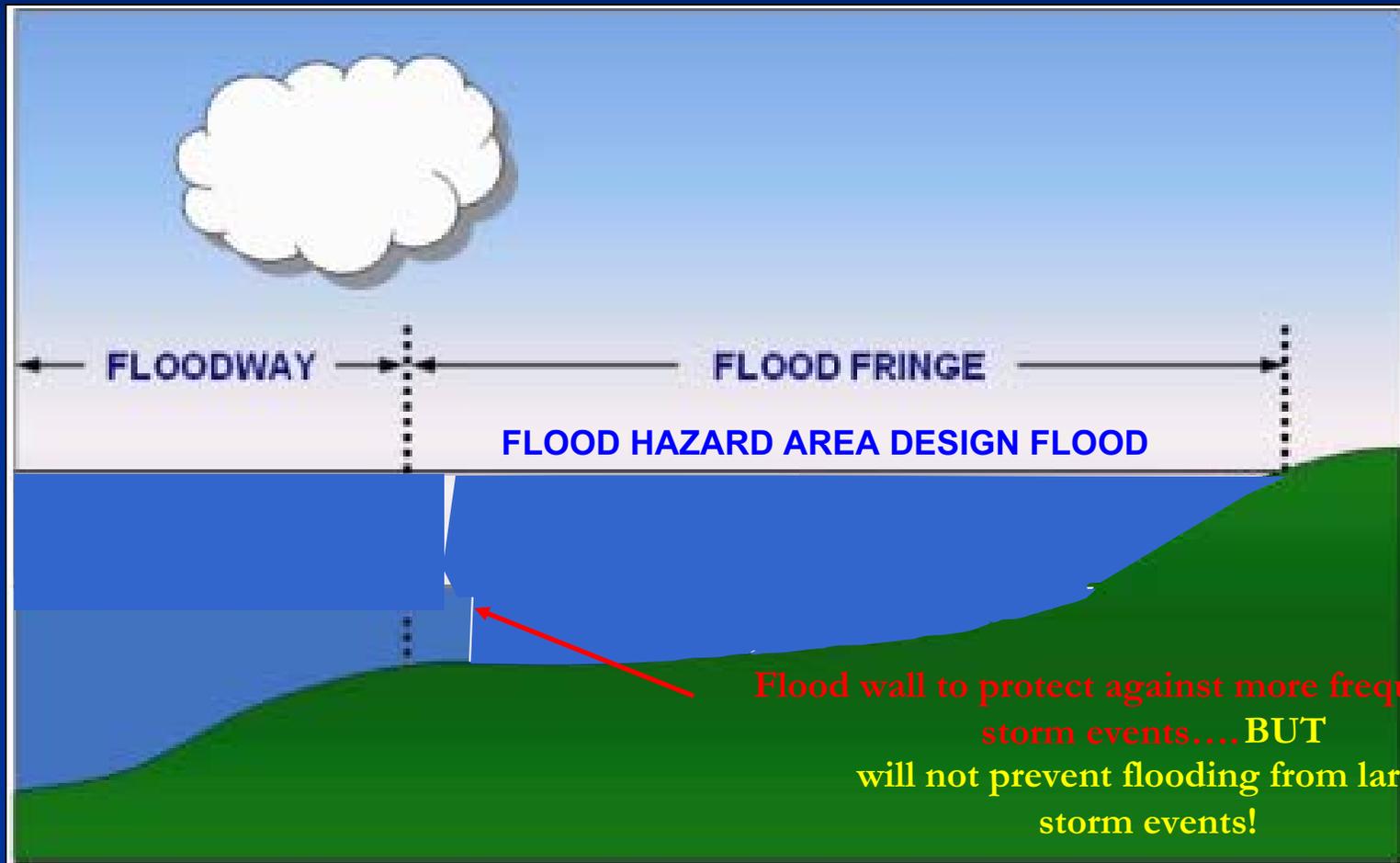
- Construct Flood Walls Along River
- Construct River Bypasses
- Controlled Release from Lake Tappan and/or Oradell Reservoir
- Create Additional Storage Along River
- Increase Bridge Size and Flow Capacity
- Increase River Channel Size and Capacity

Flood Plans Analyzed

Nonstructural Measures

- Flood-Proof Structures
- Purchase Flood-Prone Properties
- Develop Flood Warning System

Flood Walls



Potential Flood Wall Locations



Construct Flood Walls

- **Can be Hydraulically Effective**
- **Must Determine Required Wall Heights**
- **Locate Tie-In Locations and Wall Lengths**
- **Must Provide Interior Drainage**
- **Must Determine Effects of Lost Storage on Downstream Flows and Water Levels**

Construct Bypass #1

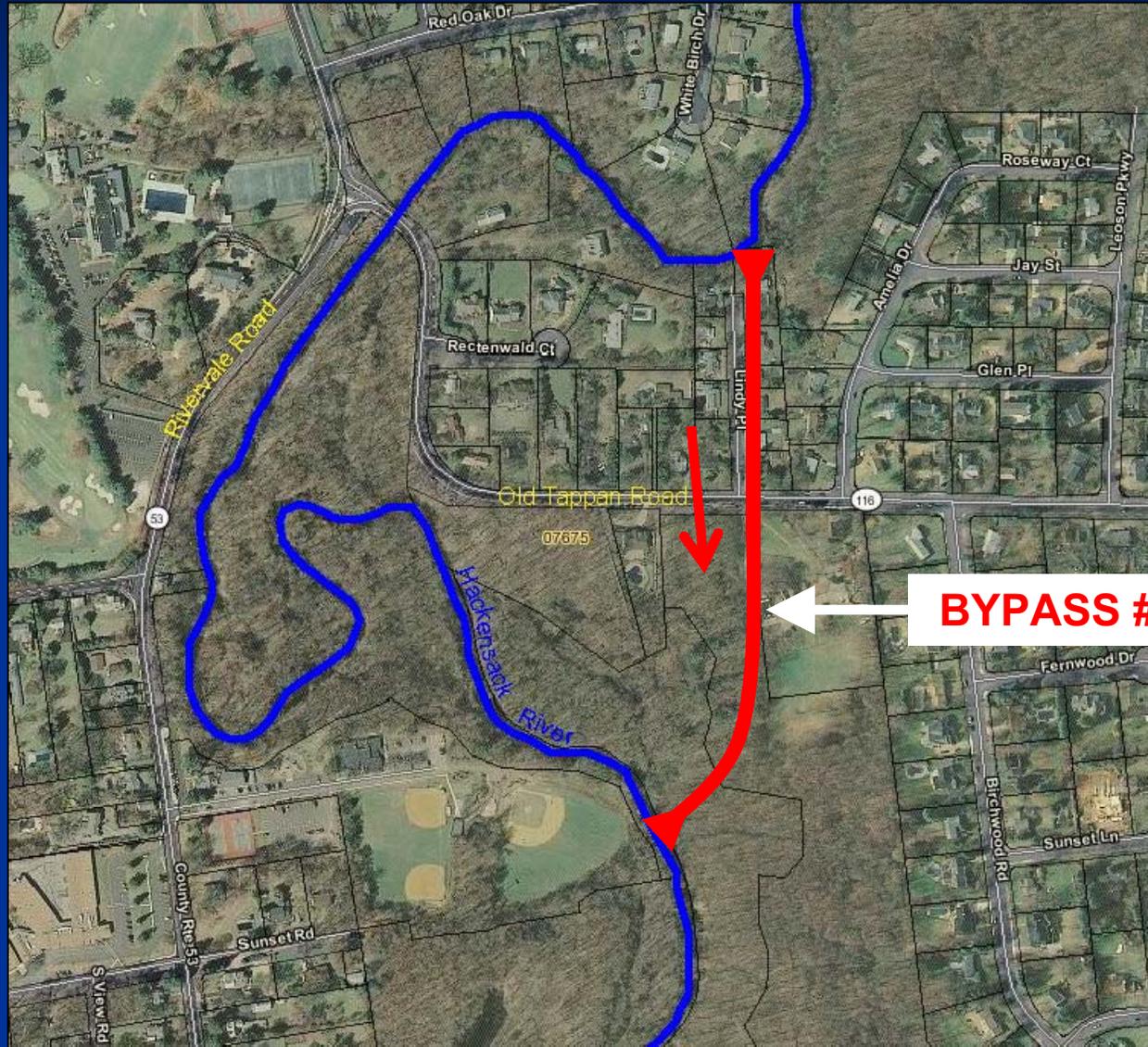
Flood Area	Existing Flood Threshold	Future Flood Threshold*
3	3 Years (33%)	6 Years (17%)
2	7 Years (14%)	15 Years (7%)
1	12 Years (8%)	12 Years (7%)

