Hazard Profile - Flood

Description

A flood is a general and temporary condition of partial or complete inundation on normally dry land. The Town / Village of Harrison is susceptible to the following types of flooding:

- Riverine flooding, including overflow from a river channel, flash floods, and ice-jam floods.
- Riverine flooding including dam-break floods;
- Urbanized or street flood events
- Floodplain

According to USGS, floods are the most frequent and costly natural disaster in terms of human hardship and economic loss. As much as 90% of damage related to natural disasters (excluding drought) are caused by floods and associated mud and debris flows.

Floods do not follow a specific pattern from onset to termination of an event. They may develop over a period of days as a result of slow and steady rainfall, or can occur relatively quickly as a result of several inches of rainfall an hour. Levels of soil saturation including water and frost, spring snow melt, intensity of rainfall, impediments and side friction in floodways can all impact the intensity and duration of a flood event.

Depending on where they occur, floods can pose significant risks to health and safety or interruption to transportation and other services. Loss of life, injury and the possibility of disease as a result of standing water are both critical and immediate concerns. Economic losses due to flooding may be significant. Collateral losses such as disruption of commerce, unemployment due to flooded workplaces, inundated transportation systems, disruption of utility systems and temporary loss of ones residence, expenses for disaster relief and cleanup, and other related costs, can add up to millions of dollars. Floods can increase the workload burden of municipal services several fold beyond typical daily operations especially for police, fire and public works operations. Health care services and professionals may become quickly overburdened during a local flood event with the potential for impacting health care and other resources outside the area. Annual economic losses due to flooding are estimated to be as high as $100 million in New York State

During the Risk Assessment for flooding in the Town / Village of Harrison, the following agency websites were visited for pertinent information:

- The New York State Department of Environmental Conservation, Bureau of Flood Protection and Dam Safety, Division of Water, web site, http://www.dec.state.ny.gov/pubs/42978.html

- The Federal Emergency Management Agency (FEMA) National Flood Insurance Program staff and web site, http://www.fema.gov/business/nfip

- National Oceanic and Atmospheric Administration (NOAA), National Climate Data Center at www.ncdc.noaa.gov.

- The United States Geological Survey (USGS) web site http://www.usgs.gov/themes/flood.html,

- New York State Climate Office, Department of Earth and Atmospheric Sciences at Cornell University web site, http://nysc.eas.cornell.edu, http://nysc.eas.cornell.edu/climate_of_ny.html

Riverine or Overbank Flooding

This type of flooding is defined as when a watercourse exceeds its "bank-full" capacity and is usually the most common type of flood event. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils or drainage systems that are already saturated or overloaded from previous rain events. The duration of riverine floods may vary from hours to several days

Factors that directly affect the amount of flood runoff include precipitation amount, intensity, and spatial and temporal distribution; the amount of soil moisture; seasonal variation in vegetation; snow depth; and the water resistance of the surface due to urbanization. Other factors, such as debris blocking a waterway or channel, can further aggravate a flood event. Development has altered the natural environment, changing and interrupting some of the natural drainageways. As a result, drainage systems can become overloaded more frequently.
The most serious overbank flooding occurs during flash floods that result from intense rainstorms or following a dam failure. The term "flash flood" describes localized floods of great peak flow and magnitude and short duration. In contrast to riverine flooding, this type of flood usually results from a heavy rainfall on a relatively small drainage area. Flash floods by definition occur very quickly and may occur with little or no warning.

Urban or Street Flood Events

These events occur due to the conversion of open space to buildings, roads and parking lots, which cause the land to lose its ability to absorb rainfall. Urbanization increases runoff two to six times over what would occur on natural terrain. Except at underpasses, street flooding and yard ponding usually do not exceed more than a foot or two and are often viewed more as a nuisance than a major hazard. However, during periods of urban flooding, high velocity flows can occur in streets, even in areas with only shallow flooding.

Floodplains

The area adjacent to a channel is the floodplain. Floodplains are illustrated on inundation maps, which show areas of potential flooding and water depths. In its common usage, the floodplain most often refers to that area that is inundated by the 100-year flood, the flood that has a 1-percent chance in any given year of being equaled or exceeded. The 100-year flood is the national minimum standard to which communities regulate their floodplains through the National Flood Insurance Program.

The potential for flooding can change and increase as a result of land use changes and changes to land surface that change the floodplain. A change in environment can create localized flooding problems in and out of natural floodplains by altering or confining natural drainage channels. These changes are most often created by human activity.

Geographic Location and Extent

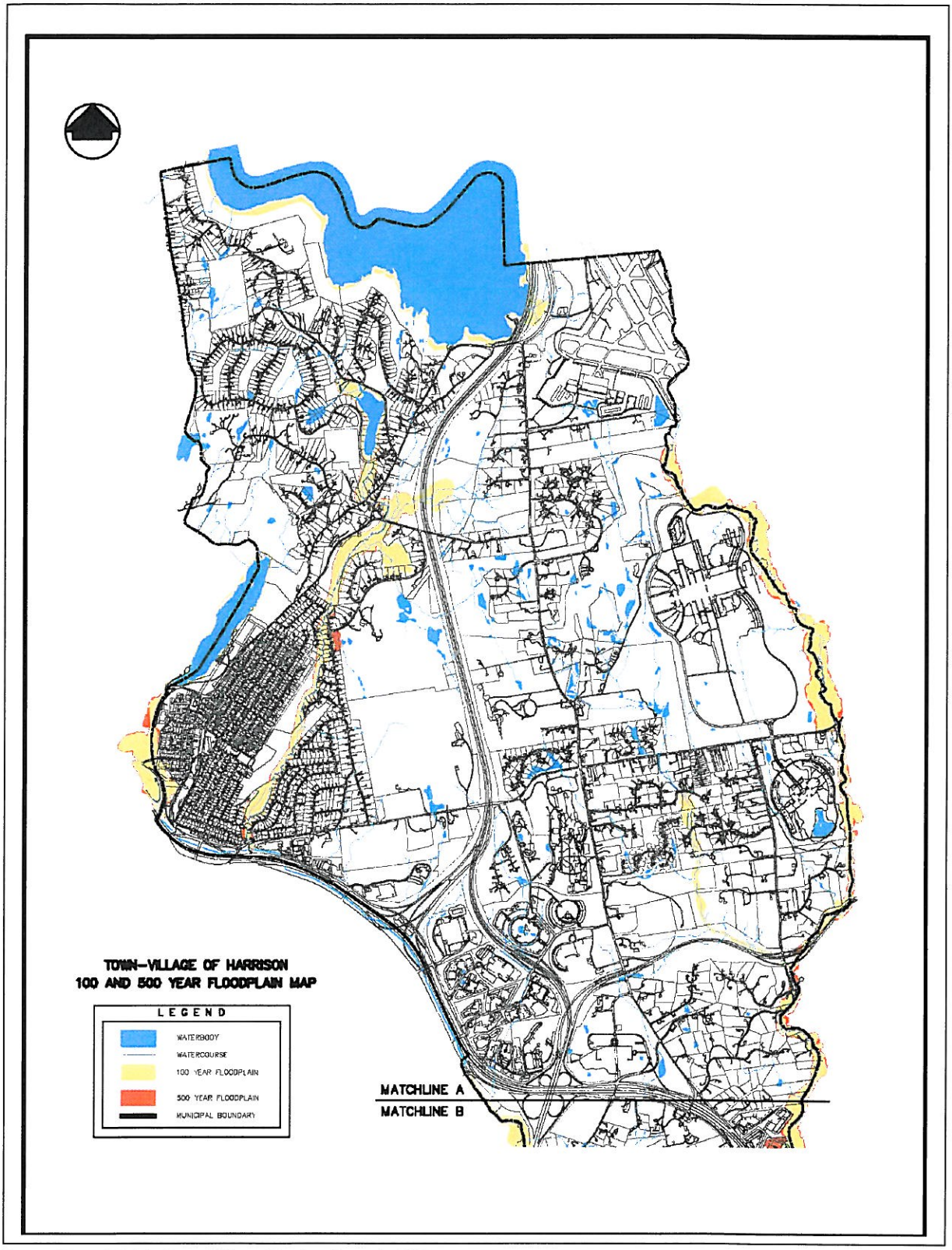
Several areas of the Town / Village of Harrison lie within 100 and 500 year floodplains. Additionally, areas outside these designated floodplains experience what is known as "urban flooding" resulting from undersized or poorly maintained drainage systems combined with intense rainfalls of short or long duration.

This study utilized FEMA Flood Insurance Rate Maps (FIRMS) dated September 2007 in order to determine sections of the study area located in the 100 and 500 year floodplains. An interview was conducted by the consultant with the Commissioner of Public Works to determine those areas most susceptible to flooding including areas where flood damage had occurred in the past. The following FEMA FIRMS contain areas in the 100 and 500 year floodplains:

- 36119C0267F 36119C0259F
- 36119C0353F 36119C0269F
- 36119C0278F
- 36119C0279F
- 36119C0286F
- 36119C0287F
- 36119C0288F
- 36119C0289F
- 36119C0293F
- 36119C0351F
- 36119C0352F
- 36119C0354F
- 36119C0356F

A complete set of Floodplain Maps is available in the office of the Commissioner of Public Works of the Town/Village of Harrison.

Figure 5-1 September 2007 FEMA FIRM of Flood Prone areas of the Town / Village of Harrison 100 (1%) and 500 Year (.2%) (Upper)



Source: FEMA FIRM for Town / Village of Harrison, September 2007

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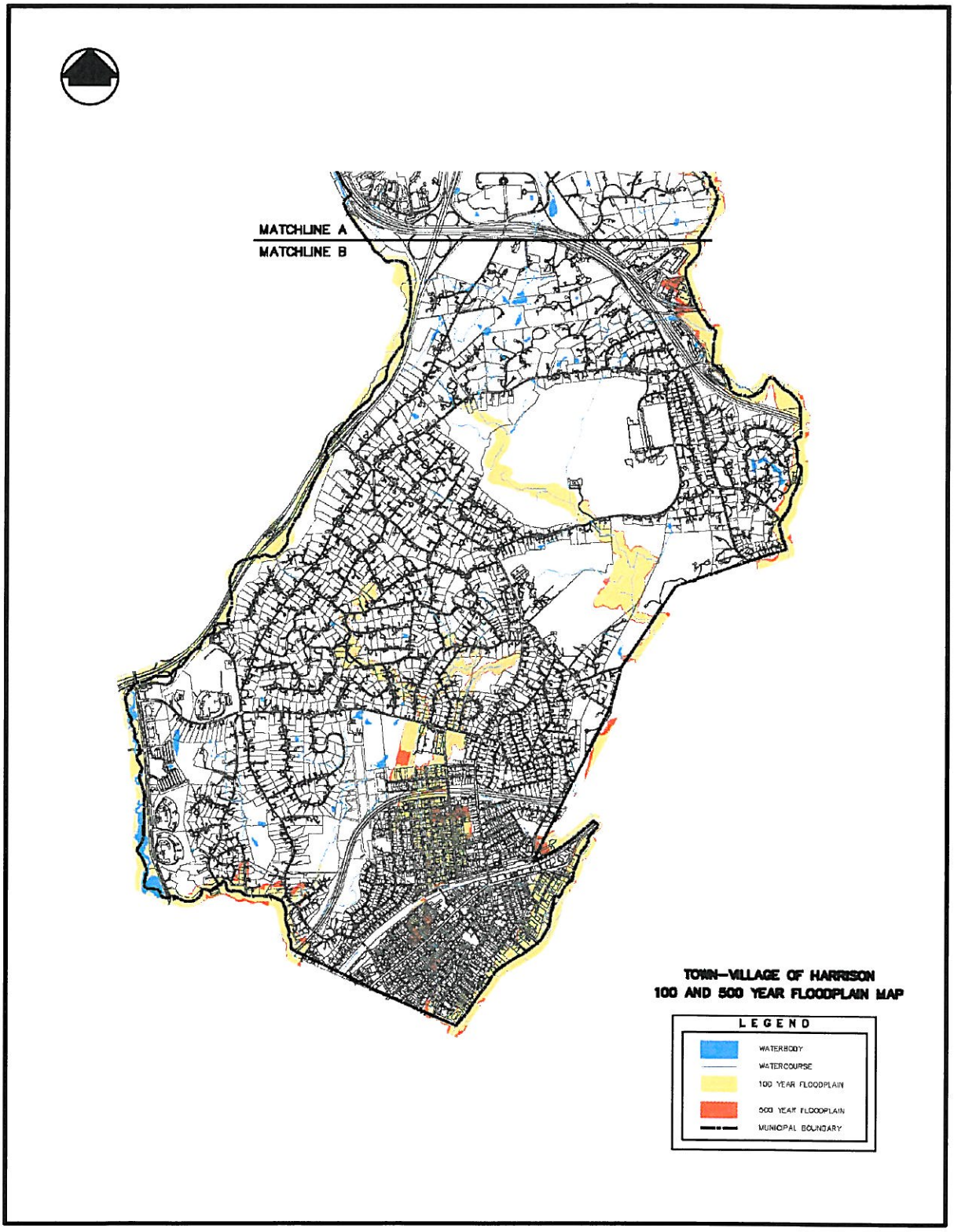
Figure 5-2 September 2007 FEMA FIRM of Flood Prone areas of the Town / Village of Harrison 100 (1%) and 500 Year (.2%) (Lower)



