Spruce Run and Mulhockaway Creek Watershed Restoration and Protection Plan

April 16 & 17, 2024

RUTGERS
New Jersey Agricultural Experiment Station

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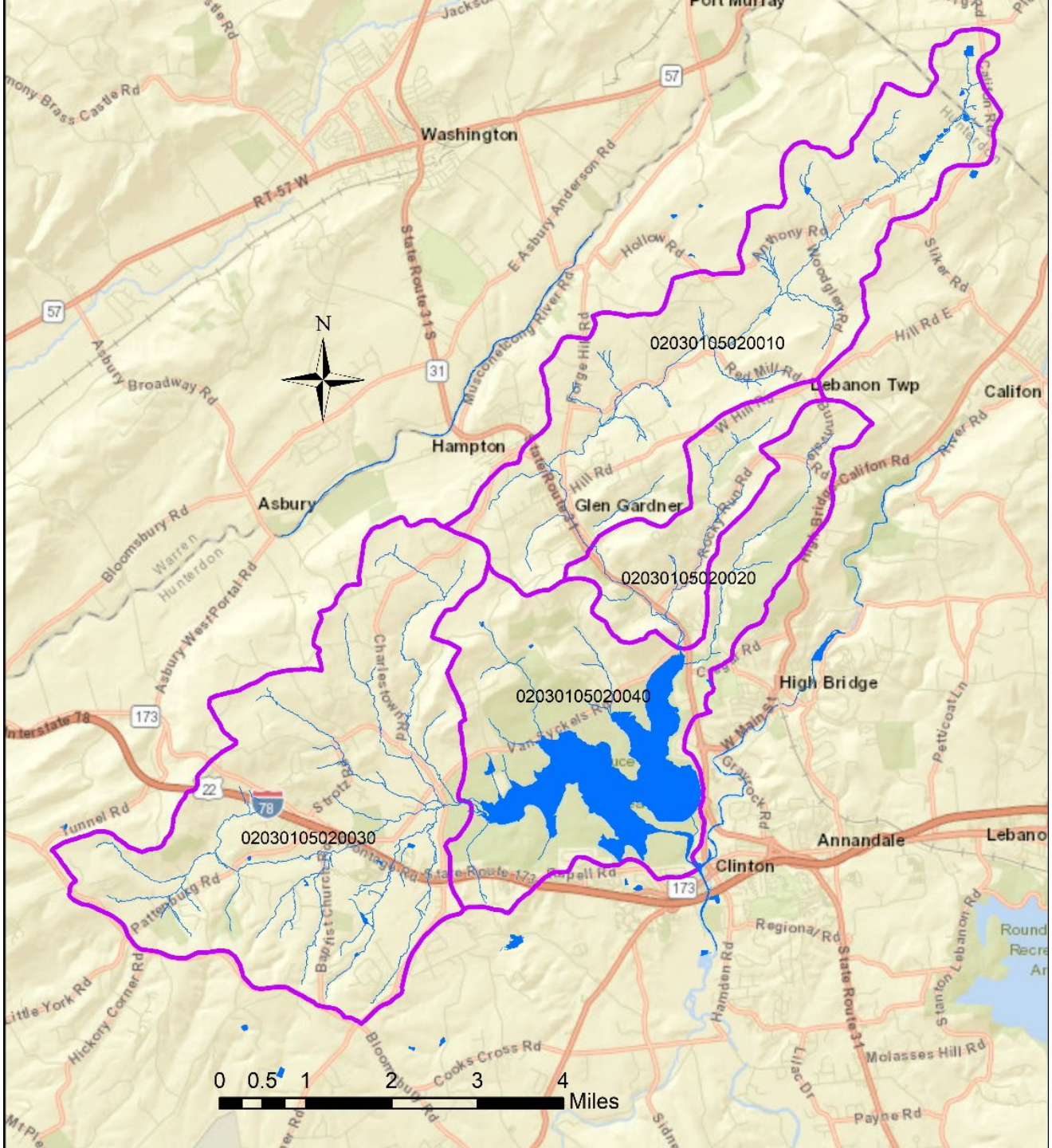
Criteria #1: Identification of the causes and sources of pollutant loading to the Spruce Run and Mulhockway Creek


N
Washington
Hampton
Asbury
Glen Gardner
Lebanon Twp
Califon
High Bridge
Annandale
Clinton
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02030105020020
02030105020040
02030105020030
RT-57-W
State Route 31 S
E Asbury Anderson Rd
Musconetcong River Rd
Forge Hill Rd
Hollow Rd
Anthony Rd
Woodglen Rd
Sliker Rd
Hill Rd E
Red Mill Rd
W Hill Rd
Bunnvale Rd
Califon Rd
River Rd
Asbury Broadway Rd
Bloomsbury Rd
Warren
Hunterdon
Asbury West Portal Rd
Interstate 78
Tunnel Rd
Charlestown Rd
Strotz Rd
Baptist Church Rd
Pattenburg Rd
Little York Rd
Hickory Corner Rd
Bloomsbury Rd
Cooks Cross Rd
Rocky Run Rd
High Bridge Rd
Van Syckels Rd
W Main St
Grantock Rd
Petticoat Ln
Rapell Rd
Regional Rd
Hamden Rd
Stanton Lebanon Rd
Molasses Hill Rd
Payne Rd
Lilac Dr
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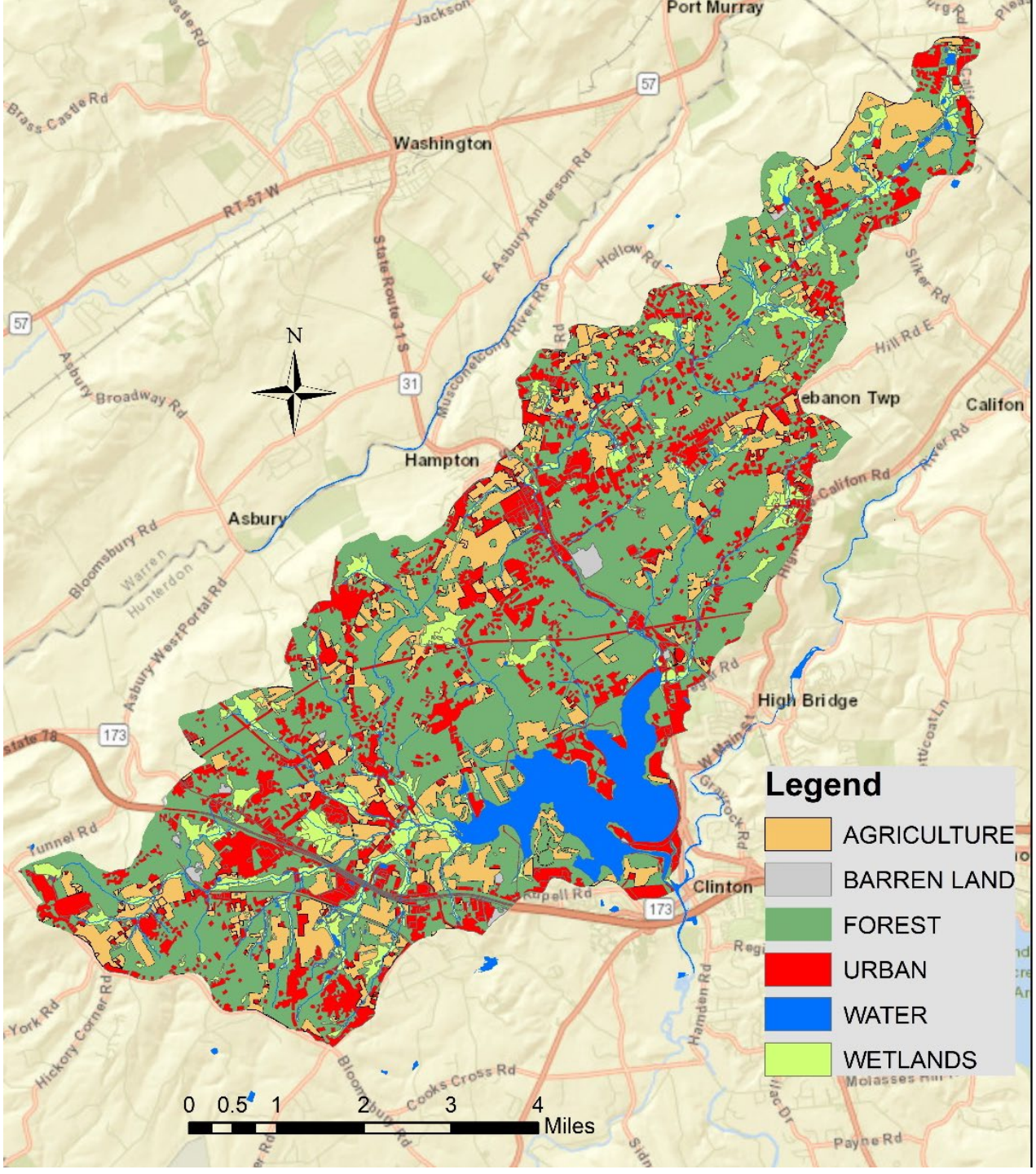
Miles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Asbury West Portal Rd
High Bridge
W Main St
Tunnel Rd
Clinton
Rupell Rd
Hickory Corner Rd
Cooks Cross Rd
Hamden Rd
Payne Rd
Molasses Hill
57
31
173
Legend
AGRICULTURE
BARREN LAND
FOREST
URBAN
WATER
WETLANDS
0 0.5 1 2 3 4
Miles

	Percentage (%)			
Land Use	HUC14: 020301050 …			
	20010	20020	20030	20040
Agriculture	19.2%	13.6%	17.4%	11.0%
Barren Land	0.1%	2.6%	0.4%	0.2%
Forest	47.0%	61.5%	46.0%	45.3%
Urban	22.7%	18.3%	25.0%	19.5%
Water	0.8%	0.7%	0.5%	18.9%
Wetlands	10.2%	3.3%	10.6%	5.1%
Total:	100%	100%	100%	100%

02030105020010 - Spruce Run (above Glen Gardner)
02030105020020 - Spruce Run (Reservoir to Glen Gardner)
02030105020030 – Mulhockaway Creek
02030105020040 - Spruce Run Reservoir/Willoughby Brook.