***Results Based Upon 7-Foot High X 15-Foot Wide Bypass Culvert**

Construct Bypass #1

- **Only Benefits Flood Areas 2 and 3**
- **Existing Flood Risk Reduced in Half:**
 - **Area 2: 14% Risk Reduced to 7%**
(7-Year Threshold Increased to 15-Year)
 - **Area 3: 33% Risk Reduced to 17%**
(3-Year Threshold Increased to 6-Year)
- **Improved Condition Risks/Thresholds Low Relative to Costs**

Potential River Bypass #2



Construct Bypass #2

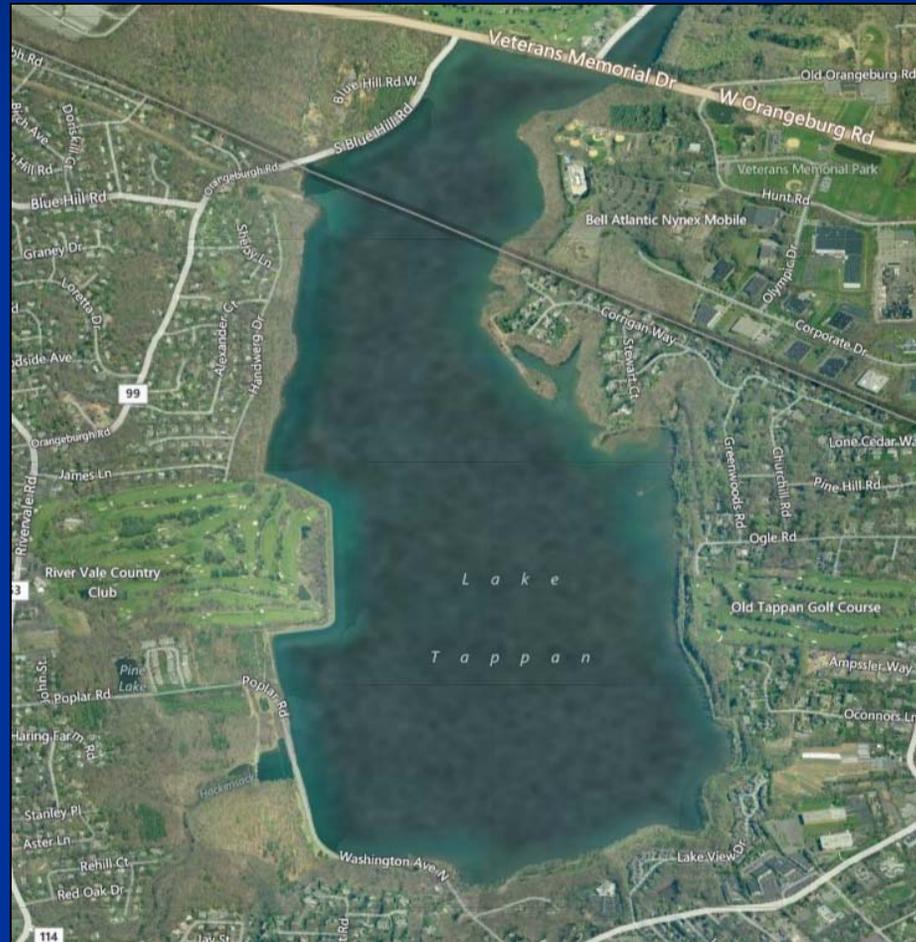
Flood Area	Existing Flood Threshold	Future Flood Threshold*
3	N/A (Downstream)	N/A (Downstream)
2	N/A (Downstream)	N/A (Downstream)
1	12 Years (8%)	18 Years (6%)

***Results Based Upon 7-Foot High X 15-Foot Wide Bypass Culvert**

Construct Bypass #2

- **Only Benefit Flood Area 1**
- **Minimal Reduction in Existing Flood Risk:**
 - **Existing 8% Risk Reduced to 6%**
(12-Year Threshold Increased to 18-Year)
- **Improved Condition Risks/Thresholds Low Relative to Costs**

Controlled Release from Lake Tappan



Updated Flood Threshold Estimates

Flood Area No.	Existing Threshold Rate	Existing Threshold Frequency	Existing Threshold Probability
1	2,500 CFS _±	12 Years _±	8%
2	2,000 CFS _±	7 Years _±	14%
3	1,400 CFS _±	3 Years _±	33%

Lower Pre-Flood Lake Tappan

Improved Flood Threshold	Flood Areas	Required Lowering Depth	Required Lowering Time*
25-Year	1, 2, and 3	6 Feet _±	5 Days _±
50-Year	1, 2, and 3	8 Feet _±	7 Days _±

***Results Based Upon Existing Lake Spillway
and Maximum 500 CFS Pre-Flood Release Rate**

Pre-Flood Lake Tappan Release

- Requires Pre-Flood Release of Approximately 6 to 8 Feet of Stored Water Below Spillway Crest
- Pre-Flood Release Limited to Approximately 500 CFS to Prevent Downstream Flooding
- Pre-Flood Release must Begin Approximately 1 Week Before Flood

Potential Off-Line Storage Areas



Potential Off-Line Storage Areas

- **Due to Existing WS Elevations and Resulting Flooding, Additional Flood Storage can Only be Achieved via Floodplain Excavation**
- **From Analysis, Insufficient Additional Storage Areas and Volumes to Reduce Existing River Flows and Increase Existing Flood Thresholds**
- **Similar Results for On-Line Storage**