Source: FEMA FIRM for Town / Village of Harrison, September 2007

Major Sources of Flooding

The Town / Village of Harrison has multiple creeks, tributaries, and associated watersheds. The Town / Village is highly urbanized as a result of the "built-out" condition of the study area. As such, the natural hazards related to stormwater and flood management are particularly complicated by the fact that space is at a premium and thus many structures are within the floodplain. All drainage ways are subject to periodic flooding. The figure below shows the major waterbodies and drainage ways in the study area. Waterways which have the ability to cause flooding include:

- Mamaroneck River
- Blind Brook
- Beaver Swamp Brook
- Brentwood Brook
- Nelson Creek

Previous Occurrences and Losses

According to the NOAA Satellite and Information Service, National Climatic Data Center, 69 Flood Events of varying degrees have occurred in Westchester County from January 1950 through May of 2008. These events have included Urban, Flash and Coastal Flooding. Table 5-1 provides a listing of Presidential Disaster Declarations for flood events impacting the Town / Village of Harrison from 1996 through 2007.

Table 5-3 Presidential Disaster Declarationsfor Flooding Events 1996 – 2007

Type of Event	Date	Declaration Number	Aid to Municipality (In Dollars)
Severe Storm Flooding	October 1996	1146-DR-NY	
Hurricane Floyd	September 1999	1296-DR-NY	
Severe StormFlooding	April 2005	1589-DR-NY	
Severe Storm, Inland and Coastal Flooding	April 2007	1692-DR-NY	

Source: FEMA website. Some overlap with Severe Storm Hazard

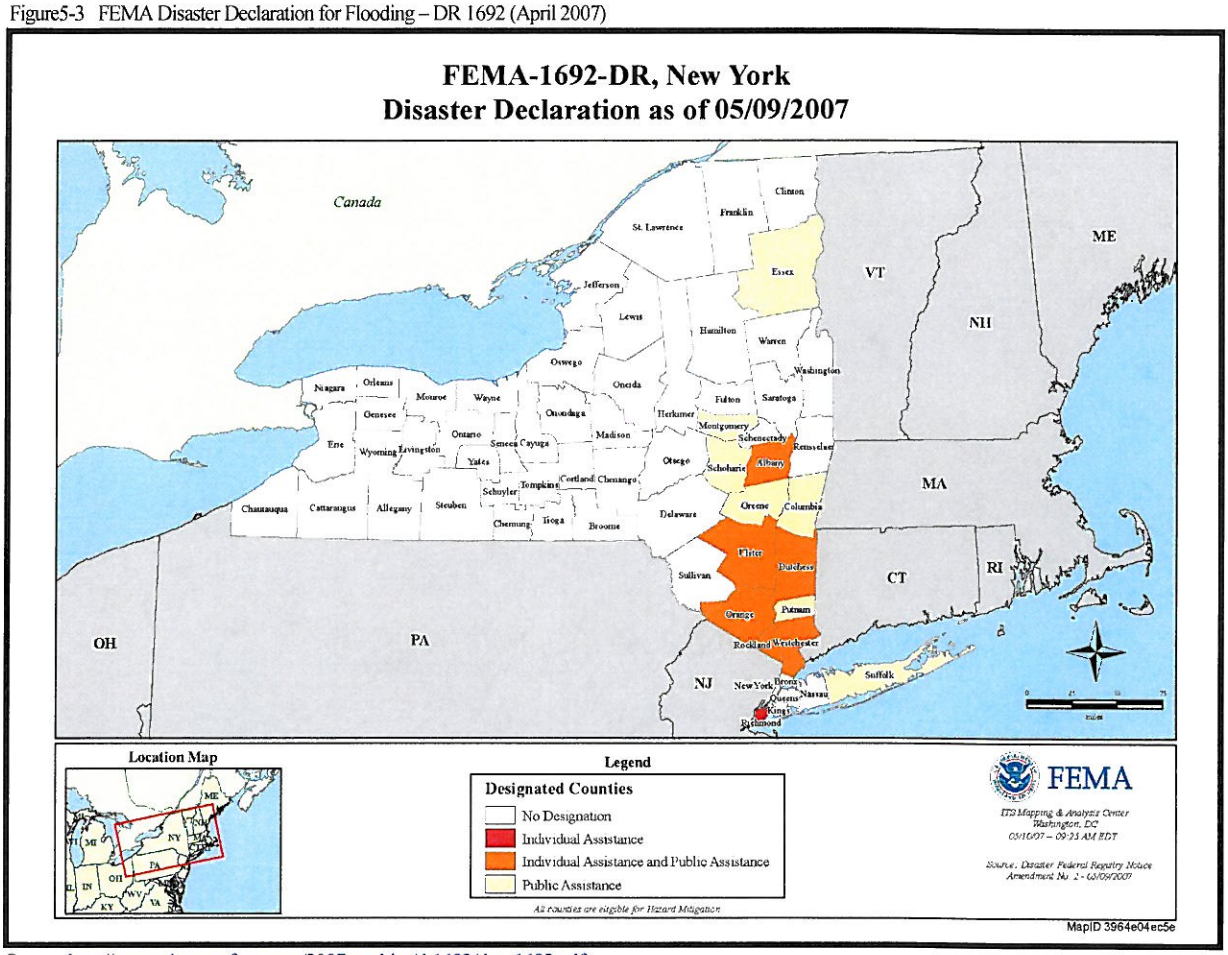
As part of the Town / Village of Harrison Flood Mitigation program, the Department of Public Works has identified eight (8) individual locations where localized flooding has previously occurred. Table 5-2 lists the area of the study area where the localized flooding has occurred, the street location as well as the reason the flooding is occurring.

Table 5-4 Localized Flooding Locations identified by Department of Public Works

Area	Location	Description
Downtown Harrison	Avondale Road and Argyle Road	Localized flooding exceeds drainage capacity, low lying area
Downtown Harrison	Genessee Trail and Woodlands Road	Over land flow due to insufficient drainage capacity
Downtown Harrison	Meadow Street and Park Avenue	Localized flooding, exceeds drainage capacity, low lying area
Downtown Harrison	Pilgrim Road	Low lying wetland area, no drainage outlet subject to overflow during storms
Downtown Harrison	Ramapo Trail	Overland flow due to insufficient drainage capacity
Purchase	Meadow Lane	Low lying wetland area, no drainage outlet
Purchase	Westerleigh Road and Sylvanleigh Road	Overland flow across highway due to insufficient drainage capacity
West Harrison	Main Street	Overland flow across highway due to insufficient drainage capacity, sewer system backups and inundation of local basements

Source: Town/Village of Harrison Department of Public Works

Figure5-3 FEMA Disaster Declaration for Flooding – DR 1692 (April 2007)



Source: http://www.gismaps.fema.gov/2007graphics/dr1692/dec_1692.pdf

Probability of Future Events

The FEMA FIRM maps when overlaid on municipal tax maps provided by the Westchester County Information Technology Department indicates a number of built out areas in the Town / Village of Harrison which are susceptible to flooding and for which historical records have verified numerous flooding events. Much of the Stormwater and Floodplain infrastructure in these areas is in excess of 75 years old and was designed when areas of open space still existed in the municipality. Many of those open space areas have been built up with roads, homes, businesses and corporate parks, depleting pervious areas where water had previously been absorbed into aquifers.

Changing storm patterns over the last few years have created rain events of greater intensity and duration which can lead to surcharging of stormwater drainage conveyance systems allowing water to spread out over flat low lying areas flooding streets and basements. Based on historical records the probability of occurrence of flood events would be considered frequent (likely to occur more than once every five years).

Vulnerability Assessment

A vulnerability assessment is defined as assessing the vulnerability of people and the built environment to a given level of hazard. After identifying types of risk, a vulnerability analysis can help to determine the weak points in the community. This assessment examines the vulnerability of the existing and future built environment, such as structures, utilities, roads and bridges, as well as environmental vulnerability, such as open space that can suffer from erosion. Once the geographic areas of risk are identified in the Town / Village, vulnerability can be assessed for the population, property and resources at risk in those areas. Vulnerability indicates what is likely to be damaged by the identified hazards and how sever the damage may be. If an area is determined to be at risk of flooding, vulnerability estimates for that area could include residential property losses, impacts to the tax base and damages to public infrastructure. Flooding events can impact several areas of Town/Village of Harrison. All assets associated with those areas including population, structures, critical facilities and utilities are vulnerable. The following sections evaluate and estimate the potential impact of flooding:

- Overview of vulnerability
- Data and methodology used in the evaluation
- Impact on life, safety and health
- Identifying structures including general building stock, critical facilities and critical infrastructure
- Economic impact
- Addressing Repetitive Loss Properties (NFIP data for floods, other hazards as available)
- Estimating Potential Losses
- Analyzing Development Trends (new buildings, critical facilities and Infrastructure)
- Additional Data and Next Steps
- Overall vulnerability conclusion
- Multi-jurisdictional Risk Assessment