	Totals	Totals	Change from
Land Use	2015	2020	2015 to 2020
	(acres)	(acres)	(acres)
Agriculture	4,299	4,227	-72
Barren Land	134.9	121.1	-14
Forest	12,566	12,615	49
Urban	5,906	5,939	32
Water	1,503	1,510	7
Wetlands	2,248	2,245	-3

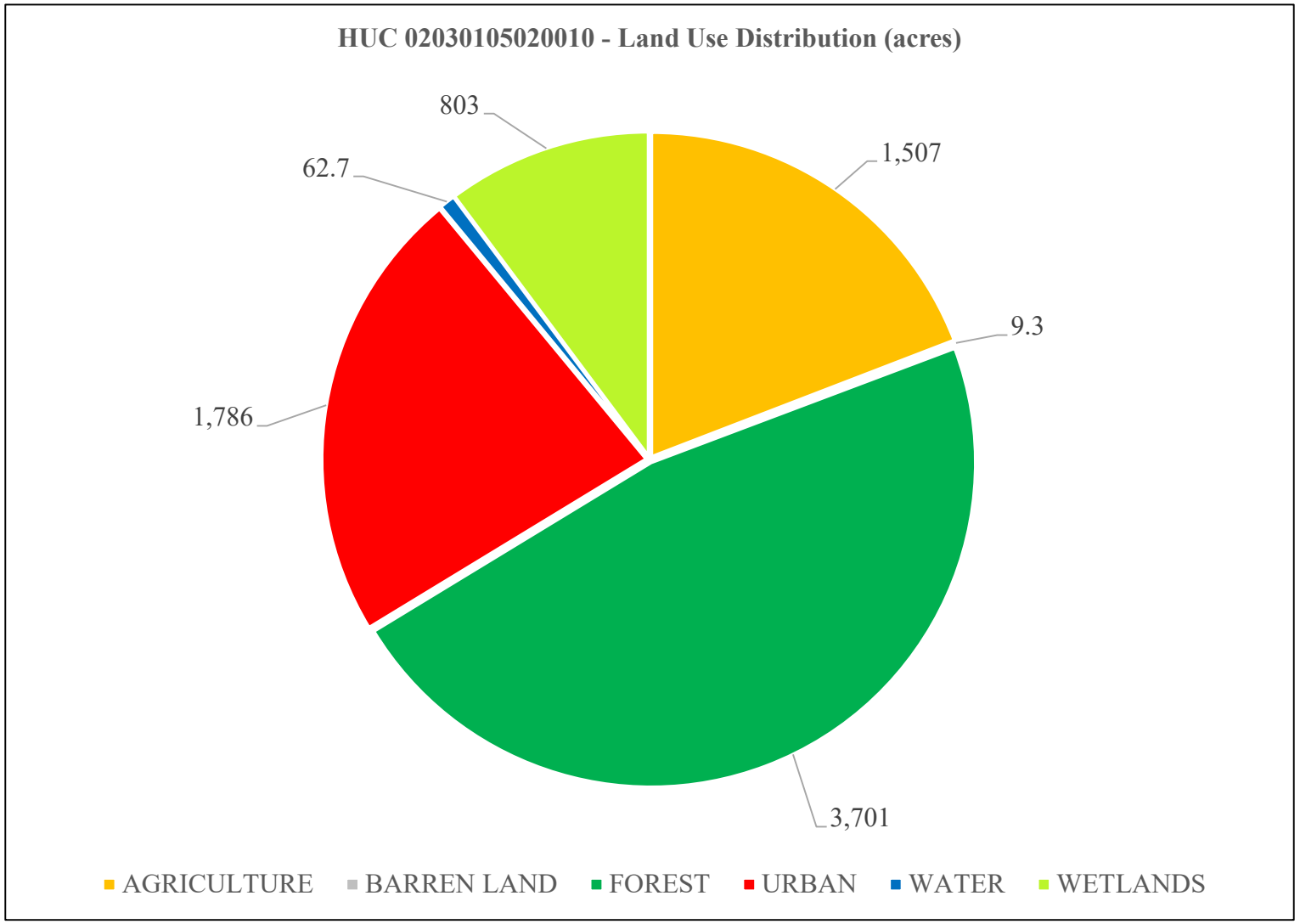
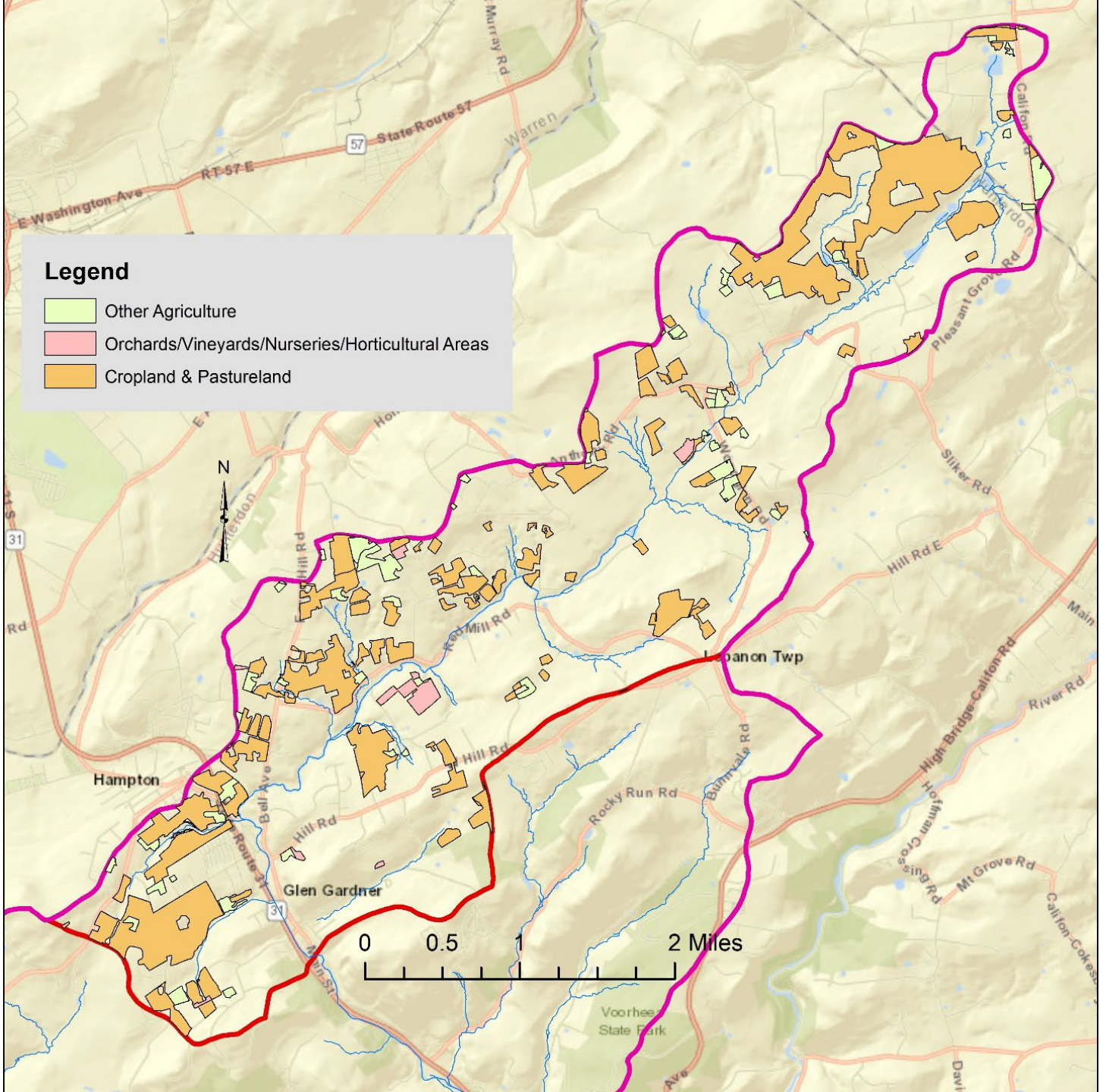


Figure 8a: Land use distribution in acres for HUC 02030105020010 - Spruce Run (above Glen Gardner) (Ref: NJDEP, 2020)

HUC 14	Agricultural Land Use	Area (ac)
02030105020010	Cropland & Pastureland	1,301
	Orchards/Vineyards/Nurseries/Horticultural Areas	44.9
	Other Agriculture	179
	Totals =	1,525
02030105020020	Cropland & Pastureland	280
	Orchards/Vineyards/Nurseries/Horticultural Areas	3.7
	Other Agriculture	38.1
	Totals =	322
02030105020030	Cropland & Pastureland	1,432
	Orchards/Vineyards/Nurseries/Horticultural Areas	77.1
	Other Agriculture	134
	Totals =	1,644
02030105020040	Cropland & Pastureland	764
	Orchards/Vineyards/Nurseries/Horticultural Areas	15.2
	Other Agriculture	29.5
	Totals =	808
Total	Cropland & Pastureland	3,777
	Orchards/Vineyards/Nurseries/Horticultural Areas	141
	Other Agriculture	381
		4,299


Legend
Other Agriculture
Orchards/Vineyards/Nurseries/Horticultural Areas
Cropland & Pastureland
N
0
0.5
1
2 Miles
Hampton
Glen Gardner
Lebanon Twp
Warren
State Route 57
RT 57 E
E Washington Ave
Murray Rd
Hill Rd
Mill Rd
Rocky Run Rd
Bunnvale Rd
High Bridge-Califon Rd
River Rd
Mt Grove Rd
Pleasant Grove Rd
Sliker Rd
Hill Rd E
Main St
Bell Ave
Route 31
Voorhees State Park

Land Cover	Total Phosphorus (TP) Load (lbs/acre/yr)	Total Nitrogen (TN) Load (lbs/acre/yr)	Total Suspended Solids (TSS) Load (lbs/acre/yr)
High, Medium Density Residential	1.4	15	140
Low Density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, Mixed Urban, Other Urban	1.0	10	120
Agriculture	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland/ Transitional Area	0.5	5	60