Increase Bridge Size and Flow Capacity

Old Tappan Road Bridge



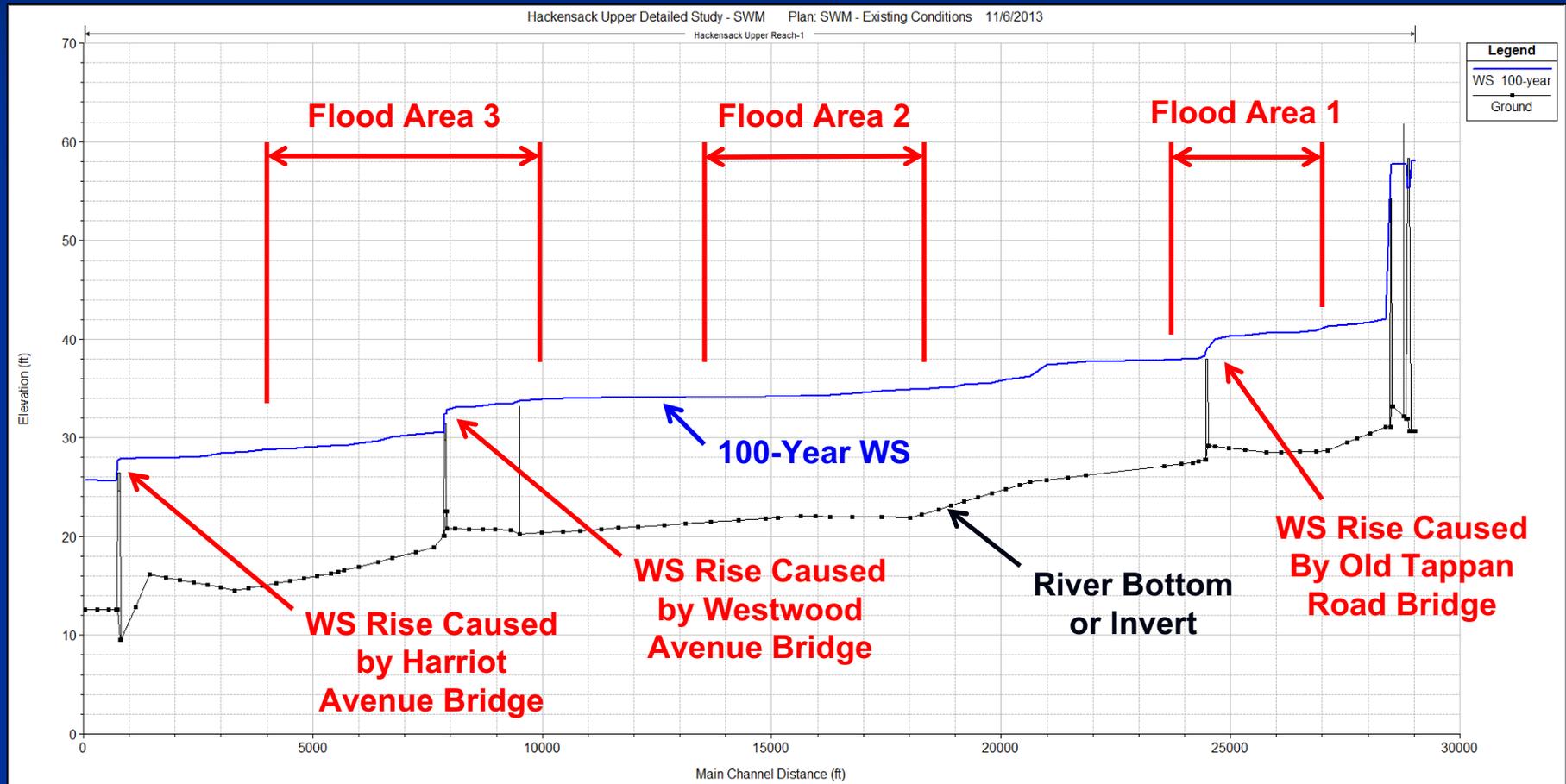
Westwood Avenue Bridge



Harriot Avenue Bridge



Existing 100-Year WS Profile

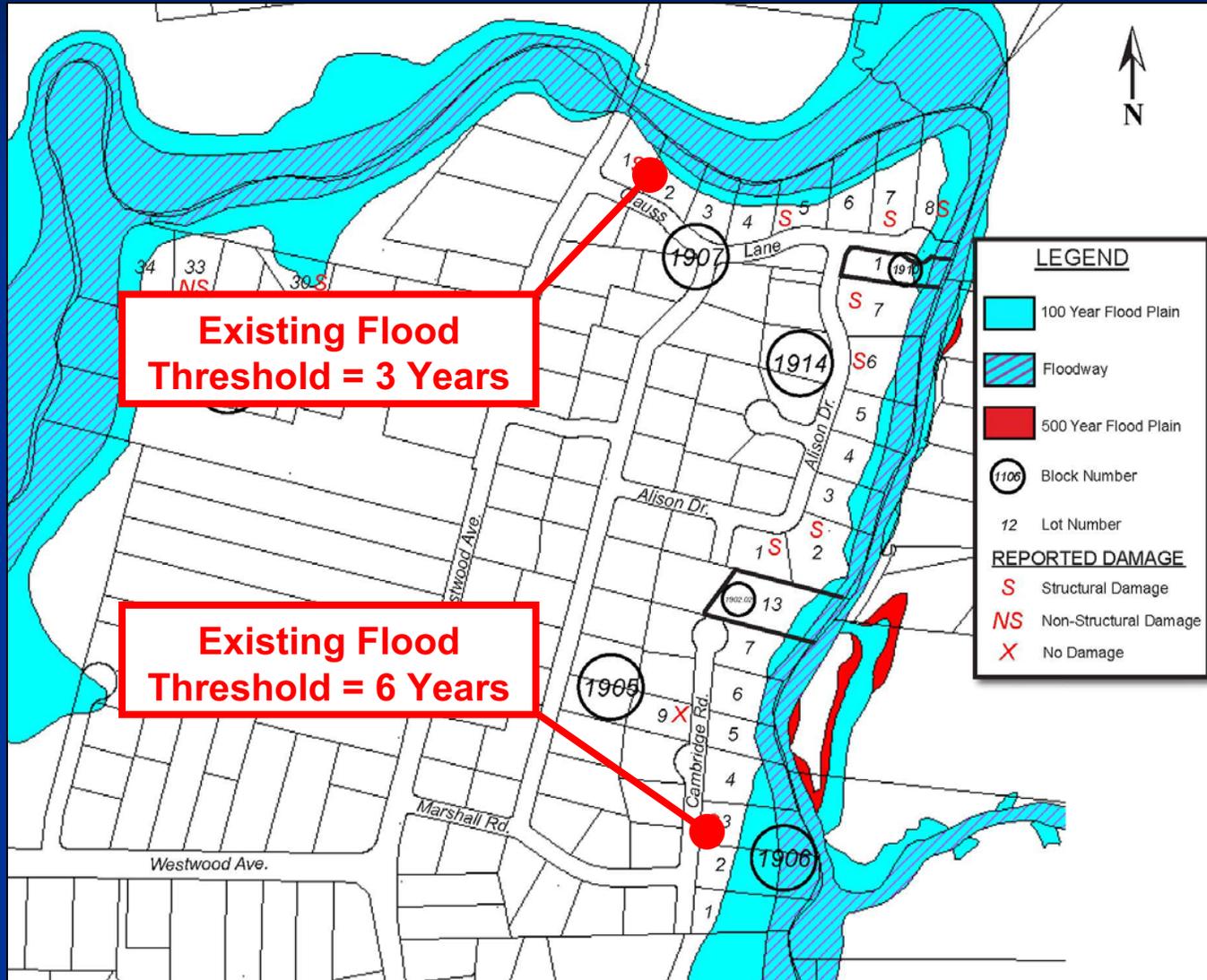


Increase Bridge Capacity

Bridge	Flood Area	Existing Flood Threshold	Future Flood Threshold
Harriot Avenue	3	3 Years (33%)	3 Years (33%)
Westwood Avenue	2	7 Years (14%)	15 Years (7%)
Old Tappan Road	1	12 Years (8%)	15 Years (7%)