Overview of Vulnerability

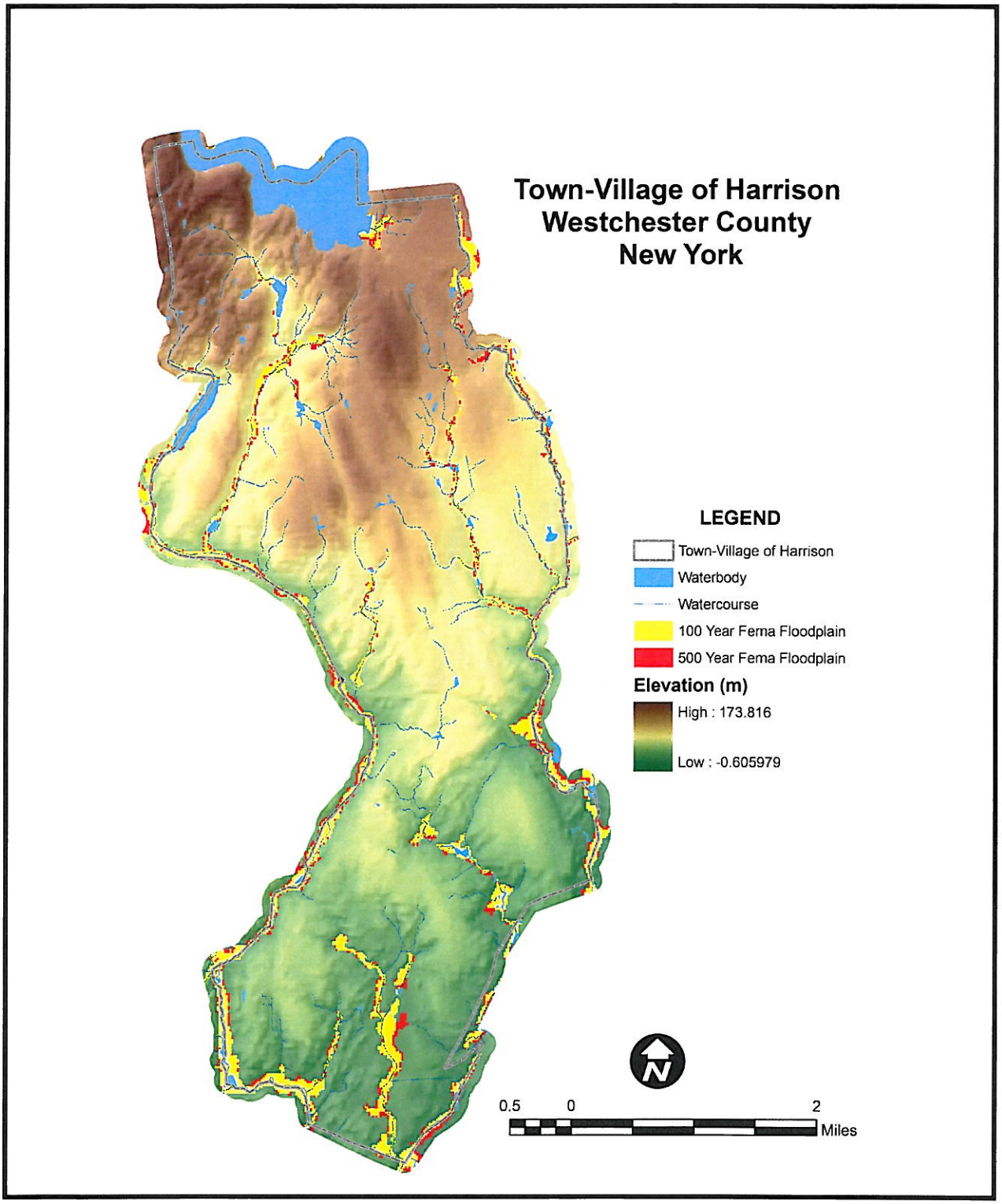
Municipal staff, the HMPC, input gathered from the Natural Disaster Survey and information gathered by the consultant identifies flooding as the most significant concern to the Town / Village of Harrison. A number of built out, densely populated areas of the municipality lie within or in close proximity to floodplains and have experienced a number of flooding events in the past. To assess vulnerability, potential losses were calculated for 100 year and 500 year flood events.

Data and Methodology

Data utilized to assess the flood hazard was gathered from historical records located in municipal offices, the September 2007 Floodplain maps for the municipality (Hard Copy and HAZUS-MH), Westchester County, New York Geographic Information Systems Maps and Overlays, input from the HMPC, the Natural Hazards Survey and information on file with the consultant. Population data, Residential and Commercial Building Stock and associated Values (Structure and Content) and FEMA Floodplain data was taken from HAZUS-MH. Critical facilities, infrastructure and lifeline information was gathered locally and by utilizing HAZUS-MH. ***In analyzing the Flood Hazard, HAZUS-MH***

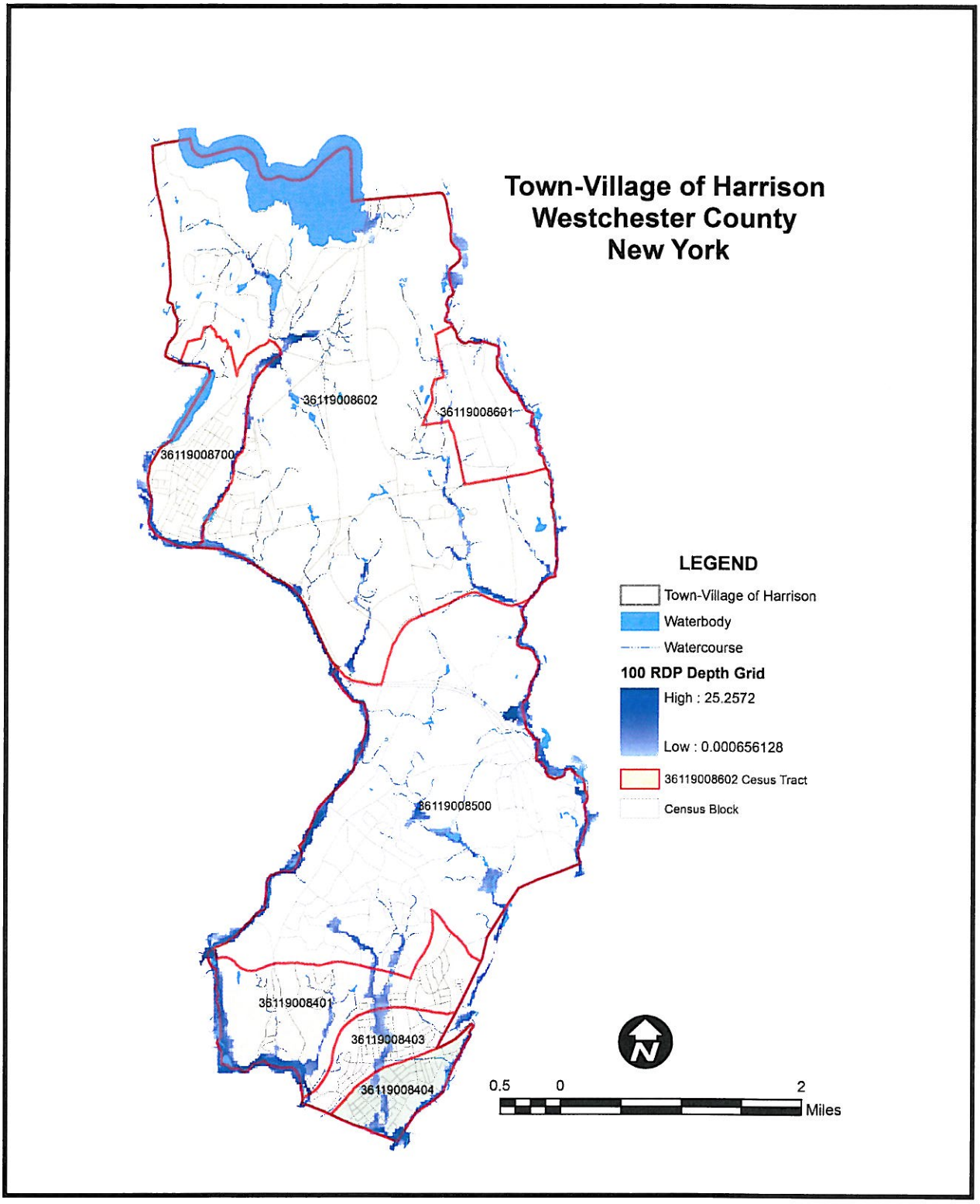
calculated loss information for 100 year and 500 year events (consistent with FEMA Floodplain Mapping).

Figure5-4: USGS Digital Elevation Model and FEMA 100 year and 500 year floodplains for the Town/Village of Harrison



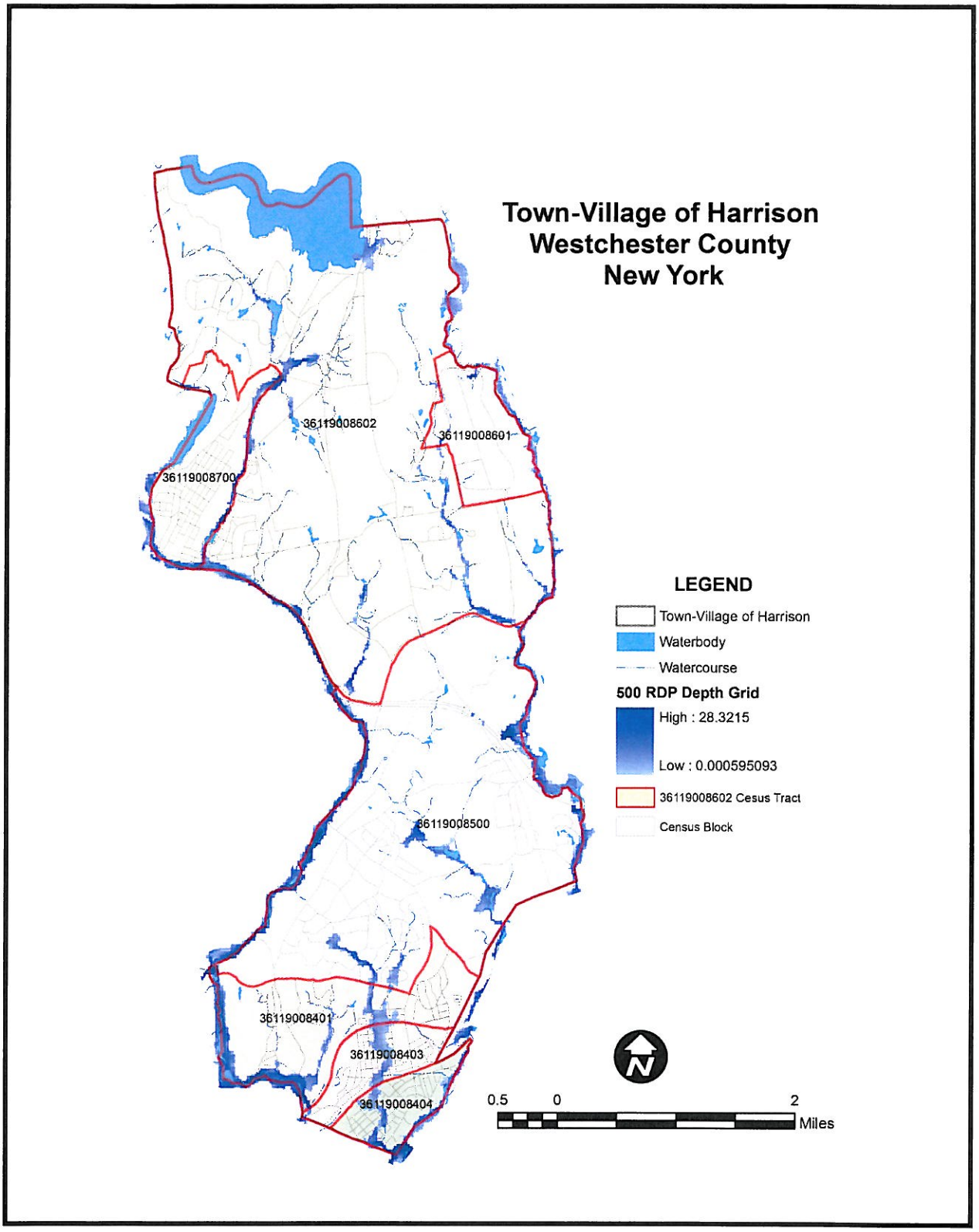
Source: HAZUS-MH

Figure 5-5: Flood Depth Grid for a 100 Year Mean Return Period Flood Event



Source: HAZUS-MH Note: Depth is measured in feet. High and Low figures indicate that at some point in the grid area, the water will rise to that particular Depth . (Source: HAZUS-MH Flood Support Team)

Figure 5-6 Flood Depth Grid for a 500 year Mean Return Period Flood Event



Source: HAZUS-MH Note: Depth is measured in feet. High and Low figures indicate that at some point in the grid area, the water will rise to that particular Depth . (Source: HAZUS-MH Flood Support Team)

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Impact on Life, Safety and Health

HAZUS-MH was utilized to determine the population at risk in the 100 and 500 year flood events. Table 5.3 below shows the population placed in jeopardy as a result flood hazard events.