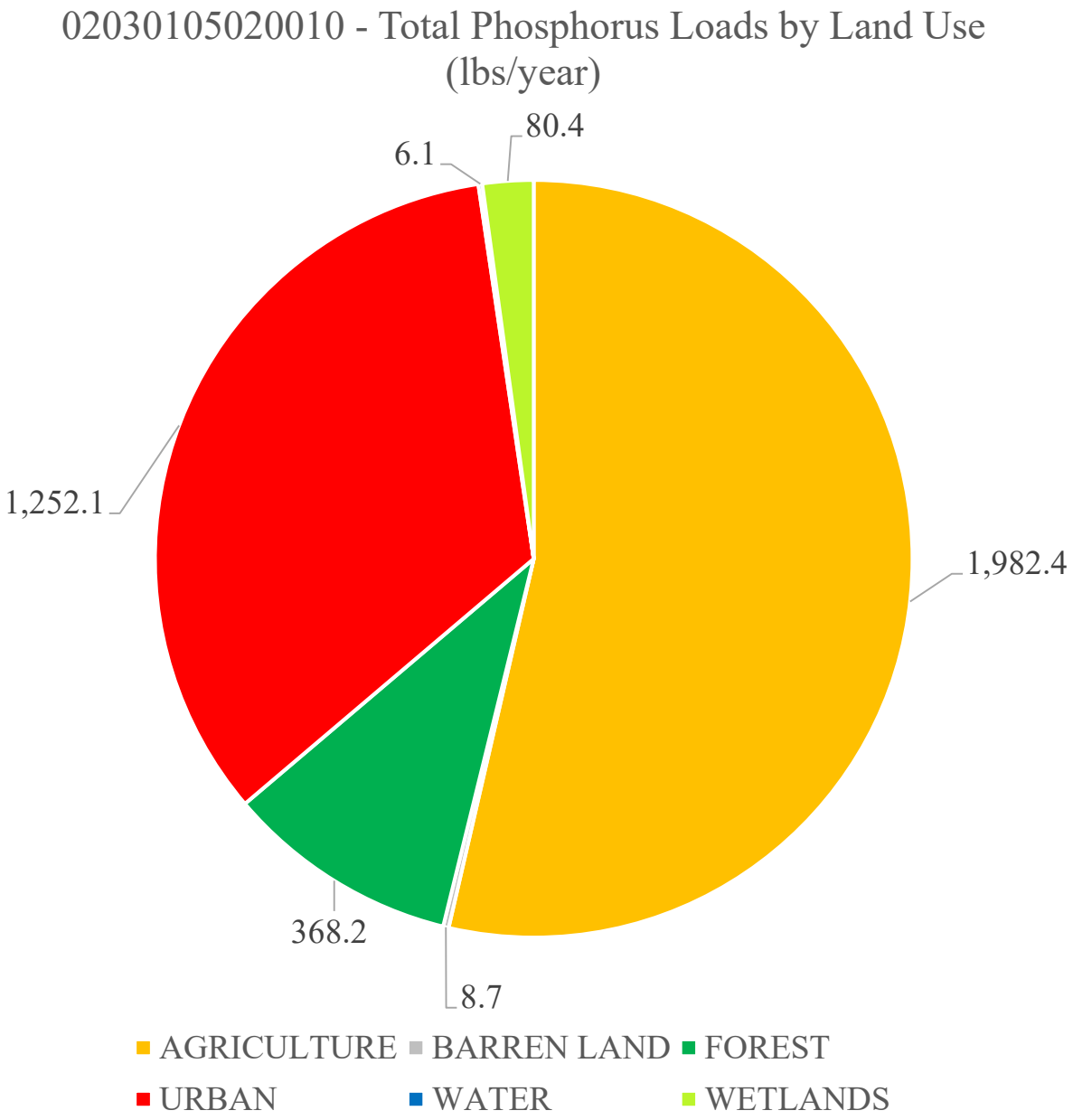
Land Use Code	Land Use Label	Land Use Type	TP	TN	TSS
1110	Residential, High Density Or Multiple Dwelling	Urban	1.4	15	140
1120	Residential, Single Unit, Medium Density	Urban	1.4	15	140
1130	Residential, Single Unit, Low Density	Urban	0.6	5	100
1140	Residential, Rural, Single Unit	Urban	0.6	5	100
1200	Commercial/Services	Urban	2.1	22	200
1300	Industrial	Urban	1.5	16	200
1400	Transportation				200
1410	Major Roadwa				200
1419	Bridge Over W				40
1420	Railroads				200
1461	Wetland Rights-Of-Way	Wetlands	0.1	3	40
1462	Upland Rights-Of-Way Developed	Urban	1	10	120
1463	Upland Rights-Of-Way Undeveloped	Urban	1	10	120
1499	Stormwater Basin	Urban	0.6	5	100
1600	Mixed Urban Or Built-Up Land	Urban	1	10	120
1700	Other Urban Or Built-Up Land	Urban	1	10	120
1710	Cemetery	Urban	1	10	120
1750	Managed Wetland In Maintained Lawn Greenspace	Wetlands	0.1	3	40

58 Unique Land Use Codes

(See Table 7)

General				
Land Use	Area	TP	TN	TSS
Category	(acres)	(lbs/yr)	(lbs/yr)	(lbs/yr)
Agriculture	1,524.9	1,982.4	15,249.4	457,482
Barren Land	17.4	8.7	86.8	1,042
Forest	3,682.1	368.2	11,046.4	147,286
Urban	1,779.3	1,252.1	11,138.0	189,367
Water	60.7	6.1	182.1	2,428
Wetlands	803.8	80.4	2,411.4	32,152
Totals =	7,868.3	3,697.9	40,114.2	829,756

Table 8: Pollutant loads for HUC 02030105020010 — Spruce Run (above Glen Gardner)


02030105020010 - Total Phosphorus Loads by Land Use (lbs/year)
80.4
6.1
1,252.1
1,982.4
368.2
8.7
AGRICULTURE
BARREN LAND
FOREST
URBAN
WATER
WETLANDS

General				
Land Use	Area	TP	TN	TSS
Category	(acres)	(lbs/yr)	(lbs/yr)	(lbs/yr)
Agriculture	4,299	5,589	42,989	1,289,658
Barren Land	134.9	67.5	674.5	8,094
Forest	12,566	1,257	37,698	502,634
Urban	5,906	4,718	43,686	671,442
Water	1,503	150.4	4,508	60,101
Wetlands	2,248	224.9	6,745	89,934
Totals =	26,656	12,006	136,299	2,621,863

Table 12: Total pollutant loads for all HUC14s

HUC 14 020301050…	Agricultural Land Use	Area (ac)	TP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)
20010	Cropland & Pastureland	1,301	1,691	13,008	390,235
	Orchards/Vineyards/Nurseries/Horticultural Areas	44.9	58.4	449	13,479
	Other Agriculture	179	233	1,792	53,768
	Totals =	1,525	1,982	15,249	457,482
20020	Cropland & Pastureland	280	364	2,803	84,094
	Orchards/Vineyards/Nurseries	3.7	4.8	36.8	1,104
	Other Agriculture	38.1	49.6	381	11,443
	Totals =	322	419	3,221	96,642
20030	Cropland & Pastureland	1,432	1,862	14,323	429,690
	Orchards/Vineyards/Nurseries	77.1	100	771	23,119
	Other Agriculture	134	174	1,342	40,255
	Totals =	1,644	2,137	16,435	493,065
20040	Cropland & Pastureland	764	993	7,635	229,064
	Orchards/Vineyards/Nurseries	15.2	19.8	152	4,566
	Other Agriculture	29.5	38.3	295	8,838
	Totals =	808	1,051	8,082	242,469
Total	Cropland & Pastureland	3,777	4,910	37,769	1,133,084
	Orchards/Vineyards/Nurseries	141	183	1,409	42,268
	Other Agriculture	381	495	3,810	114,305
	Totals =	4,299	5,589	42,989	1,289,657

Storm	Runoff Volume 2020 Design Storms (Acre-Feet)			
	20010	20020	20030	020040
Water Quality Storm (1.25")	50.5	13.6	66.9	37.9
2-Year Storm (3.45")	596	135	703	419
10-Year Storm (5.25")	1,340	311	1,576	956
100-Year Storm (9.07")	3,288	786	3,874	2,382

Storm	Runoff Volume 2100 Design Storms (Acre-Feet)			
	20010	20020	20030	020040
Water Quality Storm (1.25")	50.5	13.6	66.9	37.9
2-Year Storm (4.02")	813	185	957	574
10-Year Storm (6.15")	1,766	414	2,077	1,265
100-Year Storm (11.40")	4,600	1,111	5,256	3,351

Class	HUC 020010 Area (acres)	HUC 020020 Area (acres)	HUC 020030 Area (acres)	HUC 020040 Area (acres)
Building	81.3	17.9	99.3	55.8
Other	195.4	71.6	292.9	174.3
Road	185.1	50.9	272.6	167.8
TOTAL	461.7	140.5	664.8	397.9
% IC by HUC14	5.9%	6.8%	7.1%	5.4%

Date	Daily Totals (inches)	Date	Daily Totals (inches)	Date	Daily Totals (inches)
1/1/2021	0.73	5/5/2021	0.45	8/18/2021	0.1
1/3/2021	0.18	5/8/2021	0.38	8/19/2021	0.92
1/15/2021	0.1	5/9/2021	0.31	8/22/2021	3.68
1/16/2021	0.45	5/26/2021	0.42	8/23/2021	1.99
1/31/2021	0.29	5/28/2021	1.33	8/28/2021	0.12
2/1/2021	2.01	5/29/2021	0.61	9/1/2021	6.34
2/2/2021	0.29	5/30/2021	0.45	9/2/2021	0.2
2/7/2021	0.25	6/3/2021	0.67	9/9/2021	0.45
2/11/2021	0.16	6/4/2021	0.43	9/13/2021	0.29
2/16/2021	0.81	6/7/2021	0.17	9/23/2021	1.98
2/18/2021	0.37	6/8/2021	0.52	9/24/2021	0.13
2/19/2021	0.16	6/11/2021	0.45	10/4/2021	1.06
2/22/2021	0.27	6/19/2021	0.32	10/10/2021	0.14
2/27/2021	0.29	6/21/2021	0.1	10/16/2021	0.54
2/28/2021	0.6	6/22/2021	0.29	10/25/2021	0.45
3/1/2021	0.15	7/1/2021	0.29	10/26/2021	3.02
3/18/2021	0.92	7/2/2021	0.16	10/27/2021	0.1
3/24/2021	1.47	7/3/2021	0.35	10/29/2021	0.5
3/28/2021	0.61	7/6/2021	0.85	10/30/2021	0.66
3/31/2021	0.15	7/8/2021	0.93	10/31/2021	0.32
4/1/2021	0.11	7/9/2021	0.27	11/12/2021	0.58
4/7/2021	0.12	7/11/2021	0.21	11/13/2021	0.51
4/11/2021	0.85	7/12/2021	0.69	11/22/2021	0.15
4/12/2021	0.15	7/17/2021	1.33	11/26/2021	0.22
4/13/2021	0.12	7/18/2021	0.16	12/2/2021	0.23
4/15/2021	0.12	7/28/2021	0.28	12/6/2021	0.16
4/16/2021	0.2	7/29/2021	0.61	12/11/2021	0.23
4/21/2021	0.14	8/1/2021	0.34	12/18/2021	0.13
4/25/2021	0.53	8/10/2021	0.81	12/22/2021	0.38
5/3/2021	0.23	8/11/2021	0.49	12/29/2021	0.34
5/4/2021	0.3				

Land Use	EMC (CFU/100 mL)
Residential	7,750
Commercial	4,500
Industrial	2,500
Undeveloped	3,100
Agriculture	10,000

HUC14	2021 Runoff Volume (ac-ft)	2021 Fecal Coliform Loads (CFU/yr)
02030105020010	10,930	5.42E+14
02030105020020	3,059	1.39E+14
02030105020030	13,359	5.79E+14
02030105020040	24,513	1.13E+15

Table 20: Fecal coliform loads and annual runoff volumes for each HUC14 for 2021 rainfall data