Note: Flood Area 3 Affected by Tailwater from Oradell Reservoir

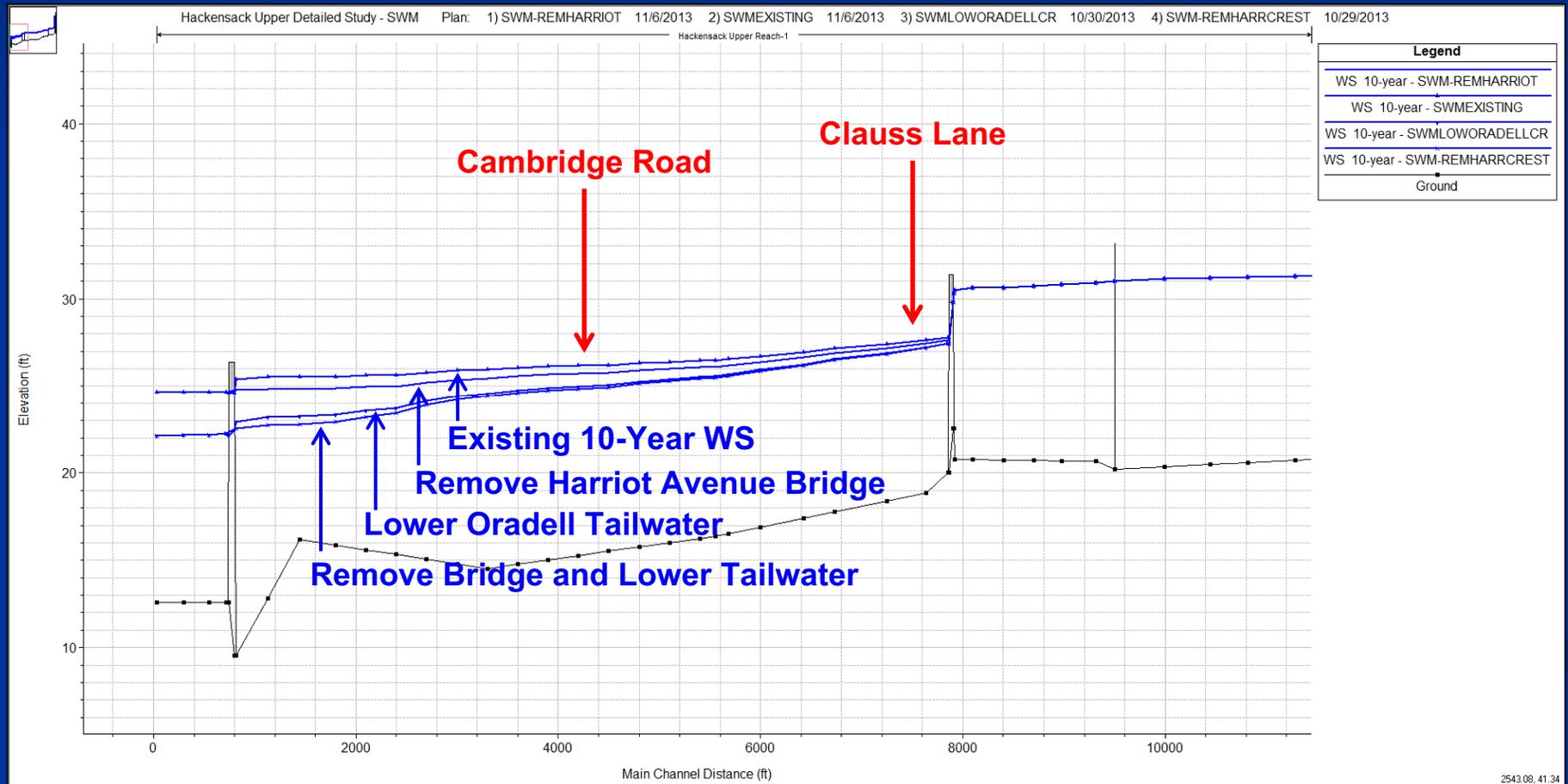
Flood Area 3



Effects of Oradell Reservoir

River Condition/Plan	Cambridge Flood Threshold	Clauss Flood Threshold
Existing	6 Years (17%)	3 Years (33%)
Remove Harriot Avenue Bridge	7 Years (14%)	3 Years (33%)
Lower Oradell Tailwater	10 Years (10%)	3 Years (33%)
Remove Bridge + Lower Oradell	12-Years (8%)	3 Years (33%)

Flood Area 3 10-Year WS Profiles



Effects of Oradell Reservoir

- Reservoir Only Affects Flood Area 3
- Largest Effect in Cambridge Road Section
- Implications for Flood Reduction via Lower Water Levels:
 - Flood Areas 1 and 2 Do Not Require Lower Reservoir Water Levels
 - Flood Area 3 Will Require Lower Reservoir Water Levels

Increase Bridge Sizes

- Harriot Avenue:

- Only Effective with Lower Oradell Reservoir Water Levels
- Only Benefits Cambridge Road Portion of Flood Area 3
- Minimal Reduction in Flood Risk
 - Existing 17% Risk Reduced to 14% (6-Year Threshold Increased to 7-Year)

Increase Bridge Sizes

- Westwood Avenue:
 - Benefits Flood Area 2
 - Existing Flood Risk Reduced in Half:
 - Existing 14% Risk Reduced to 7%
(7-Year Threshold Increased to 15-Year)

Increase Bridge Sizes

- Old Tappan Road:
 - Benefits Flood Area 1
 - Minimal Reduction in Flood Risk
 - Existing 8% Risk Reduced to 7%
(12-Year Threshold Increased to 15-Year)

Increase River Channel Size

- **18 Different Channel Modification Plans Analyzed**
- **Included 6 Different Channel Widths**
- **With and Without Bridge Enlargements**
- **With and Without Oradell Reservoir Water Level Changes**
- **Reminder: Only Hydraulic Effects of Channel Modifications Evaluated**

Increase River Channel Size

- **Final Channel Plan:**
 - **100-Foot Wide Bottom Width from Harriot Avenue to Westwood Avenue**
 - **50-Foot Bottom Width from Westwood Avenue to Upstream Limit of Flood Area 1 at White Birch and Rehill**
 - **Earthen Channel Like Existing**
 - **2:1 Channel Side Slopes**