Table 5-5 Sheltering Requirements

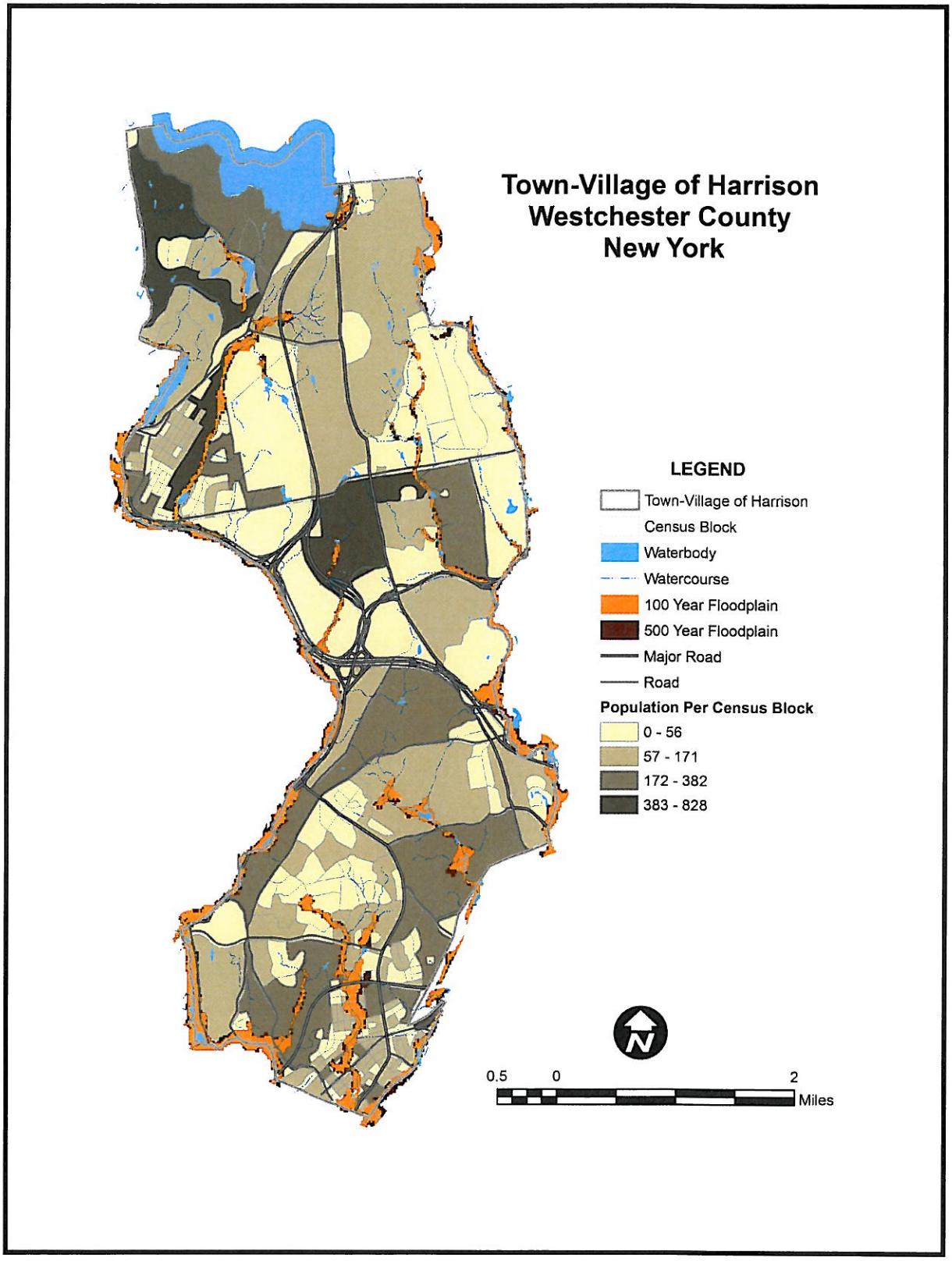
Category	100 Year Event	500 Year Event
Number of People Displaced	1,960	2,291
Households Displaced	653	764
Persons Seeking Temporary Shelter	1,458	1,774

Source: HAZUS-MH

The table above is utilized as part of the municipalities emergency response plan when considering relocation and sheltering needs. Because of numerous past flooding events, those living and working in the floodplain areas are generally aware under what conditions they may experience flooding thus keeping to a minimum injuries and deaths. The emergency response plan for such areas includes closing off of flooded streets which limits the exposure to injury or death to pedestrians and motorists. Increasing public awareness as to the dangers associated with flooding, which is part of this plans mitigation strategy, will aid in reducing future injuries or deaths.

The following Figures and Tables show comparisons between the 100 year and 500 year floodplain areas in relation to population densities for the elderly and low income families.

Figure 5-7 Distribution of Population Density Relative to 100 and 500 Year Floodplains



Source: HAZUS-MH

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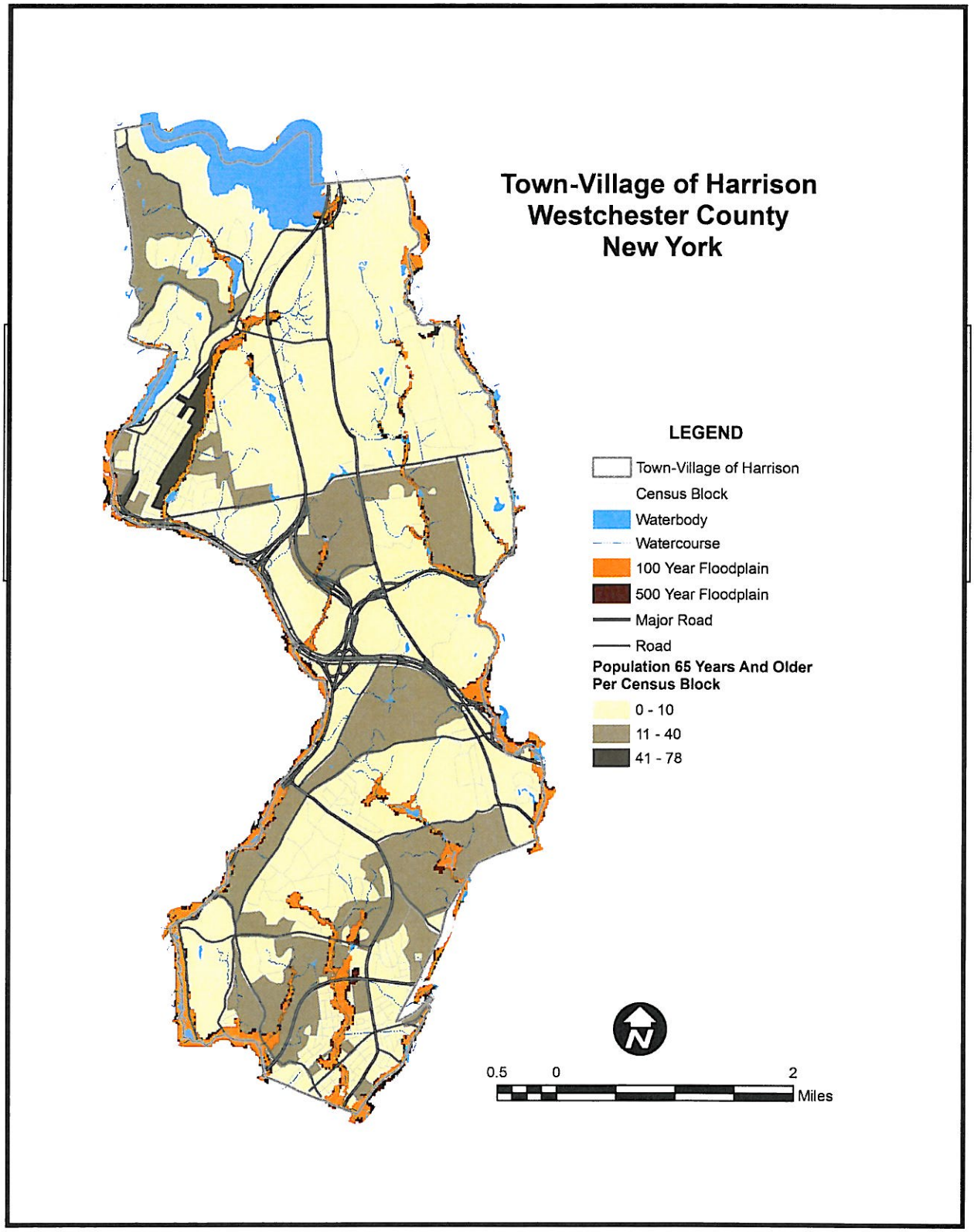
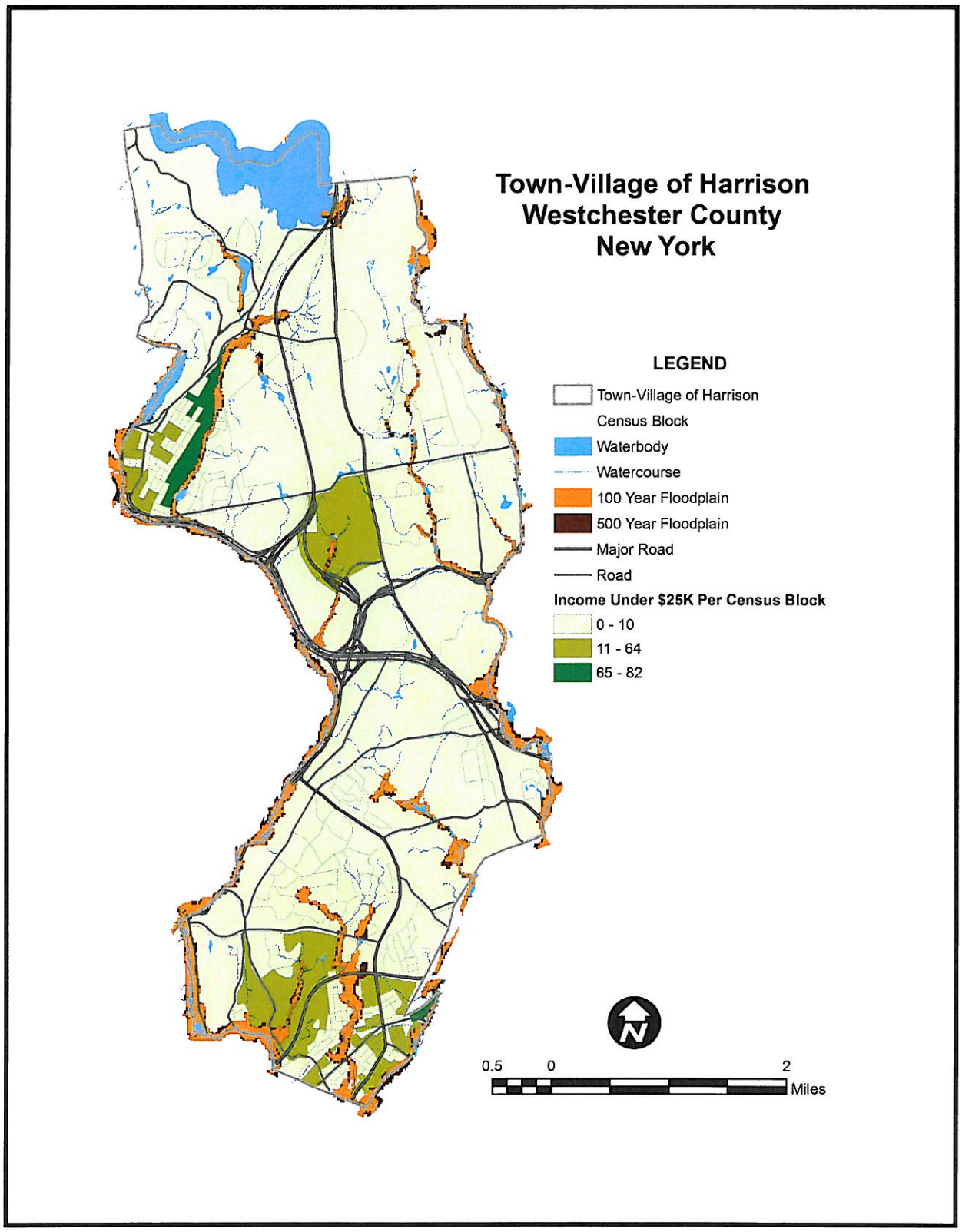
Figure 5-8 Distribution of Elderly Population (65 and older) Relative to 100 and 500 Year Floodplains