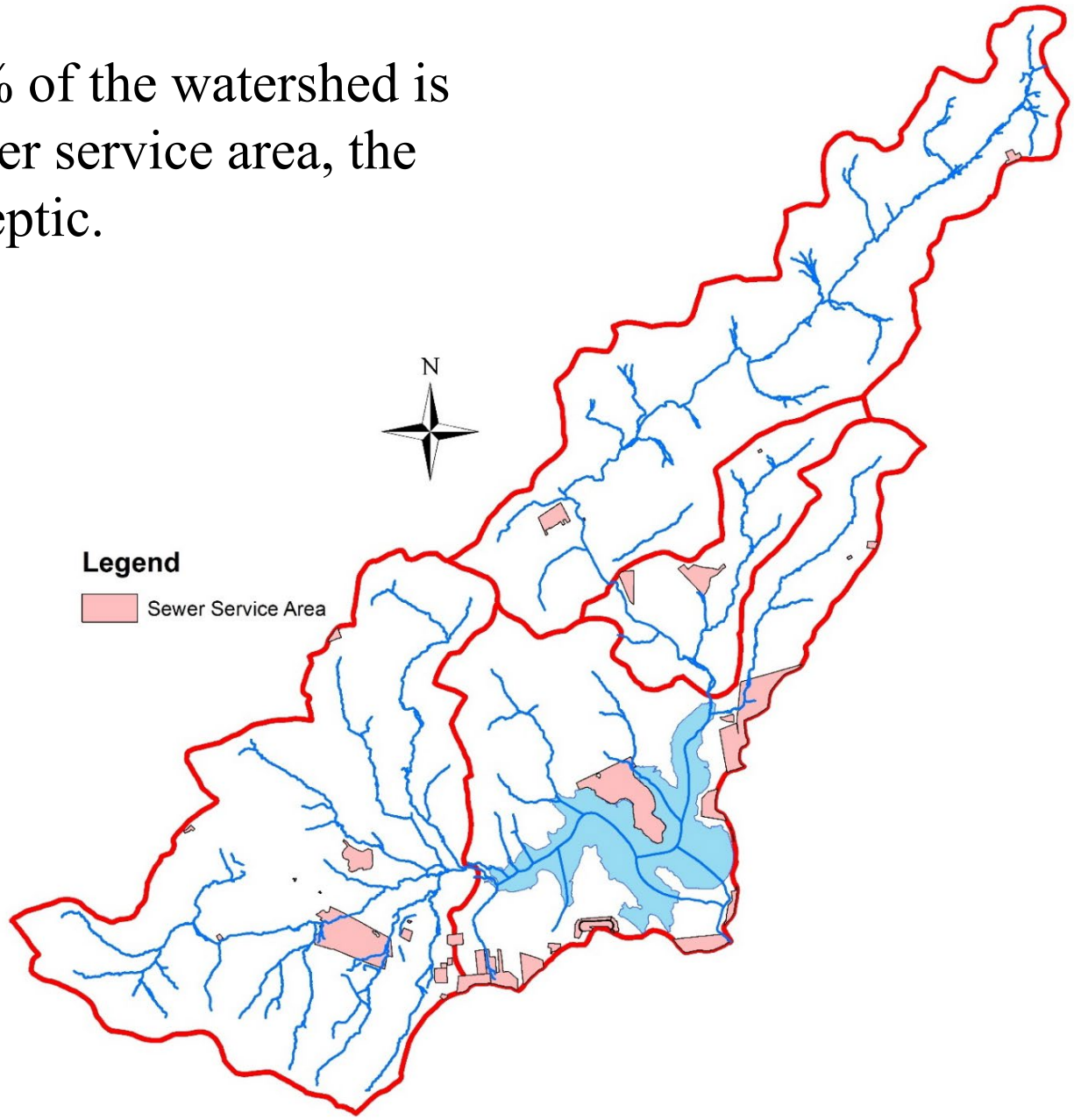
HUC14 02030105020010	2021 Runoff Volume (ac-ft)	2021 Fecal Coliform Loads (CFU/yr)
Residential	1,691	1.31E+14
Commercial	67	2.36E+12
Industrial	13	2.59E+11
Agriculture	1,917	1.50E+14
Other	7,242	2.58E+14
TOTALS:	10,930	5.42E+14

Table 21: Fecal coliform loads and annual runoff volumes for HUC 02030105020010 for 2021 rainfall data

Other Sources Added to the Plan

- Stormwater runoff flows that are exacerbated by increased impervious cover can be important when evaluating sources of total phosphorus to the Spruce Run and Mulhockaway Creek. These high stream flow can cause severe ***bank erosion and downcutting*** of the stream channel, thereby releasing large amounts of phosphorus laden sediment into the water column.
- Since only 980 acres of the 26,657-acre study area has sewer service, ***septic systems*** may be another potential source of total phosphorus and fecal coliform loading to the Spruce Run and Mulhockaway Creek.
- One final source of total phosphorus is ***wildlife***.

Only 4% of the watershed is in a sewer service area, the rest is septic.



Criteria #2: Estimation of the load reductions expected for the management measures

Current Tools to Reduce TP and Fecal Coliform to the Waterways

- 2011 Fertilizer Law
- Street Sweeping
- Leaf Collection
- Catch Basin Cleaning
- Existing Detention Basins

Land Use	Area (acres)	TP (lbs/year)	TN (lbs/year)	% of TP Load	% of TN Load
Roadways	676.4	1,352.8	20,833.8	11.27 %	15.29 %
All Land Use	26,656.73	12,005.51	136,299	100%	100%

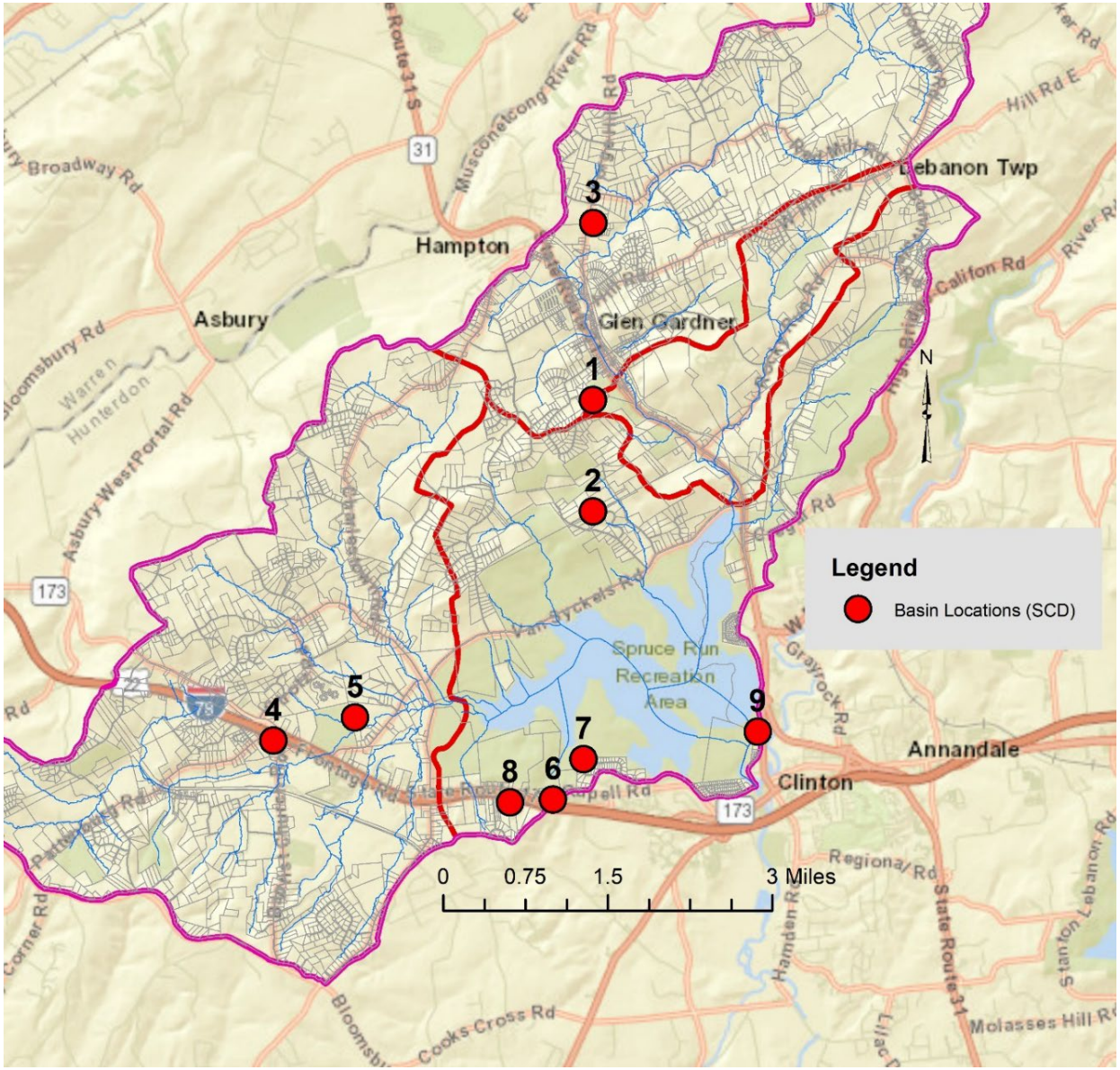
Loading from roadways in the entire watershed (all three HUC14s)

Land Use	Area (acres)	TP (lbs/year)	TN (lbs/year)	TP Reduction (lbs/yr)	TN Reduction (lbs/yr)
Roadways	676.4	1,352.8	20,833.8	135.3	833.4

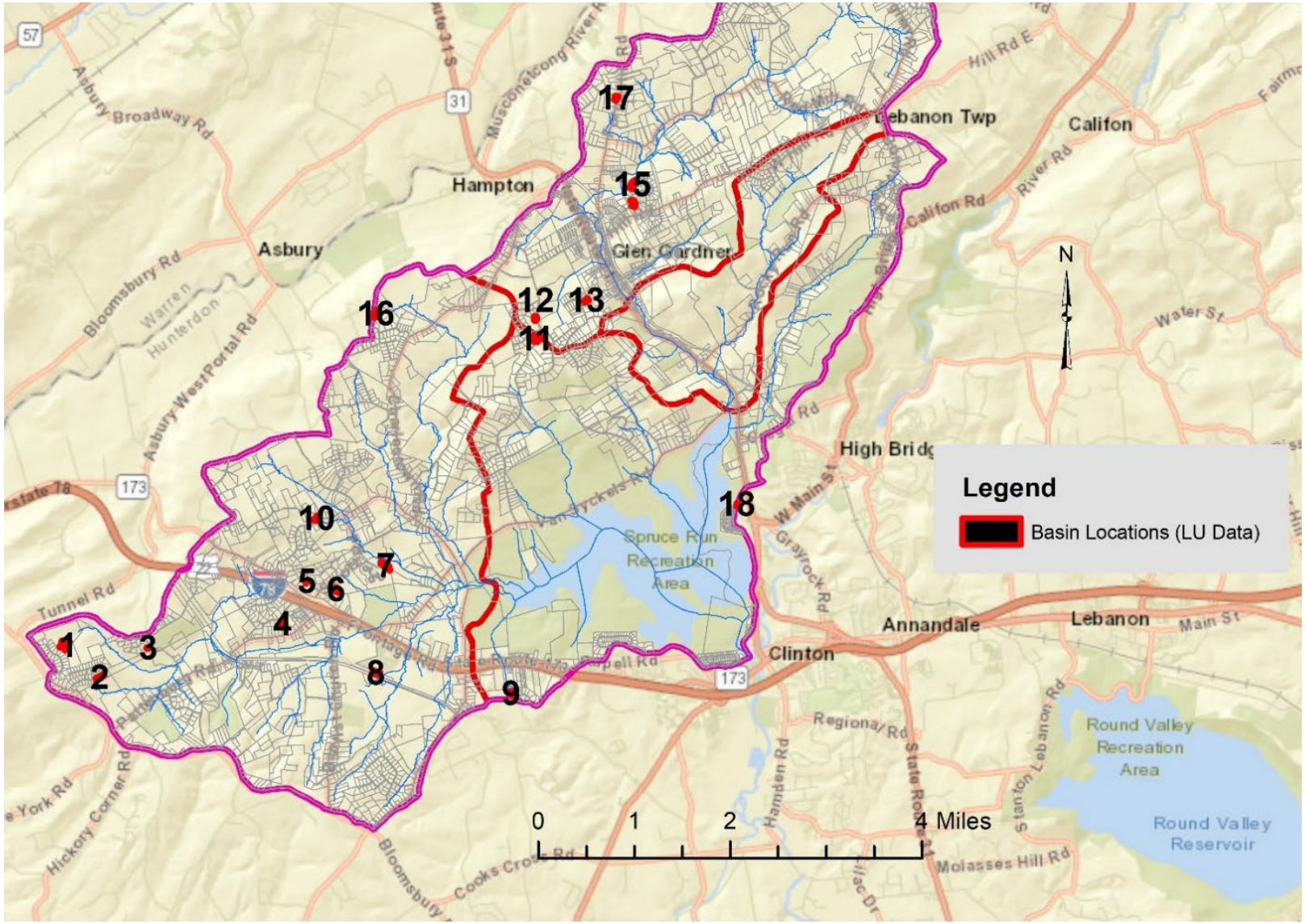
Roadway load reduction from street sweeping using maximum reduction values from the Chesapeake Bay Program