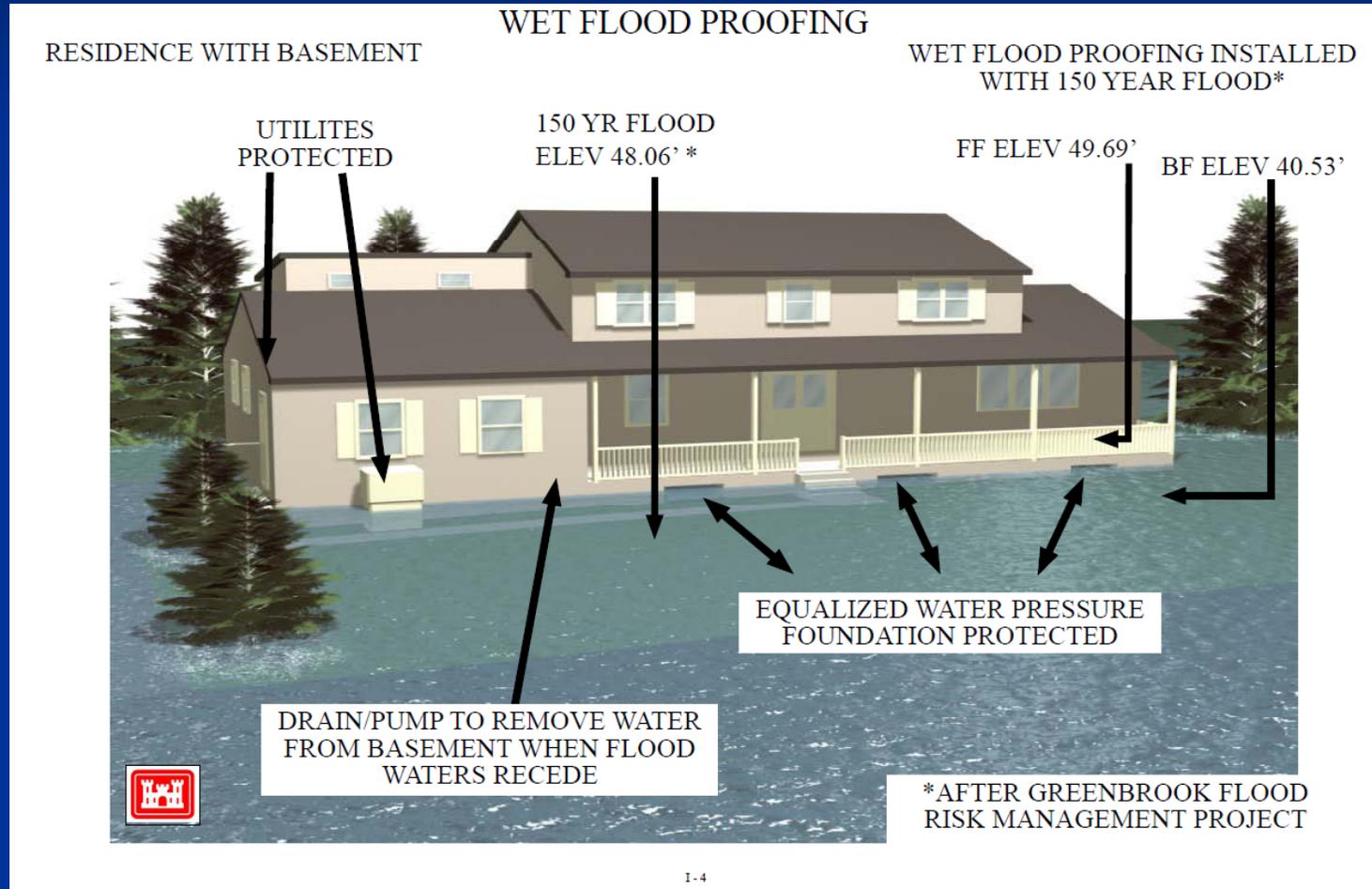
Increase River Channel Size

River Condition/ Plan	Flood Threshold		
	Flood Area 3 (100' Channel)	Flood Area 2 (50' Channel)	Flood Area 1 (50' Channel)
Existing	3 Years (33%)	7 Years (14%)	12 Years (8%)
Channel Modification	7 Years (14%)	80 Years (1.3%)	80 Years (1.3%)
Channel and Bridge Expansion	10 Years (10%)	100 Years (1%)	100 Years (1%)
Channel, Bridge, and Lower Reservoir	100 Years (1%)	100 Years (1%)	100 Years (1%)

Increase River Channel Size

- **Channel Bottom Widths:**
 - 100 Feet from Harriot to Westwood
 - 50 Feet from Westwood to Rehill
- **Provides 100-Year (1% Risk) Flood Threshold for All Three Flood Areas:**
 - Area 3 Requires Replacement of Harriot Avenue and Lower Oradell
 - Areas 1 and 2 Requires Replacement of Westwood Avenue Bridge

Wet Flood-Proofing

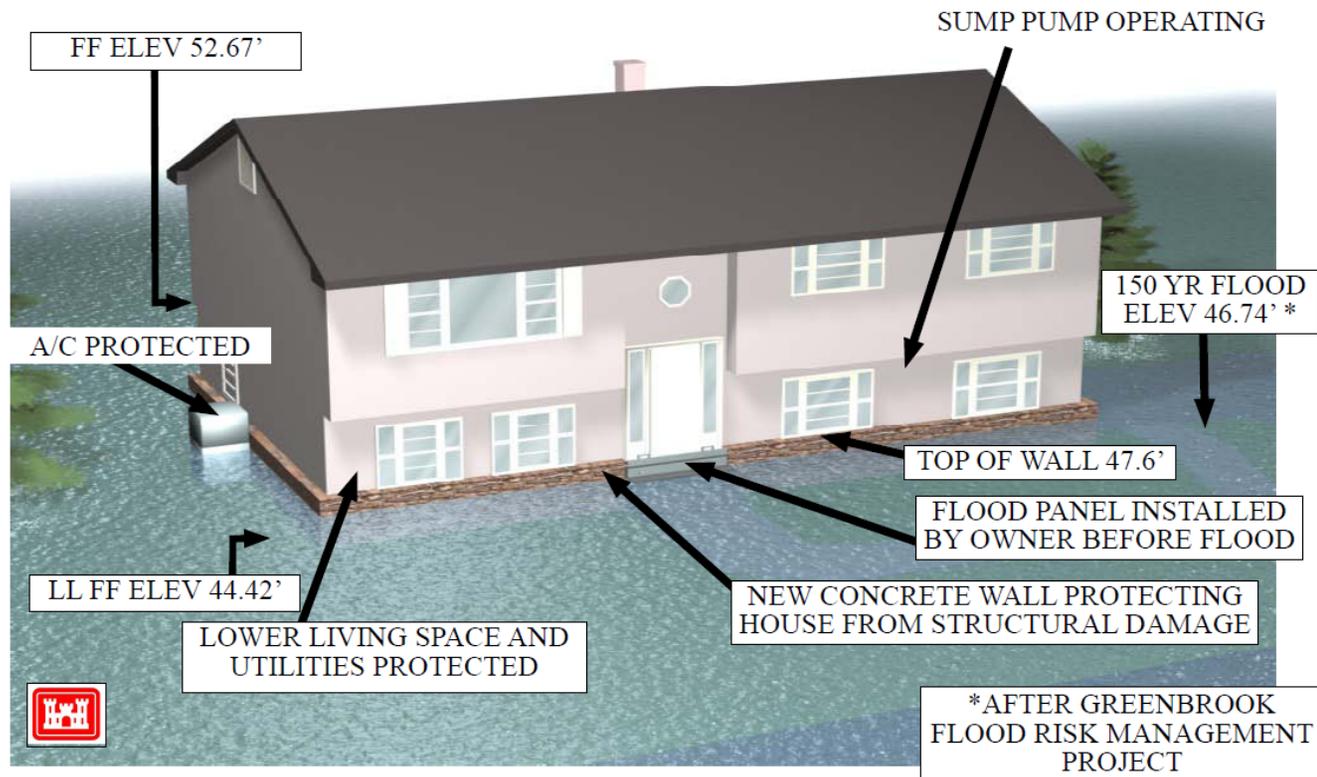


Dry Flood-Proofing

DRY FLOOD PROOFING

RESIDENCE WITH FINISHED LOWER LEVEL

DRY FLOODPROOFING
INSTALLED WITH 150YR FLOOD*



Flood-Proofing

- Can be Effective in Reducing Structure and Content Damage
- Cannot Reduce Property or Road Flooding
- Voluntary Participation
- Township can Develop Property and Structure Inventory from Computer Data and Topography
- Use Inventory Used to Prioritize Projects