Source: HAZUS – MH

Figure 5-9 Distribution of Low Income Population Density Relative to the 100 and 500 Year Floodplains



Source: HAZUS – MH

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Identifying structures including general building stock, critical facilities and critical infrastructure

General Building Stock, Critical Facilities and Critical Infrastructure were evaluated relative to their locations within 100 and 500 year floodplains. The potential loss value was determined using HAZUS – MH. The following Table were created using HAZUS-MH.

Table 5-6: Buildings Exposed to the 100 year and 500 year Flood Hazard Event by Occupancy Class and Total Replacement Value ($1,000)

Building Occupancy Class	Number of Buildings In Study Area	Exposure Value in Study Area (in 2006 dollars)	Percent of Total For Study Area	Exposure Value For 100 Year Event	Percent Total For 100 Year Event	Exposure Value For 500 Year Event	Percent Total For 500 Year Event
Agriculture	57	9,704	.3%	4,946	.3%	4,998	.3%
Commercial	673	669,177	23.6%	481,562	29.4%	484,809	29.1%
Education	27	52,876	1.9%	40,694	2.5%	40,694	2.4%
Government	16	18,789	.7%	15,945	1.0%	15,945	1%
Industrial	190	180,212	6.3%	156,239	9.5%	159,420	9.6%
Residential	6,618	1,865,990	65.8%	919,330	56.1%	936,600	56.3%
Religion	43	41,243	1.5%	20,291	1.2%	21,467	1.3%
Total	**7,624**	2,837,991	100%	1,639,007	100%	1,663,933	100%

Source: HAZUS-MH

Table 5-7 Building Stock by Construction Type as a Percentage of Study Area Total

Building Construction	Count	Percent of Total
Wood	5,409	70.95
Steel	498	6.54
Concrete	183	2.40
Precast	32	.42
Reinforced Masonry	234	3.07
Un-reinforced Masonry	1268	16.63
Manufactured Homes	0	0
Total	7,624	

Source: HAZUS-MH

Table 5-8 Essential Facilities

Category	Number of Facilities in Study Area
Hospitals	0
Medical Clinics	0
Schools	10
Fire Stations	3
Police Stations	1
Emergency Operations	0
Public Works Operations and Maintenance	2

Source: HAZUS-MH / Local Information

Transportation and Utility Lifeline Facilities are those infrastructure both public and privately owned that provide services which allow communities to function and be economically viable. The HAZUS-MH program maintains a local inventory of these facilities including transportation system which include highways, railways, light rail, bus, ports, ferry and airports. Also included in the inventory are utility systems such as potable water, wastewater, natural gas, crude and refined oil, electric power and communications. The total value of the lifeline inventory exceeds $1,209,000,000 and includes 96 kilometers of highways, 43 bridges and 481 kilometers of pipes.

Table:5-9 Transporation System Lifeline Inventory

System	Component	No. of locations / segments	Replacement Value (millions of dollars)
Highway	Bridges	43	655.70
	Segments	19	462.50
	Tunnels	0	0
		Subtotal	1,118.20
Railways	Bridges	1	0
	Facilities	0	0
	Segments	2	11.20
	Tunnels	0	0
		Subtotal	11.20
Light Rail	Bridges	0	0
	Facilities	0	0
	Segments	0	0
	Tunnels	0	0
		Subtotal	0
Bus	Facilities	0	0
		Subtotal	0
Ferry	Facilities		0
		Subtotal	0
Port	Facilities	0	0
		Subtotal	0
Airport	Facilities	1	6.40
	Runways	2	73.30
		Subtotal	79.80
		Total	**1,209.20**

Source: HAZUS-MH

While the facilities shown in Table 5-7 exist in the study area, only a portion of the highway network is the operating and maintenance responsibility of the Town/ Village of Harrison. Highway mileage in the study area is broken down as shown in the Table 5-8

Table 5-10 Municipal Entity Responsible for Highway Transportation System

Municipal Entity Responsible	Mileage
Town/Village of Harrison	81.5
New York State Department of Transportation	23.5
New York State Thruway Authority	6.2
County of Westchester	18.4

Source: New York State Department of transportation Highway Inventory

The railway system is operated and maintained by the Metro-North Commuter Railroad and the Airport is operated and maintained by the County of Westchester.

Table: 5-11 Utility System Lifeline Inventory

System	Component	No. of locations / segments	Replacement Value (millions of dollars)
Potable Water	Distribution Lines	NA	4.80
	Facilities	0	0
	Pipelines	0	0
		Subtotal	4.80
Waste Water	Distribution Lines	NA	2.90
	Facilities	0	0
	Pipelines	0	0
		Subtotal	2.90
Natural Gas	Distribution Lines	NA	1.90
	Facilities	0	0
	Pipelines	0	0
		Subtotal	1.90
Oil Systems	Distribution Lines	0	0
	Facilities	0	0
	Pipelines	0	0
Electric Power	Distribution Lines	0	0
	Facilities	0	0
		Subtotal	0
Communication	Distribution Lines	0	0
	Facilities	0	0
		Subtotal	0
		Total	**9.60**

Source: HAZUS-MH

In order to fully evaluate the potential for damage and loss based on occupancy class, severity of damage to each type of occupancy must also be considered. Table 5-10 provides definitions for damage categories to a light wood framed building.

Table: 5-12 Example of Structural Damage by Category and Description for Light Wood Framed Buildings

Damage Category	Description
None	
Slight	Small plaster or gypsum board cracks at corners of door and window openings and wall /ceiling intersections; Small cracks in masonry chimneys and masonry veneer.
Moderate	Large plaster or gypsum board cracks at corners of doors and window openings; small diagonal cracks across Shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations.
Complete	Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Source: HAZUS-MH, 2005

Economic Impact

HAZUS-MH was utilized to estimate economic losses for buildings, critical facilities and transportation and lifeline systems. Building related losses are broken into two categories: direct building losses and business interruption looses. The direct building losses are estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during a flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood. The total loss estimated for the 100 year floods is 80.86 million dollars and 109.13 million dollars for the 500 year flood which represents 4.93% and 6.57% respectively of the total replacement value of the scenario buildings.

Table 5-13 Building –Related Economic Loss Estimates 100 Year Event (Millions of Dollars)

Category	Area	Residential	Commercial	Industrial	Other	Total
Building Loss	Building	22.22	7.71	3.00	1.19	34.12
	Content	12.70	19.20	7.58	5.45	44.92
	Inventory	0	.20	1.12	.03	1.35
	Subtotal	34.92	27.11	11.69	6.67	80.40
Business Interruption	Income	0	.12	0	.02	.14
	Relocation	.05	.02	0	0	.07
	Rental Income	.02	.01	0	0	.03
	Wage	0	.10	0	.12	.23
	Subtotal	.06	.26	.01	.14	.46
All	Total	34.98	27.37	11.70	6.81	80.86

Source: HAZUS-MH

Table 5-14 Building –Related Economic Loss Estimates 500 Year Event (Millions of Dollars)

Category	Area	Residential	Commercial	Industrial	Other	Total
Building Loss	Building	32.68	10.22	3.65	1.62	48.17
	Content	18.39	25.02	9.03	6.33	56.76
	Inventory	0	.26	1.31	.05	1.62
	Subtotal	51.08	35.50	13.99	8.00	108.56
Business Interruption	Income	0	.15	0	.02	.19
	Relocation	.06	.03	0	0	.09
	Rental Income	.02	.02	0	0	.04
	Wage	0	.14	0	.13	.27
	Subtotal	.08	.33	.01	.15	.57
All	Total	51.16	35.83	13.99	8.14	109.13

Source: HAZUS-MH

For Transportation and Utility Lifeline System Losses, HAZUS-MH computes the direct repair cost for each component only. There are no losses computed by HAZUS-MH for business interruption due to lifeline outages. Long term economic impacts are estimated for 15 years after the earthquake. This information is quantified in terms of income and employment changes within the study area. For the 100 year and 500 year Flood Events, there was no direct economic loss for transportation or lifeline systems.

The direct Economic Losses for Vehicles by type and time of day was calculated by HAZUS-MH. Table 5-13 reflects the values calculated.

Table 5-15 Direct Economic Losses for Vehicles (in dollars)

Category	Cars	Light Trucks	Heavy Trucks	Total
Study Area Day	$43,656,746	$18,358,965	$33,984,571	$96,000,232
Study Area Night	$66,568,078	$27,993,864	$51,819,886	$146,381,827
100 Year Event Day	$3,440,254	$1,247,078	$1,154,519	$5,841,851
100 Year Event Night	$2,986,099	$918,334	$744,474	$4,648,907
500 Year Event Day	$3,796,645	$1,417,639	$1,628,726	$6,843,010
500 Year Event Night	$3,696,750	$1,196,021	$1,054,457	$5,947,228

Source: HAZUS-MH

HAZUS-MH, for the 100 year and 500 year flood event scenarios, did not indicate any Economic Income and Employment Impact with or without outside aid.