Residential Land Use	Area (acres)	TP (lbs/year)	TP Reduction (lbs/yr)
HUC 02030105020010	1,590.0	1,019.2	173.3
HUC 02030105020020	197.4	124.1	21.1
HUC 02030105020030	1,770.0	1,082.2	184.0
HUC 02030105020040	821.5	558,2	94.9
Totals:	4,378.9	2,783.7	473.2

Total phosphorus load reduction due to leaf collection coupled with street sweeping from late September through November



Location of existing stormwater management basins in New Jersey Hydrologic Modeling Database in the study area



Location of existing stormwater management basins in New Jersey land use data in the study area

Detention Basins

1. 11 basins in the NJ Hydrologic Modeling Database (3 on one site)
2. 21 basins in land use database (3 were already identified in #1)
3. Conducted inspections of all basins
4. Some basins were already naturalized
5. 24 could still be naturalized or converted into bioretention systems
6. NJ Hydrologic Modeling Database contains some design information including drainage area
7. Drainage areas for basins identified using land use data was estimated using best engineering judgement

Criteria #3: Recommendation of NPS management measures to address the causes and sources

Green Infrastructure Retrofit Site

- 13 sites were inspected for suitability to retrofit with green infrastructure
- Concept plans were prepared
- 8 additional sites were identified by Kathy Hale
- ***We will conduct inspections of these sites and include them in the plan***

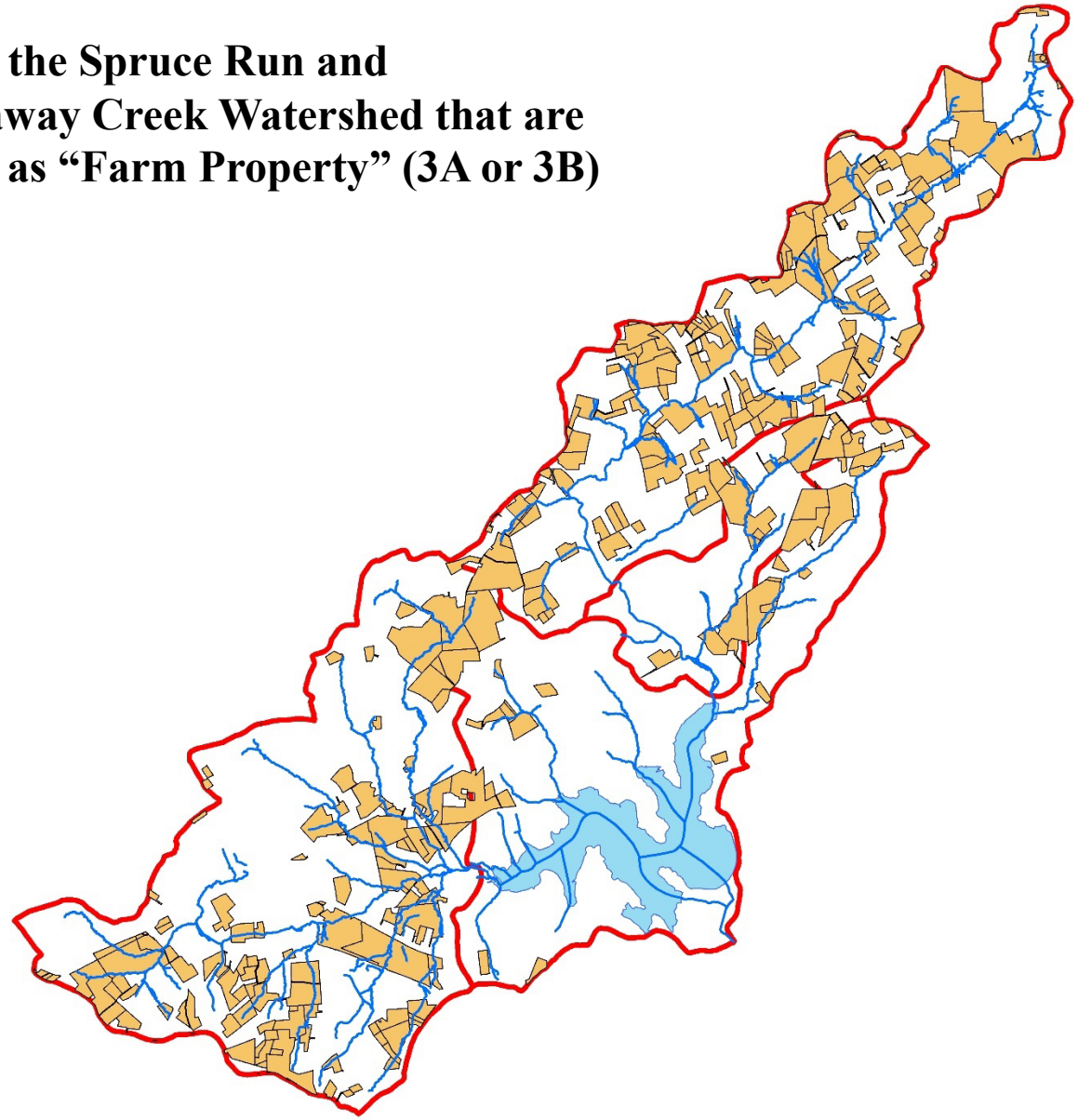
Other Items Included

- Rain gardens to reduce stormwater runoff from rooftops (2015 IC Layer = 4,858 building = 254.4 acres)
- Recommendation is to capture 25% of rooftop runoff from 25% of the buildings
- Roadside bioswales to reduce stormwater runoff from roadways (2015 IC Layer = 676.4 acres)
- Recommendation to install bioswales to capture 10% of roadway runoff

Agriculture

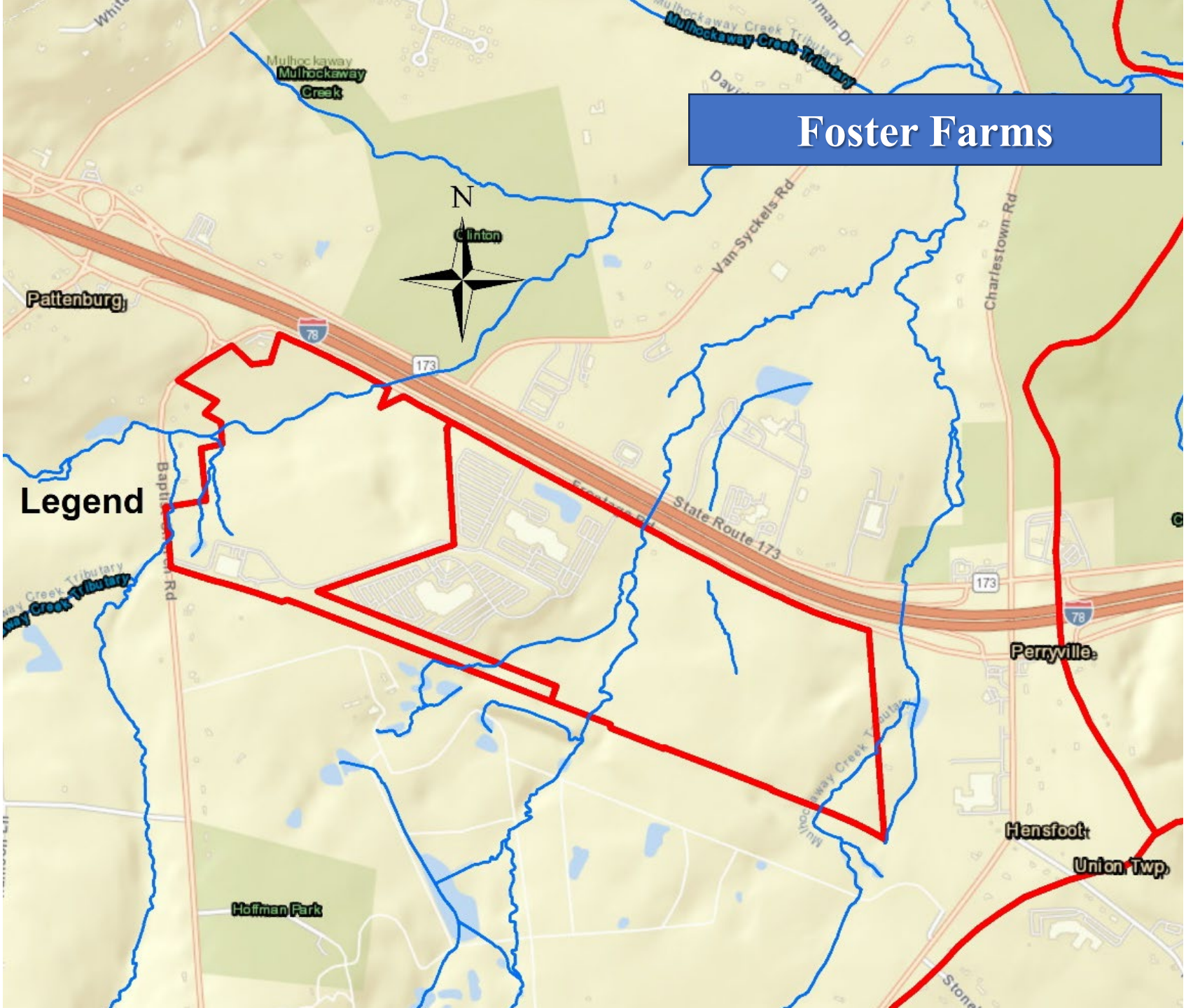
- 2020 land use layer = 4,227 acres of ag land use
- NPS calculations = 5,589 lbs of TP/yr from ag land use
- 2021 parcel data layer = 299 farms = 6,918 acres of farm parcels
- We grouped farm parcels = 230 farms
- Separate analysis of farms > 100 acres (15 farms = 2,157 acres)
- Here is where it gets complicated…