Purchase Flood-Prone Properties

- FEMA Hazard Mitigation Assistance
- NJDEP Blue Acres
- Township Buyouts

Total Equalized Value of Properties*	
Within 100-Year Flood Plain	\$34,725,829
Affected by Severe and/or Frequent Flooding	\$14,074,622

*Source: Municipal Tax Assessor Records

Purchase Flood-Prone Properties

- Township can Utilize New Computer Model Data and Topography to Develop Property and Structure Inventory
- Use Inventory Used to Prioritize Projects
- Voluntary Participation

Flood Warning System

- **Can Provide Advanced Notice of Potential Flood Event**
- **Can Provide River and Flood Status and Updates During Event**
- **Can Provide Forecast River Crest and Flood Limits?**

Flood Warning System

- ✓ ■ Requires Water Level and Flow Gage(s)
- ✓ ■ Requires Knowledge/Data of Past River Flood Events and River Response
- ✓ ■ Computer Model of River Enhances System Coverage
- ? ■ Requires Communication System to Collect Data and Send Information

Enhanced Flood Warning System

■ Hackensack River Gate at River Vale

USGS 01377000 Hackensack River at Rivervale NJ

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Time-series: Current/Historical Observations

Estimated flood stage is 5 feet. Reservoir releases from Lake Tappan are included in the flow at this gage.

LOCATION. --Lat 40°59'57", long 73°59'21" referenced to North American Datum of 1983, River Vale Township, Bergen County, NJ, Hydrologic Unit 02030103, on upstream right bank at bridge on Westwood Avenue in Rivervale, 1.5 mi upstream from Pascack Brook, 4.1 mi downstream of Lake Tappan, and 4.6 mi upstream from Oradell Dam.

DRAINAGE AREA. --58.0 mi².

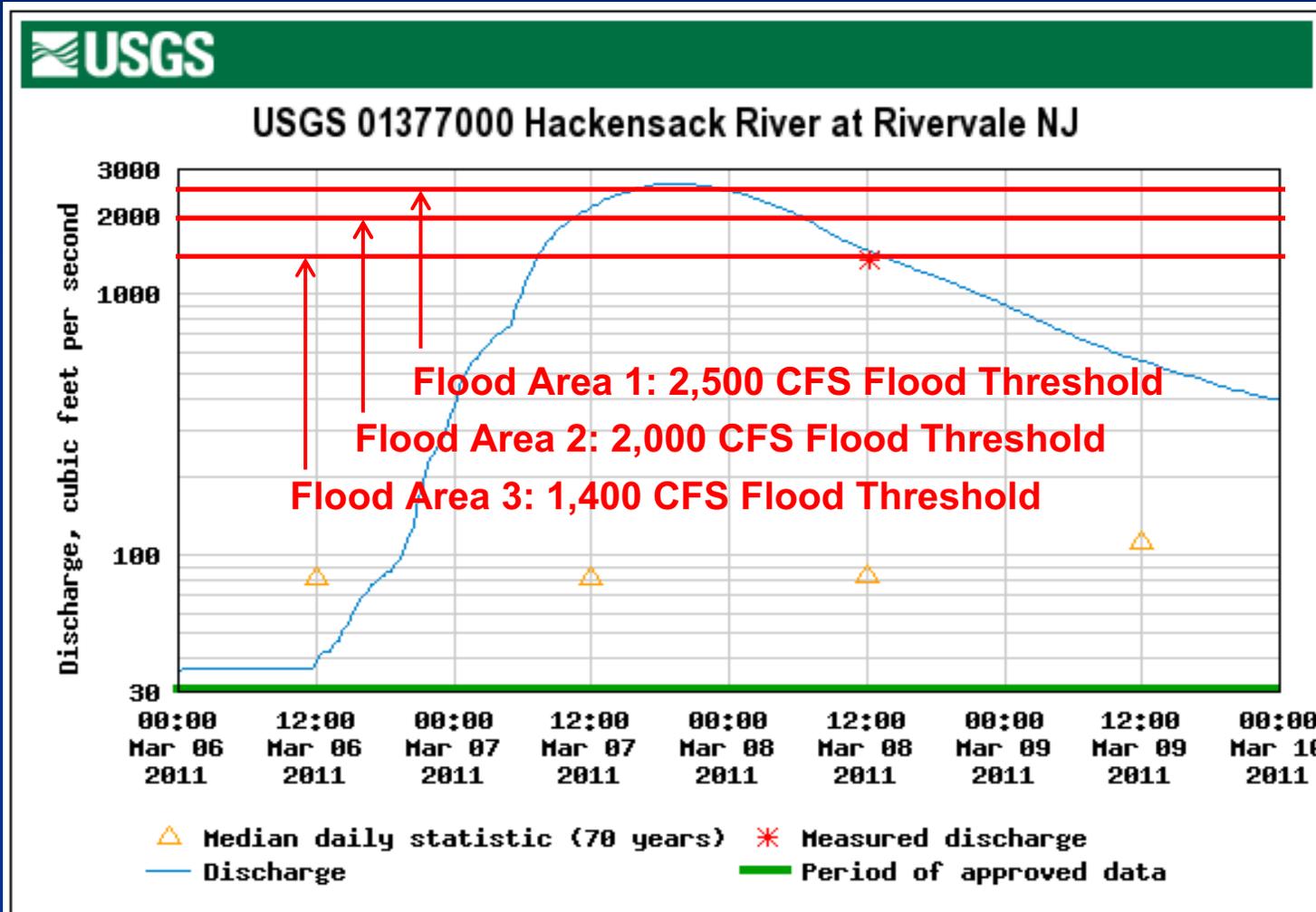
PERIOD OF RECORD. --October 1941 to current year.

GAGE. --Water-stage recorder, crest-stage gages, and concrete control. Datum of gage is 22.51 ft above NGVD of 1929.

COOPERATION. --Funding for this gage is provided by the New Jersey Department of Environmental Protection in cooperation with United Water New Jersey and the U.S. Geological Survey.



Hackensack River at River Vale



Enhanced Flood Warning System

USGS 01376950 Lake Tappan at Old Tappan NJ

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Time-series: Current/Historical Observations

Elevation at top of Bascule gates is 55.00 ft.

LOCATION.—Lat 41°01'06", long 74°00'04" referenced to North American Datum of 1983, Old Tappan Borough, Bergen County, NJ, Hydrologic Unit 02030103, at dam on Hackensack River, 0.8 mi upstream from gaging station 01377000).

DRAINAGE AREA.—49.1 mi².

PERIOD OF RECORD.—From 1929 to present, with month-end elevation and discharge data available from 1929 to present.

GAGE.—Water-stage recorder. Datum of gage is 0 ft above NGVD of 1929.

COOPERATION.—Funding for this gage is provided by the New Jersey Department of Environmental Protection.

USGS 01378480 Oradell Reservoir at Oradell NJ

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site Time-series: Current/Historical Observations

Elevation of spillway crest is 23.16 ft.