Addressing Repetitive Loss Properties (NFIP data for floods)

The Federal Emergency Management Agency National Flood Insurance Program provides flood loss data as a result of insurance claims filed by home/business owners who have purchased a separate insurance policy with respect to flood damage. Loss information based on claims files is shown in the following table:

Table 5-16 FEMA NFIP Loss Cases and Payments to the Town/Village of Harrison 1978 to November 30, 2008 (Repetitive and Non-Repetitive)

Total Losses	Closed Losses	Open Losses	Closed without Payment	Total Payments
668	558	0	110	$3,476,352

Source: FEMA NFIP BureauNet (http://bsa.nfipstat.com/reports/1040.htm#36)

The Town / Village of Harrison requested and received from the New York State Department of Environmental Conservation Floodplain Management Section, repetitive flood loss information for buildings for the period 1978 through December 2008. Buildings defined as repetitive loss are those sustaining four or more paid losses of more than $1,000 each, or two losses within a 10-year period that, in the aggregate, equal or exceed the current value of the insured property, or three or more losses that, in the aggregate, equal or exceed the current value of the insured property. For the study area, a total of 66 properties were identified as having incurred repetitive losses. Property types incurring repetitive losses include 34 single family units, 27 multi-family (2-4) units, 2 condominium units and 3 non-residential properties. Tables 5-17 and 5-18 list the number of repeat losses and losses in defined flood zones.

Table 5-17 Properties sustaining multiple repetitive losses

Number of repetitive losses	Number of Properties sustaining losses
2	25
3	21
4	13
5	3
6	1
7	0
8	0
9	1
10	0
11	2

Source: NYSDEC Floodplain Management Section

Table 5-18 Properties sustaining losses by flood zone type

Flood Zone Designation	Number of Repetitive Loss Properties in the Flood Zone	Flood Zone Description (See glossary for detailed descriptions)
A	14	An area inundated by 100 year flooding for which no Base Flood Elevations (BFE's) have been established
AE	16	An area inundated by 100 year flooding for which BFE's have been determined
AH	20	An area inundated by 100 year flooding (usually ponding) for which BFE's have been determined, flood depths may range from 1 – 3 feet
B	1	An area inundated by 100 year and 500 year flooding
C	3	An area determined to be outside the 100 year floodplain
A02	1	An area inundated by 100 year flooding for which no BFE's have been established
A07	3	An area inundated by 100 year flooding for which no BFE's have been established
X	8	An area determined to be outside the 100 year floodplain

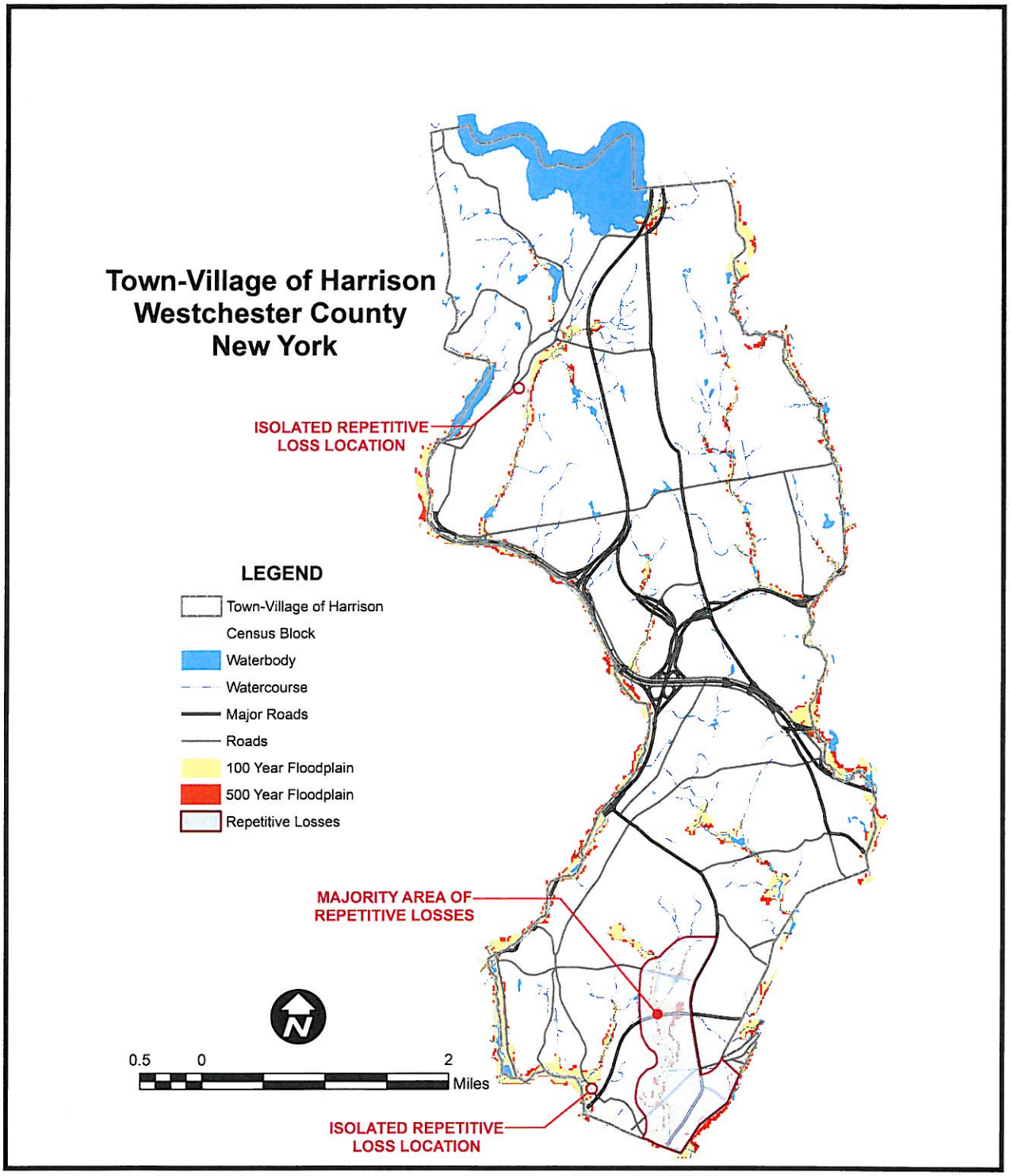
Source: NYSDEC Floodplain Management Section

Taking the Repetitive Flood Loss Data provided and overlaying the loss locations on the study area's FIRM maps, it is estimated that 90% of the Repetitive loss building are located in, or are in close proximity to the 100 and 500 year floodplains. Figure 5.9A shows the 100 and 500 year floodplain areas overlaid with the location of 65 of the 66 Repetitive Loss locations.

In order to estimate the vulnerability in terms of estimated potential dollar losses, actual loss information was taken from the data provided, analyzed and categorized for all the Repetitive Loss Buildings. Based on the data provided, there were 217 reported losses for the 66 identified properties. The total dollar value of these losses was $1,840,099.00 and the average payout per

loss was $8,480.00. The largest single payout averaged $85,786.00 on a non-residential structure with 2 reported claims. The largest single payout on a resident structure averaged $78,221.00 with 2 reported claims

Figure 5.9A. 100 and 500 year floodplain areas overlaid with Repetitive Loss locations.



Source: HAZUS-MH, NFIP Loss Data

Narrative of Flood Area

The area in which the majority of repetitive losses takes place (99% of all loss properties) is locally identified as the downtown area of Harrison. The area which has sustained the greatest number of impacted properties is bounded by the New England Thruway on the north and west, by Harrison Avenue (NY127) on the east, and the New Haven Division of the Metro North Commuter Railroad on the south. The majority of other impacted areas are just north and south of this area (see Figure 5.9A).

The natural features which make up the area where the majority of losses take place includes the relative consistency in elevation over a large area. Combined with both an aged and outdated stormwater conveyance system, the majority of the area lies in the 100 and 500 year floodplain, or may be influenced by the 100 and 500 year floodplain depending on storm intensity and duration. Land use is primarily residential with single and two family homes on small parcels of 5,000 to 10,000 square feet. Two schools with associated playing fields and a pond are located on the north side of the area. The area is generally considered to be built out with minimal vacant land present.

There are 4 streams which impact the flood loss area. Flowing from the north are Nelson Creek, Woodlands Road Brook 1 and 2, and Brentwood Brook. Flowing along the south side of the impacted area is the Beaver Swamp Brook.. These watercourse features are shown on the Town/Village of Harrison Flood Insurance Rate Maps (FIRMS).

National Flood Insurance Program – Community Rating System

The Town / Village of Harrison is not a participant in the National Flood Insurance Program Community Rating System (CRS) meaning that the community is classified as a 10 and that flood insurance purchased does not receive a discount for efforts by the Town / Village of Harrison to mitigate flooding.

As part of the Town/Village's mitigation efforts, registration with and participation in the National Flood Insurance Program – Community Rating System will be implemented . Details of this effort are included in the Mitigation Strategies section

Estimating Potential Losses

Vulnerability in terms of dollar losses provides the study area and the State with a common framework in which to measure the effects of hazards on vulnerable structures.

HAZUS-MH was utilized to develop estimated losses based on 100 year and 500 year floodplains events The analysis in Tables 5-15 to 5-19 reflects loss data for 100 and 500 year flood events.

For the 100 year floodplain event it is estimated that 86 buildings will be at least moderately damaged with 19 completely destroyed. (definitions with respect to "damage states" is documented in Volume 1, Chapter 5 of the HAZUS Flood Technical Manual.

Table 5-19 Expected Building Damage by Occupancy and Range of Damage Percent (%) (100 year event)

Occupancy	Count / 1-10%	Count / 11-20%	Count / 21-30%	Count / 31-40%	Count/ 41-50%	Count/ Substantially
Agriculture	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Commercial	0 / 0	3 / 100	0 / 0	0 / 0	0 / 0	0 / 0
Education	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Government	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Industrial	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Religion	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Residential	0 / 0	8 / 9.64	10 / 12.05	22 / 26.51	24 / 28.92	19 /22.89
Total Count	0 / 0	11	10	22	25	19

Source: HAZUS-MH

Table 5-20 Expected Building Damage by Building Type and Range of Damage Percent (%) (100 year event)

Building Type	Count / 1-10%	Count / 11-20%	Count / 21-30%	Count / 31-40%	Count/ 41-50%	Count/ Substantially
Concrete	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Manufactured Hsg	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Masonry	0 / 0	1 / 12.50	2 / 25.00	1 / 12.50	3 / 37.50	1 / 12.50
Steel	0 / 0	1 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Wood	0 / 0	8 / 10.81	7 / 9.46	21 / 28.38	20 / 27.03	18 / 24.32

Source: HAZUS-MH

For the 500 year floodplain event it is estimated that 145 buildings will be at least moderately damaged with 36 completely destroyed. (definitions with respect to "damage states" is documented in Volume 1, Chapter 5 of the HAZUS Flood Technical Manual.