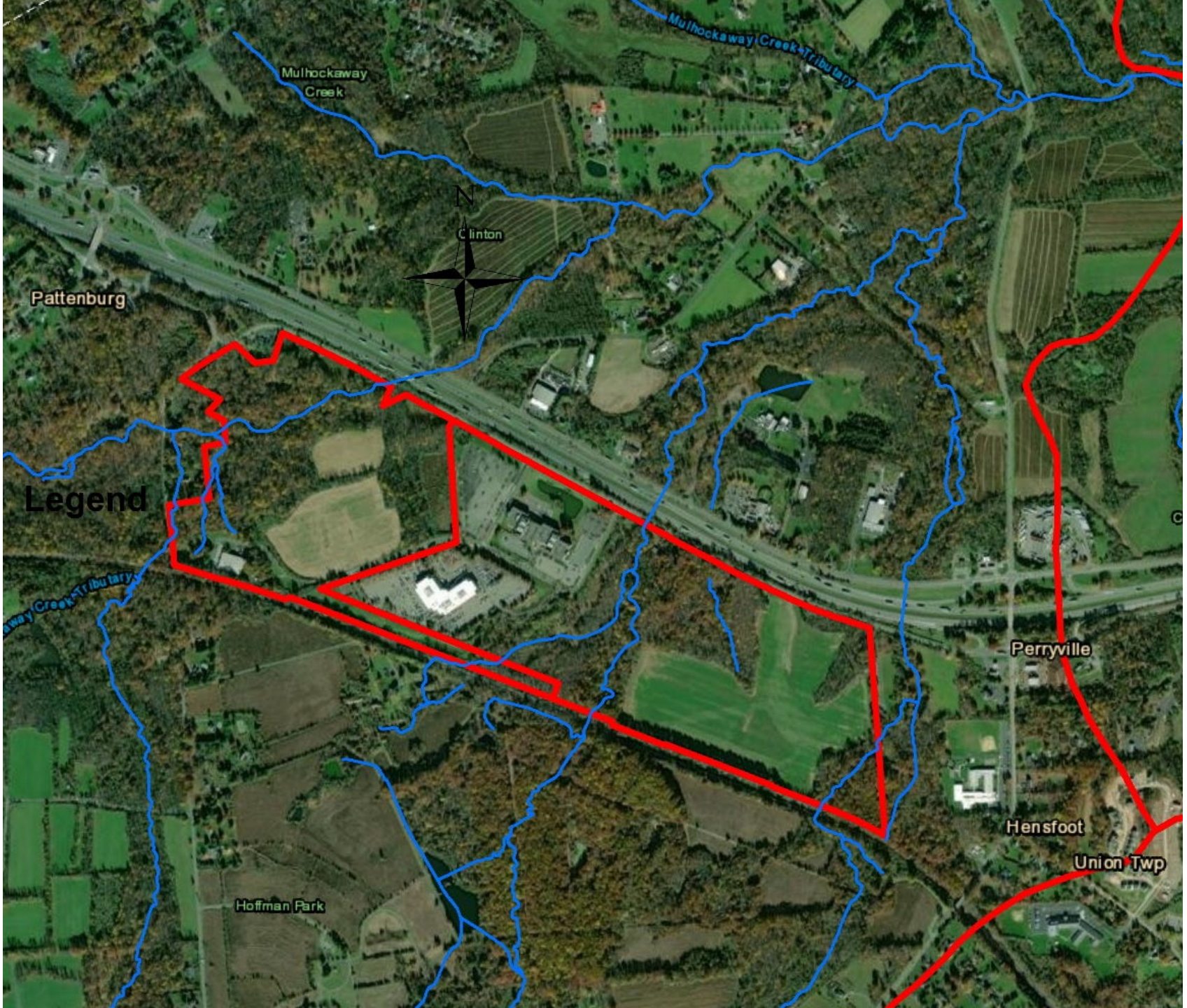
Parcels in the Spruce Run and Mulhockaway Creek Watershed that are Classified as "Farm Property" (3A or 3B)



Analysis of top 15 farms

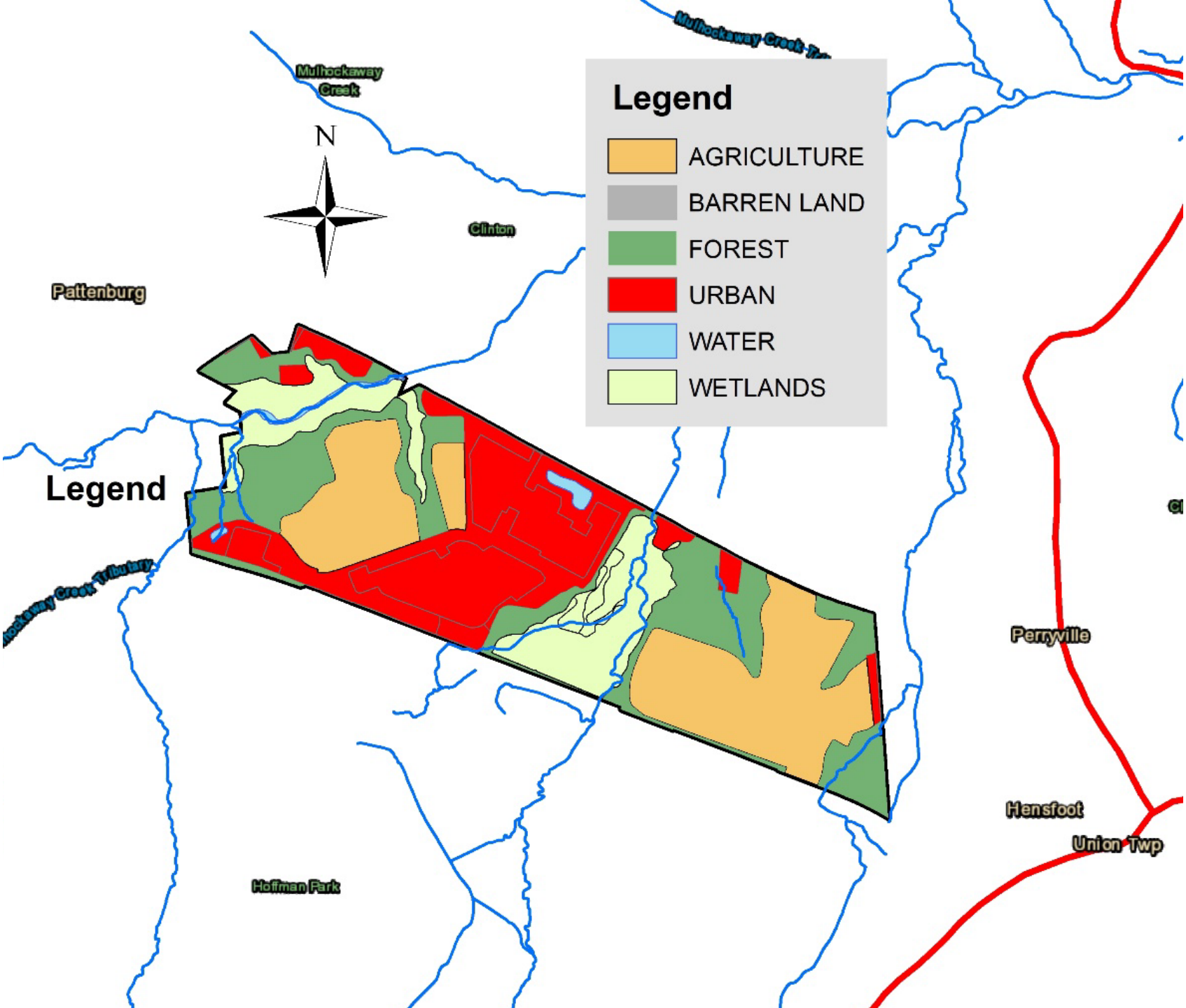
Ref No.	Municipality	Property Location	Owner	Area (Ac)
1	Union Twp	Route 173 E	FW LLC Foster Wheeler Realty	266.24
2	Lebanon Twp	29 Pleasant Grove Road	NJ Synod Evang Luth Church	212.57
3	Union Twp	Route 635	Amherst College/Att: Rosely Levay	183.78
4	Lebanon Twp	12-28 Berk Lane	Tucker, Lauren B	165.58
5	Lebanon Twp	85-107 Anthony Road	Glenn-Stevens Inc, J Vuocolo	153.33
6	Lebanon Twp	4 Sunset Farm Lane	Schmidt, Michael & Hardy Sharon	147.93
7	Bethlehem Twp	Charlestown Road	Milo, John Estate Of	126.70
8	Bethlehem Twp	Mullin Lane	Bartnett, Patrick Orourke & R Simms	126.19
9	Bethlehem Twp	Pheasant Ridge	Bunting, George A Trustee	118.87
10	Hampton Boro	43-53 Foss Ave	Grochowicz, Thomas D. & Michelle	115.66
11	Bethlehem Twp	Charlestown Road, 445-455	Rizza, Joseph D & Inessa	114.57
12	Bethlehem Twp	Bellwood Park Road	Case Farm Llc	113.29
13	Lebanon Twp	80-84 Anthony Road	Tullo-Mcvicar, Jamie Marie	106.16
14	Lebanon Twp	93 Red Mill Road	Sekel, C Scott	103.34
15	Lebanon Twp	16 Sharrer Road	Weeks, Matilda K	102.89


Foster Farms
N
Legend
Pattenburg
Clinton
Mulhockaway Creek
Mulhockaway Creek Tributary
Van Syckels Rd
Charlestown Rd
State Route 173
Perryville
Hensfoot
Union Twp
Hoffman Park
78
173


Mulhockaway Creek
Mulhockaway Creek Tributary
N
Clinton
Pattenburg
Legend
Perryville
Hensfoot
Union Twp
Hoffman Park