LOCATION. --Lat 40°57'23", long 74°01'46" referenced to North American Datum of 1983, Oradell Borough, Bergen County, NJ, Hydrologic Unit 02030103, at dam on Hackensack River at Oradell, and 0.8 mi upstream of Hirshfeld Brook.

DRAINAGE AREA. --113 mi².

PERIOD OF RECORD. --April 2009 to current year.

GAGE. --Water-stage recorder. Datum of gage is 0 ft above NGVD of 1929.

COOPERATION. --Funding for this gage is provided by the New Jersey Department of Environmental Protection.



Enhanced Flood Warning System

■ Knowledge and Data of Past Floods and River Response

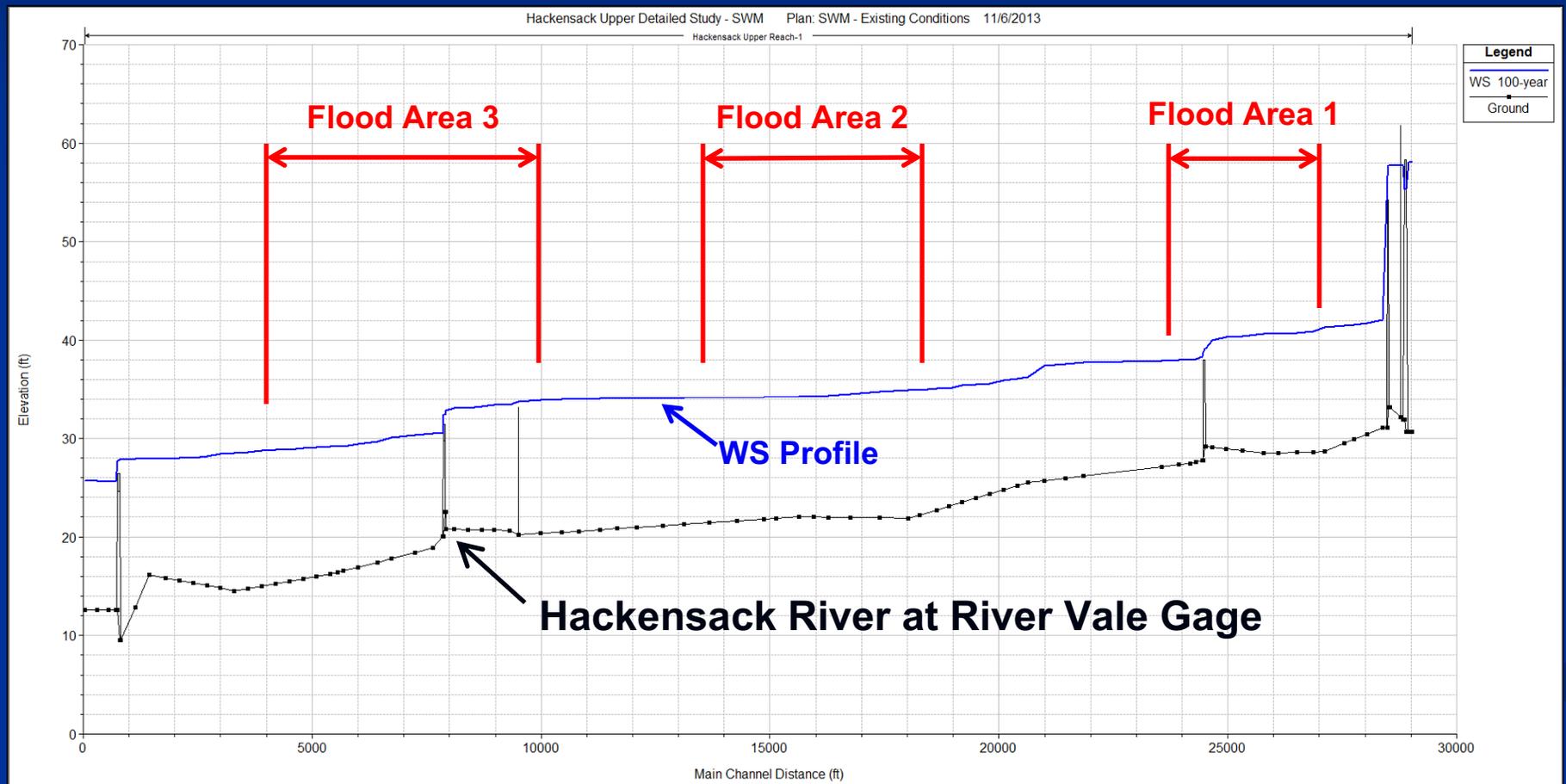
Past Flood Data and Gage Thresholds from River Vale OEM Coordinator

	4.16.2007	3.14.2010	3.7.2011	3.11.2011	4.11.2011	6.23.11	8.28.2012	12.8.11
55'@LTD			0030 hrs	0330 hrs	2200 hrs	21:15hrs	0500 hrs	00:15 hrs
HRWN when LTD @55'			0030 hrs 10.67' 1510 cfs	0330 hrs 9.21' 1140 cfs	2200hrs 8.24' 911 cfs	21:15hrs 10.05' 1380 cfs	0500 hrs Hgt unavail. 1030 cfs	00:15 hrs 8.09' 878 cfs
Crest @ HRWN	11.37' 1710 cfs		0445 hrs 11.02' 1630cfs	0900 hrs 10.07' 1350 cfs	0545 hrs 10.45' 1450 cfs	1600hrs 10.17' 1380 cfs	1800 hrs	0430 hrs 8.39' 945 cfs
HRRV when HRWN Crest			0045 hrs 7.56' 2320 cfs	0900 hrs 5.72' 1600 cfs	0545 hrs 8.5' 2700 cfs	1600hrs 3.42' 619 cfs	1800 hrs 11.05' 1740 cfs	0430 hrs 6.68' 1970 cfs
5'@HRRV			0630 hrs 1270 cfs	0600 hrs 1300 cfs	0030 hrs 1280 cfs	1745hrs 1300 cfs	Unavail.	0100 hrs 1970 cfs
HRWN when HRRV @5'			0630 hrs 10.85' 1510 cfs	0600 hrs 9.84' 1300 cfs	0030 hrs 9.80' 1290 cfs	1745hrs 10.09' 1360 cfs	Unavail.	0100 hrs 8.29' 923 cfs
Crest @ HRRV	12.19' 4620 cfs	8.12' 2550 cfs	1745 hrs 8.63' 2750 cfs	2100 hrs 7.17' 2170 cfs	0545 hrs 8.5' 2700 cfs	0730hrs 6.56' 1970 cfs	1315 hrs Hgt unavail. 4660 cfs	0400 hrs 6.71' 1980 cfs
HRWN when HRRV Crest			1745 hrs 9.22' 1140 cfs	2100 hrs 7.15' 678 cfs	0545 hrs 10.45' 1450 cfs	0730hrs 6.56' 562 cfs	1315 hrs Hgt unavail. 1710 cfs	0730 hrs 8.36' 939 cfs
HRRV start to recede			3 hrs	1.5 hrs	1.5 hrs	3 hrs	3 hrs	1 hr

Notes:

1. Old Tappan Rd @ Bridge flooded at 6.3' gage height
2. First house on Claus in water of brick wall over approx. 7.6' gage height