Table 5-21 Expected Building Damage by Occupancy and Range of Damage Percent (%) (500 year event)

Occupancy	Count / 1-10%	Count / 11-20%	Count / 21-30%	Count / 31-40%	Count/ 41-50%	Count/ Substantially
Agriculture	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Commercial	0 / 0	3 / 100	0 / 0	0 / 0	0 / 0	0 / 0
Education	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Government	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Industrial	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Religion	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Residential	0 / 0	10 / 7.04	17 / 11.97	43 / 30.28	36 / 25.35	36 /25.35
Total Count	0 / 0	13	17	43	365	36

Source: HAZUS-MH

Table 5-22 Expected Building Damage by Building Type and Range of Damage Percent (%) (500 year event)

Building Type	Count / 1-10%	Count / 11-20%	Count / 21-30%	Count / 31-40%	Count/ 41-50%	Count/ Substantially
Concrete	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Manufactured Hsg	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Masonry	0 / 0	1 / 12.50	3/ 20.00	4 / 26.67	3 / 20.00	4 / 26.67
Steel	0 / 0	1 / 0	0 / 0	0 / 0	0 / 0	0 / 0
Wood	0 / 0	10 / 8.00	14 / 11.20	37/29.60	33 / 26.40	31 / 24.80

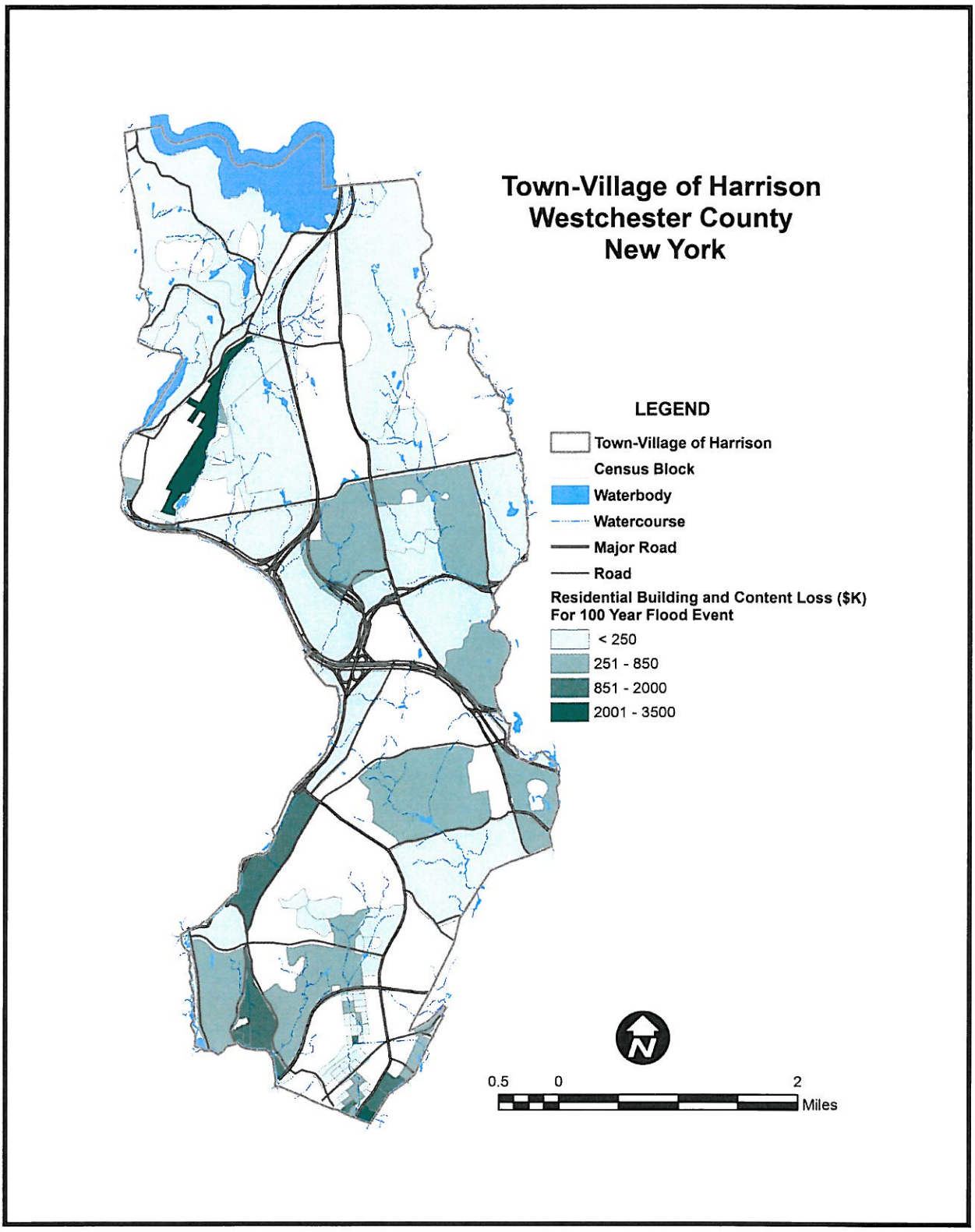
Source: HAZUS-MH

Table 5-23 School Damage and Functionally ($1,000)

Event Scenario	Count of Schools	Total Building Damage ($)	Total Content Damage ($)	Non-Functional Schools	Average Restoration Time
100 Year	1	376.18	2,036.85	0	480
500 Year	3	647.96	3,507.18	1	480

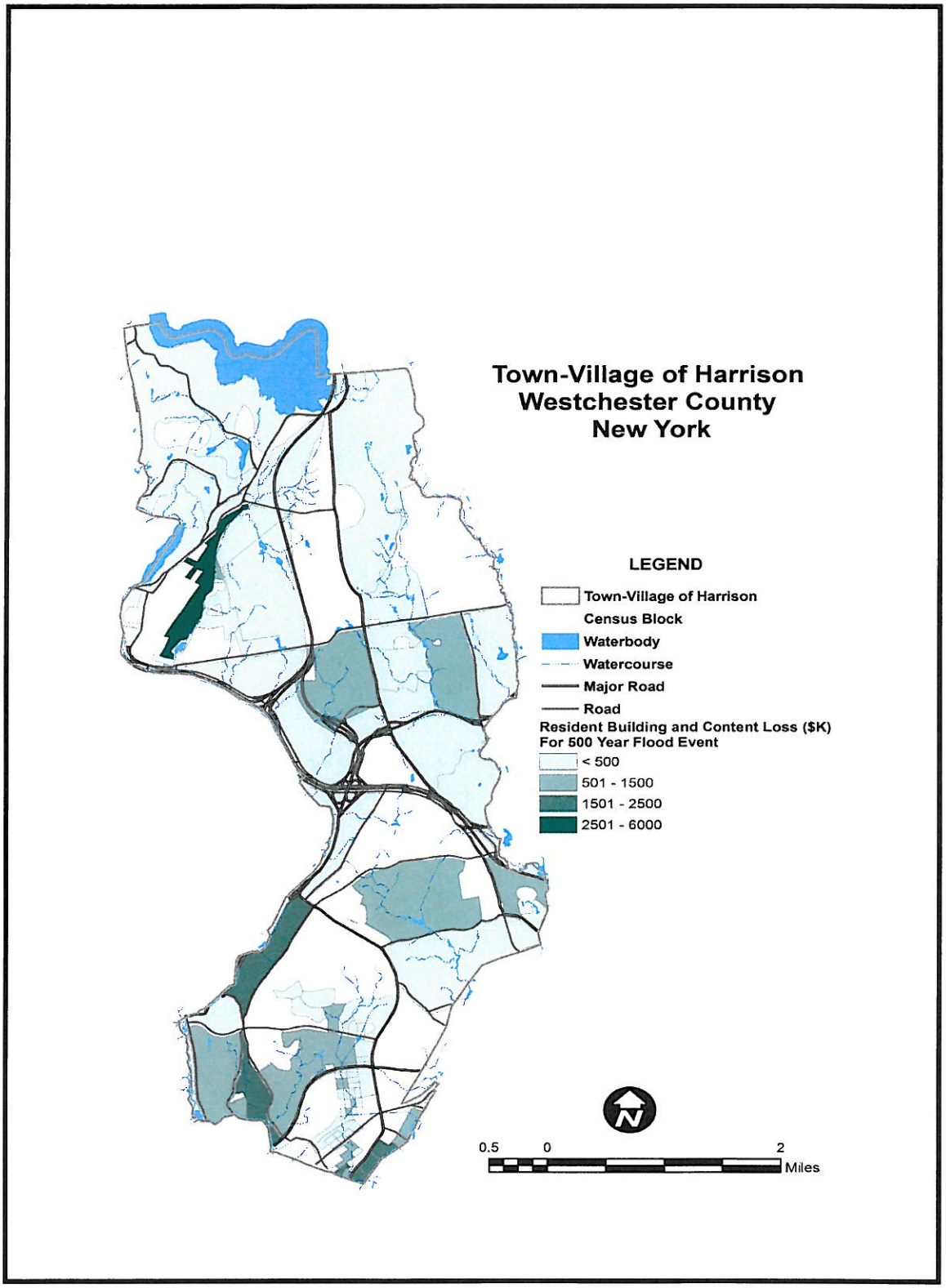
For Transportation and Utility Lifeline System Losses, HAZUS-MH computes that none of these facilities would be flooded / sustain flood damage. Based on past experience, these type of analysis, are better left to local officials since some form of damage, particularly to highways and stormwater culverts has occurred in the past as a result of flood events. The need for further analysis will be addressed in the Mitigation Strategy Section of this Plan.

Figure 5-10 Density of Losses for Residential Buildings (Structure and Content) for the 100 year Flood Event



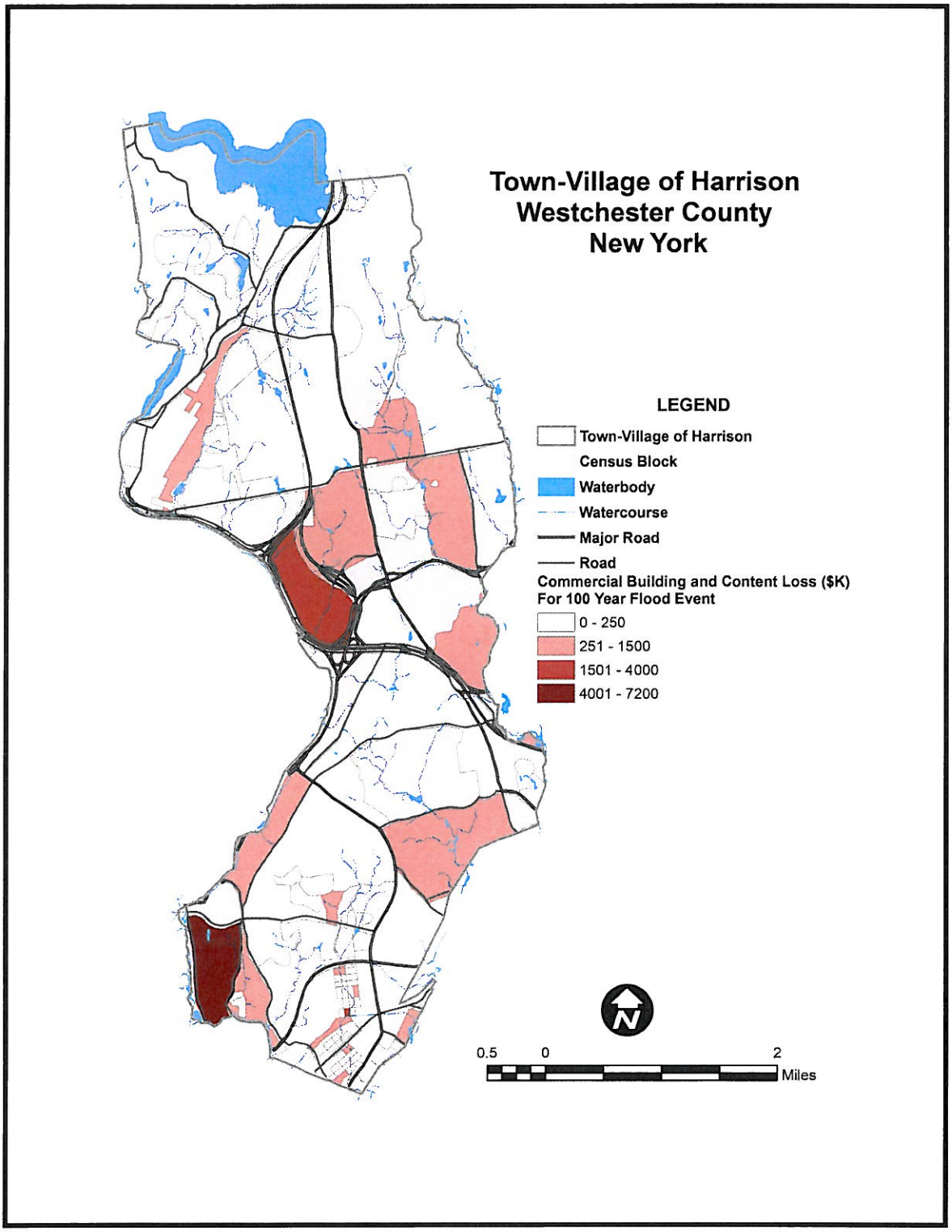
Source: HAZUS –MH

Figure 5-11 Density of Losses for Residential Buildings (Structure and Content) for the 500 year Flood Event