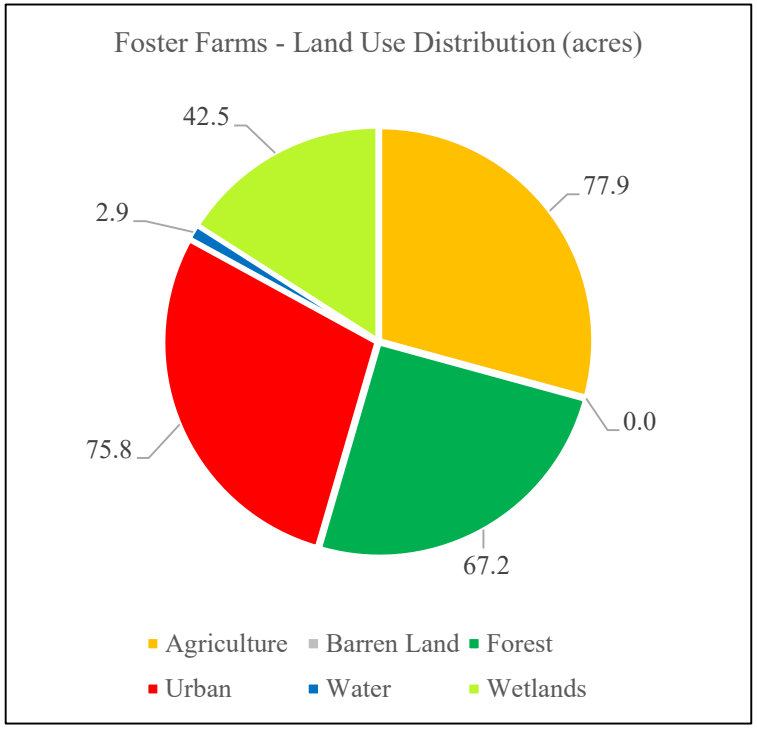
Foster Farms

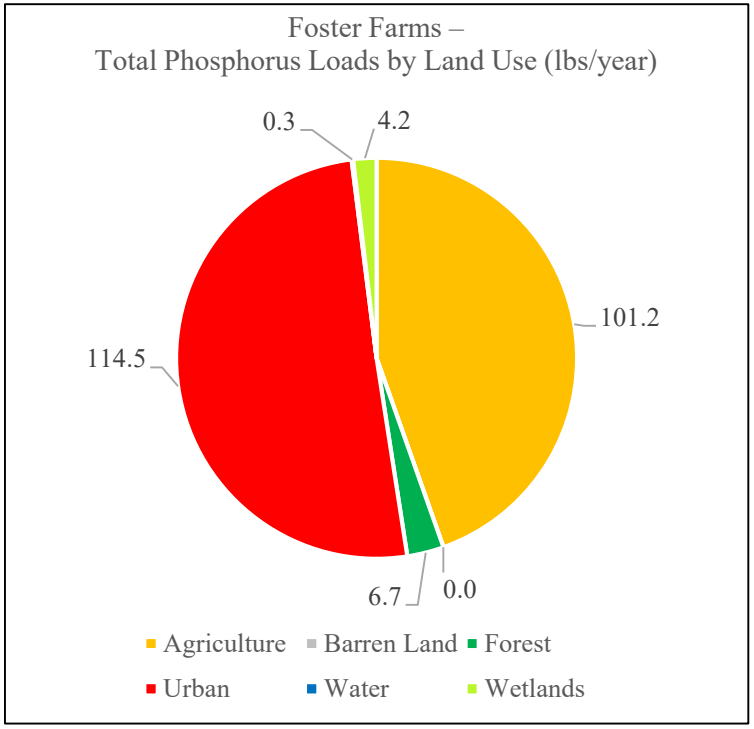
Block	Lot	Prop. Class.	Municipality	Property Location	Owner Name	Area (ac)
13	6	3B	Union Twp	ROUTE 173 E	FW LLC % FOSTER WHEELER REALTY SVS	165.07
13	7	3B	Union Twp	ROUTE 173 E	FW LLC % FOSTER WHEELER REALTY SVS	101.16
TOTAL						**266.24**


Legend
AGRICULTURE
BARREN LAND
FOREST
URBAN
WATER
WETLANDS
N
Mulhockaway Creek
Clinton
Pattenburg
Legend
Perryville
Hensfoot
Union Twp
Hoffman Park

Foster Farms - Land Use and Total Phosphorus Load

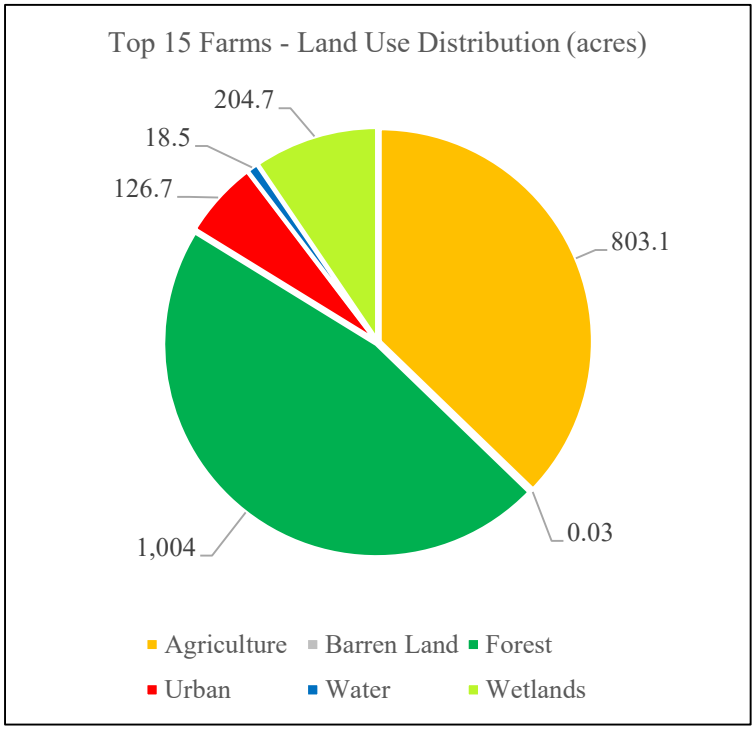
Land Use	Area	TP	TN	TSS
2020	(acres)	(lbs/yr)	(lbs/yr)	(lbs/yr)
Agriculture	77.9	101.2	778.7	23,361
Barren Land	0.0	0.0	0.0	0.0
Forest	67.2	6.7	201.7	2,690
Urban	75.8	114.5	1,178	12,027
Water	2.9	0.3	8.7	115.5
Wetlands	42.5	4.2	127.4	1,699
TOTAL	266.24	227.03	2,294	39,892

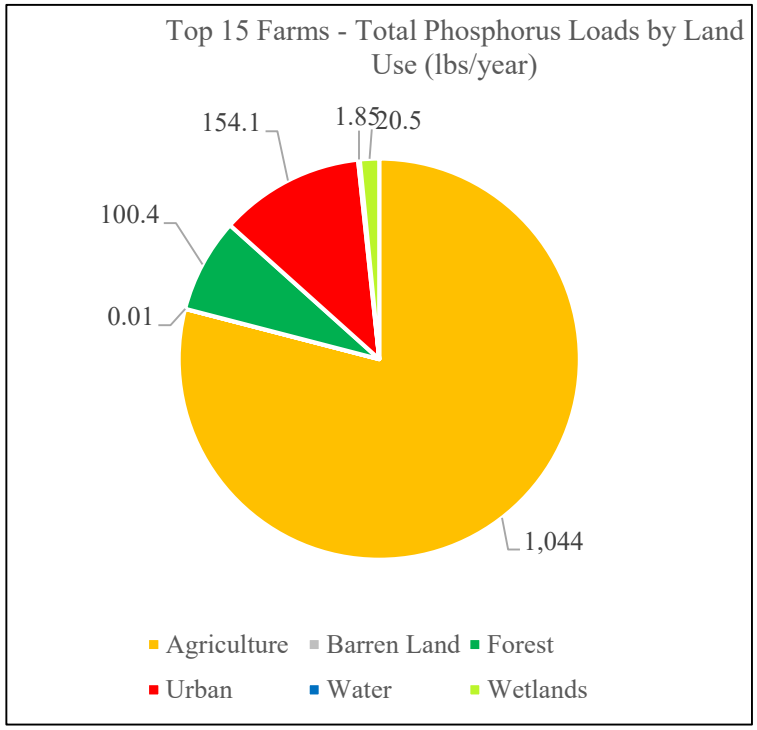




All 15 Top Farms - Land Use and Total Phosphorus Load

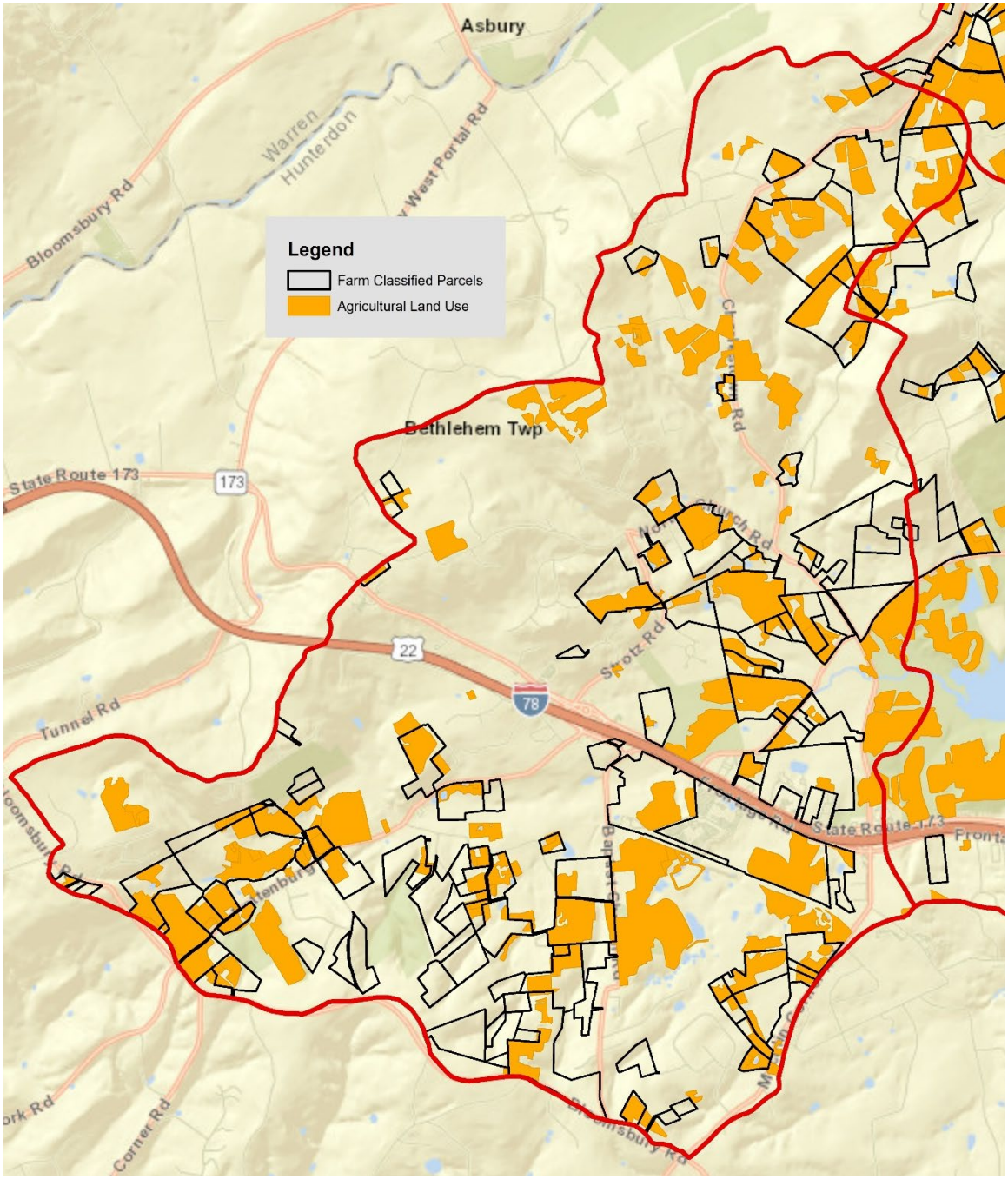
Land Use 2020	Area (acres)	TP (lbs/yr)	TN (lbs/yr)	TSS (lbs/yr)
Agriculture	803.1	1,044	8,031	240,926
Barren Land	0.03	0.01	0.13	1.61
Forest	1,004	100.4	3,012	40,166
Urban	126.7	154.1	1,545	17,701
Water	18.5	1.85	55.5	739.9
Wetlands	204.7	20.5	614.0	8,186
TOTAL	2157.09	1320.90	13,258	307,722