Computer Model of River

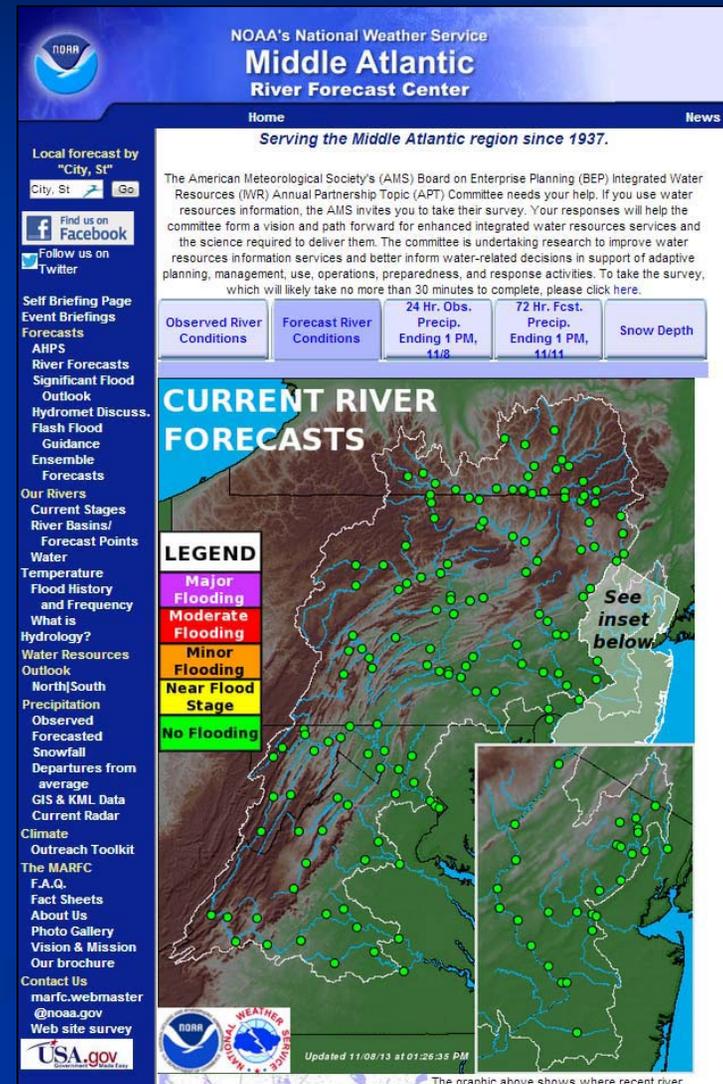


Enhanced Flood Warning System

- **Communication System:**
 - Existing Township System
 - Internet
 - Reverse 911
 - Email
 - Social Media

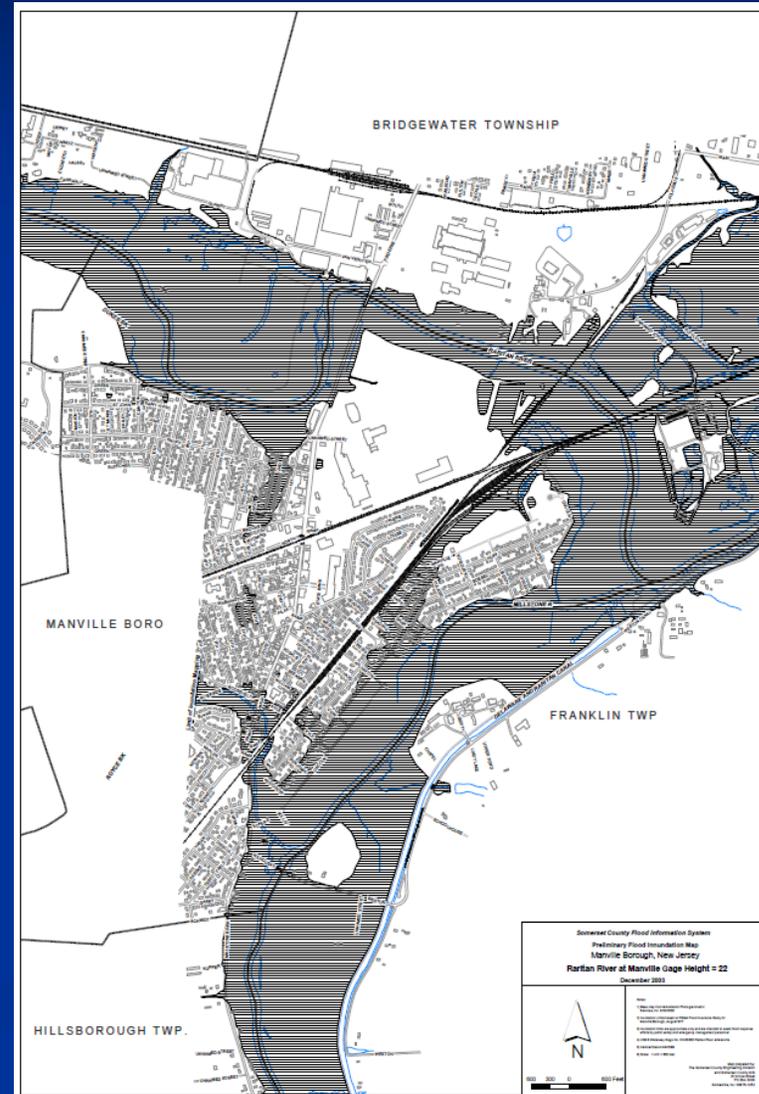
Enhanced Flood Warning System

- Effectiveness would be Significantly Increased if River Vale Gage Included in NOAA Forecasts
- Forecasts may be Difficult due to Upstream Lakes
- Township can Initiate Discussion with NOAA



Enhanced Flood Warning System

- Prepare and Distribute Township Flood Inundation Maps
- Particularly Effective if River Vale Gage Upgraded to NOAA Forecast Gage



Summary of Plan Analyses

Important Reminder

- **Study Analyzed Hydraulic Effectiveness of Alternative Flood Reduction Plans**
- **Other Important Plan Aspects Must Also be Addressed, Including:**
 - **Cost, Benefits, and Cost-to-Benefit Ratio**
 - **Upstream and Downstream Impacts**
 - **Environmental Impacts**
 - **Property Acquisition**
 - **Local and State Permits**

Plans Investigated

- Flood Walls
- Bypasses
- Pre-Flood Lake Tappan Release
- On & Off-Line Storage
- Increase Bridge Sizes
- Increase Channel Size
- Flood Proofing
- Purchase Flood-Prone Properties
- Enhanced Flood Warning System

Study Summary

- Study Objective:
To Identify
Hydraulically
Effective Concept
Plans to Reducing
Flooding Prior to
Addressing Non-
Hydraulic Issues.
- **Hydraulically
Effective Plans:**
 - Floodwalls
 - Channel and Bridge
Expansions
 - Flood-Proofing
 - Property Buyouts
 - Enhanced Flood
Warning System

Recommended Plans for Further Investigation

- Purchase of Flood Prone Properties
- Flood Proofing
- Flood Warning System
- Replace Westwood Ave & Old Tappan Road Bridges (*IF funding available*)

Looking Ahead

- ***Potential Future Partners:***
 - **River Vale Residents**
 - **Bergen County**
 - **United Water**
 - **NJDEP**
 - **Bergen SWAN**
 - **FEMA**
 - **Army Corps of Engineers**

Township of River Vale



Hackensack River Flood Reduction Study Update

Q & A