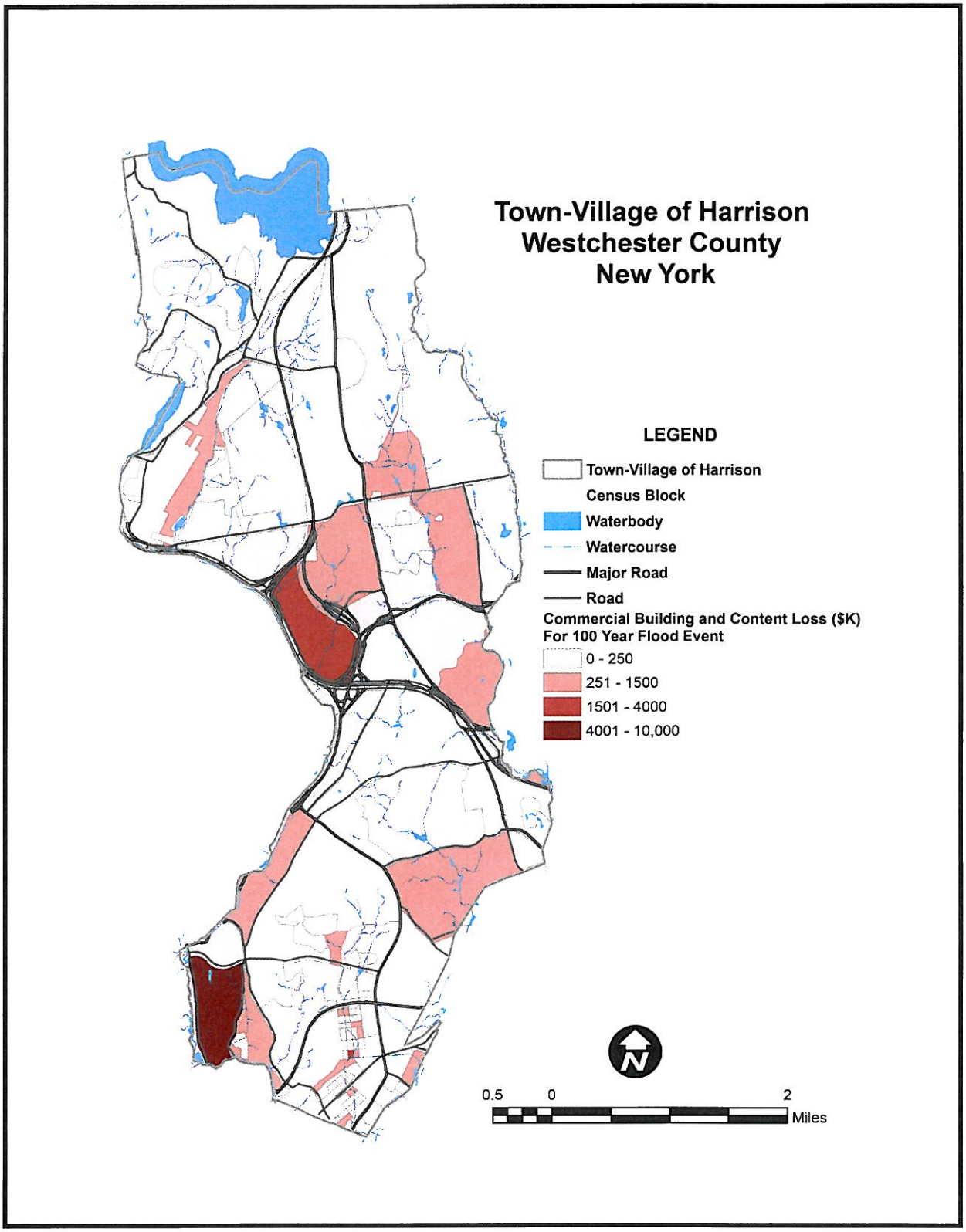
Source: HAZUS –MH

Figure 5-12 Density of Losses for Commercial Buildings (Structure and Content) for the 100 year Flood Event



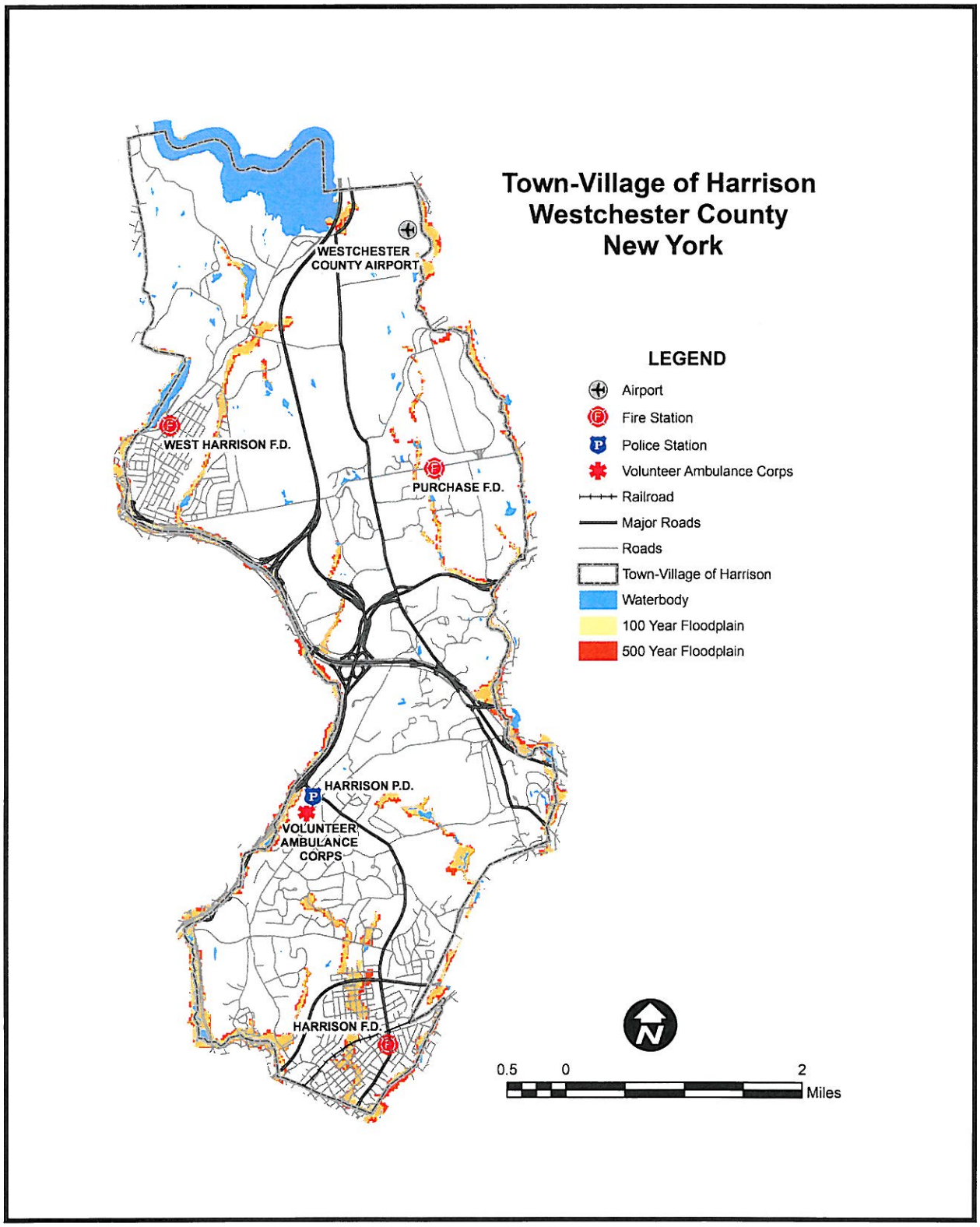
Source: HAZUS -MH

Figure 5-13 Density of Losses for Commercial Buildings (Structure and Content) for the 500 year Flood Event



Source: HAZUS –MH

Figure 5-14 Critical Facilities in relation to the 100 and 500 year floodplains



Source: Local information/ HAZUS-MH and WCGIS

In April 2007, the Town / Village sustained severe flooding which resulted in a Federal Disaster Declaration (DR-1692-NY) which provided both individual and public assistance. Widespread areas of the Town Village sustained flooding including the following areas/streets:

Loss data NFIP properties for this flood event is provided elsewhere in this plan. The Town / Village submitted assistance applications to FEMA in the amount of $ XXXXXXXXXXfor which included damage to infrastructure, equipment and debris management.

In addition to general building stock at risk form floods, critical facilities and infrastructure susceptible to floods were also evaluated. Critical facilities include police, fire, EMS, public works, schools, hospitals, senior facilities and transportation/transmission systems. Figure 5-14 depicts where these type facilities are located in the Town/Village of Harrison

According to the analysis, the following critical facilities are in or are in close proximity to the 100 and 500 year floodplains and thus may be susceptible to damage or destruction during a flood hazard event:

- Portions of the Public Works and Fleet Maintenance Facility on Harrison Avenue

As a result of floods, debris is generated as a result of damage to buildings and infrastructure as well as natural features such as trees and rock formations. HAZUS –MH estimates the amount of debris which can be generated by a particular earthquake event. The model breaks the debris into three general categories; finishes, structures and foundations This distinction is made due to the different types of material handling equipment required to handle the debris. Table: XXX shows to amount of debris generated by event scenario.

Table: 5-24 Debris Generated (Tons)

Category	100 Year Event	500 Year Event
Finishes	2,928	4,120
Structures	01,218	1,943
Foundations	948	1,547

Source: HAZUS-MH

Analyzing Development Trends (new buildings, critical facilities and Infrastructure)

Section 4 of this plan Municipal Profile – Future Development identifies several areas in the Town / Village of Harrison where the potential for development or redevelopment exists. As of January 1, 2009, construction underway is limited due to the economic turndown. Recent changes to the New York State Building Code have increased first floor elevations in residential units from 1 foot to 2 feet above the base flood elevation and includes other provisions related to flooding. Any structures which are proposed need to take into account there impact on the surrounding areas due to any increases in impervious surfaces as well as the ability of the existing stormwater conveyance system to accommodate increased flows. Where newly developed or redeveloped sites are proposed the concept of zero (0) runoff should be given due consideration.

Additional Data and Next Steps

The Town/Village of Harrison will continue to monitor and record the impacts of flood hazard events as they occur, better educate the public about flooding and encourage the use of the NFIP Flood Insurance Program. Monitoring and recording of the impacts of flood events will allow for both short term and long range planning for improving stormwater conveyance infrastructure where possible which will in term lessen the impacts of flood hazard events.

Overall vulnerability conclusion

The flood hazard has been determined to be a significant event and has been ranked as a high risk for the Town /Village of Harrison.