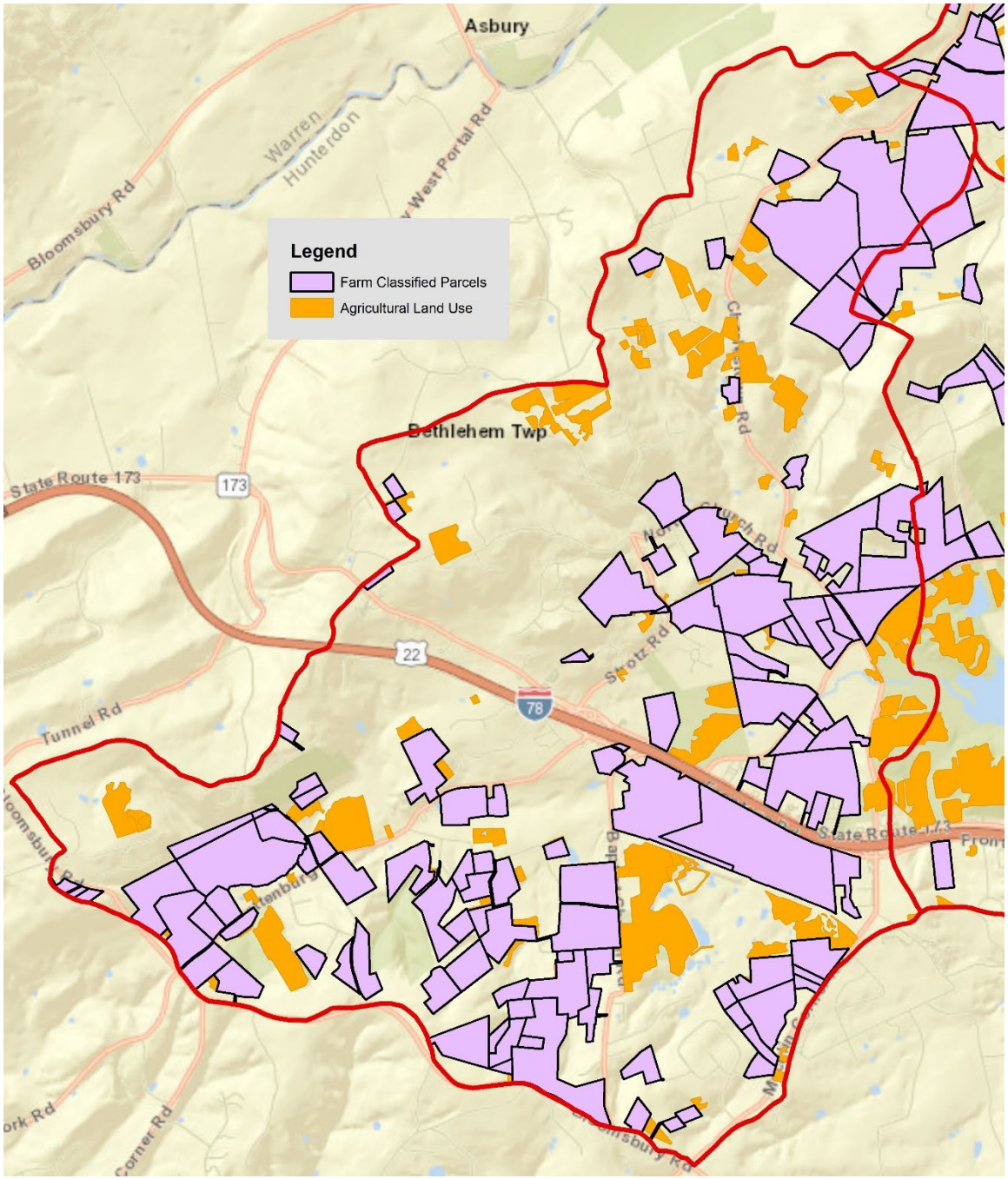


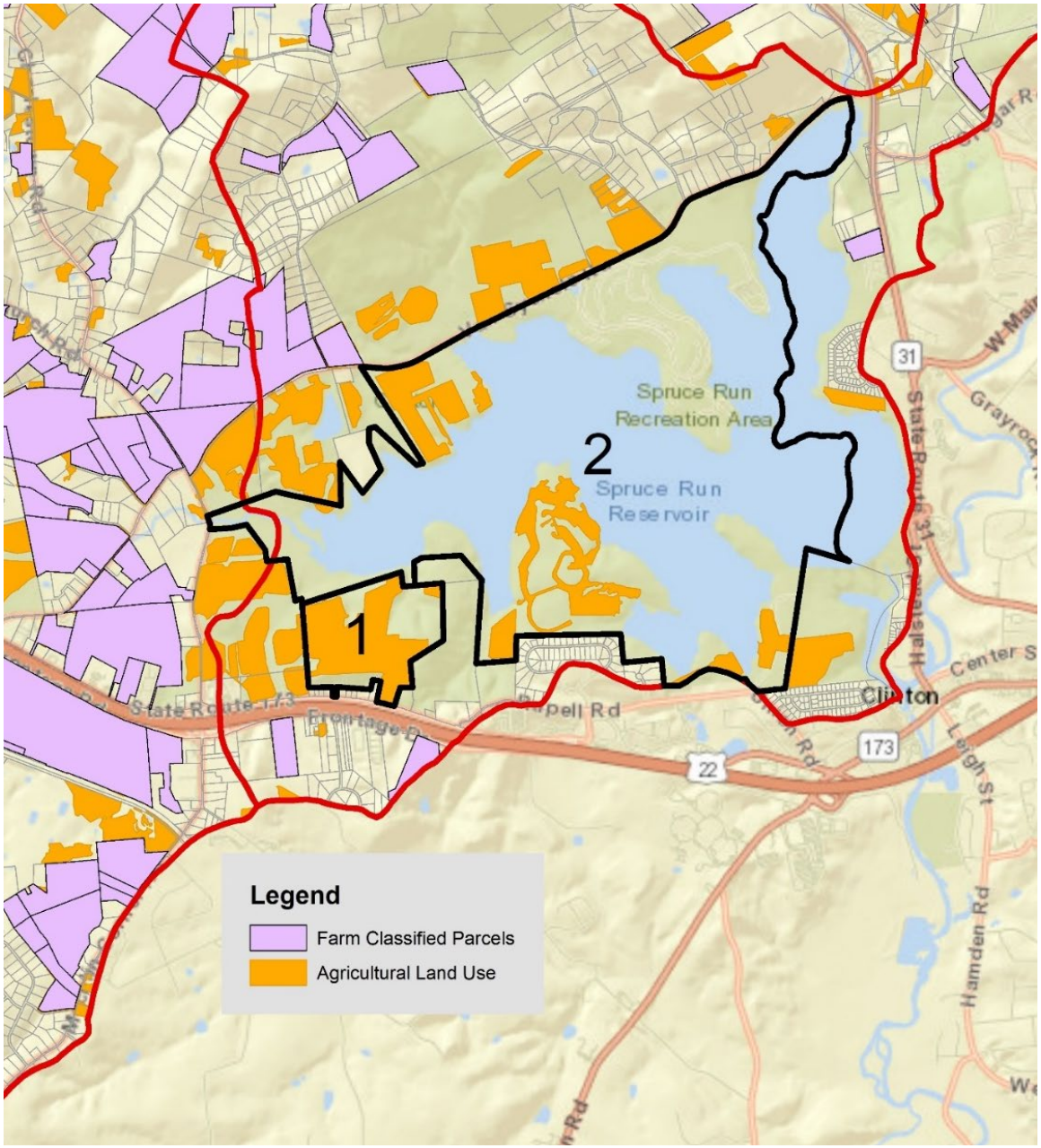


More on Agriculture

- 15 top farms = 803 acres of agriculture land use
- 15 top farms = 1,044 lbs of TP/yr
- All 230 farms (299 farm parcels) = 2,300 ag land use
- 2020 land use layer = 4,227 acres of ag land use
- What about the 1,927 other acres of ag land use?
- All 230 farms = 2,990 lbs of TP/yr
- Total phosphorus contributed from ag land uses = 5,589 lbs/yr
- What about the 2,599 lbs of TP/yr from other acres of ag land use?


Asbury
Warren
Hunterdon
Bloomsbury Rd
West Portal Rd
Legend
Farm Classified Parcels
Agricultural Land Use
Bethlehem Twp
State Route 173
173
22
78
Tunnel Rd
Spotz Rd
Church Rd
Corner Rd


Asbury
Warren
Hunterdon
Bloomsbury Rd
West Portal Rd
Legend
Farm Classified Parcels
Agricultural Land Use
Bethlehem Twp
State Route 173
173
22
78
Tunnel Rd
Strotz Rd
State Route 173


Spruce Run
Recreation Area
2
Spruce Run
Reservoir
1
31
W Main
State Route 31
Center S
Clinton
Lepell Rd
State Route 173
Frontage Rd
173
22
Leigh St
Hamden Rd
Legend
Farm Classified Parcels
Agricultural Land Use

More on Agriculture

- There are 4,540 parcels in the database
- 149 parcels do not have property classifications
- These 149 parcels = 1,894 acres and 358 acres of agricultural land uses
- This is less than 20% of the missing ag land use
- The remainder is on properties that are not classified as farms
- The target still needs to be the 230 farmers in the watershed since they are most like the ones farming non-farm parcels

Load Reduction Accounting

Management Strategy	TP Reduction (lb/yr)
Street Sweeping	135.3
Leaf Collection and Street Sweeping	473.2
Green Infrastructure for proposed retrofit sites	17.03
Rain gardens for ¼ rooftops for ¼ of buildings	20.0
Bioswales for 10% of roadways	121.8
Converting existing detention basins to bioretention basins	60.3
Agricultural management practices on the 230 farms	1,794
TOTAL =	2,621.6

Existing TP load from urban land use	=	4,718	lbs/yr
Existing TP load from agricultural land use	=	5,589	lbs/yr
TP reductions due to existing stormwater basins	=	39	lbs/yr
TP reductions from proposed strategies	=	2,622	lbs/yr
Future TP load from urban and agricultural land uses	=	7,646	lbs/yr

= 25.8% reduction