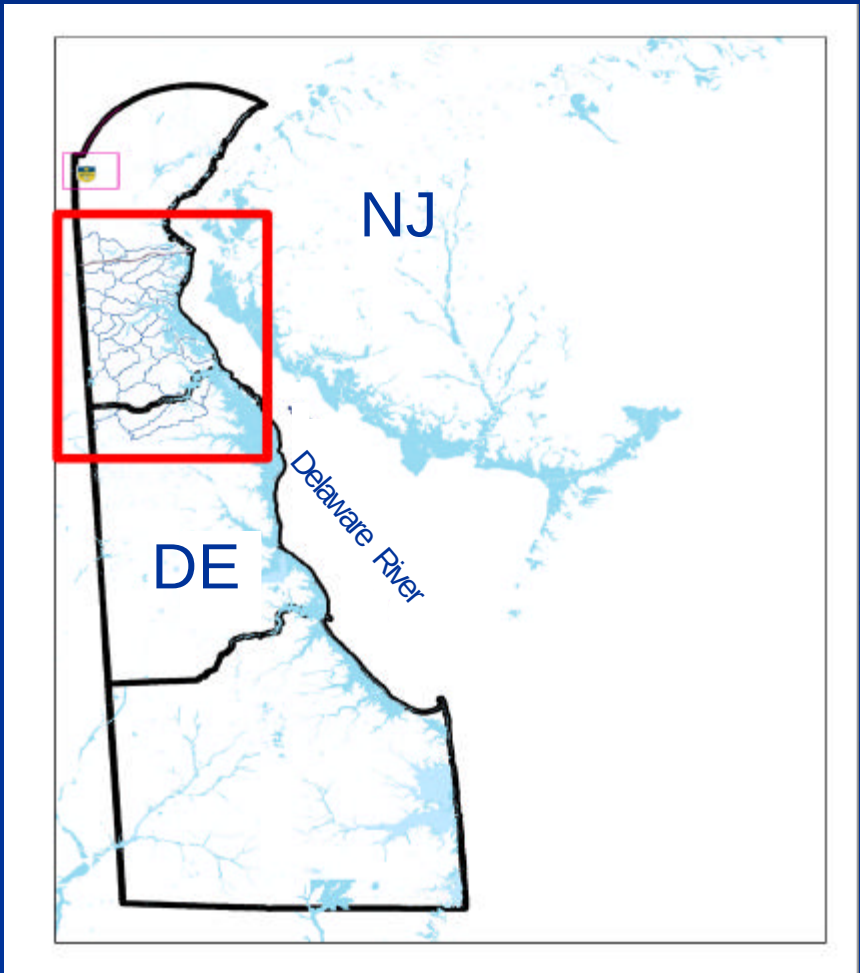
Watershed Based
Wetlands and Water Resource Protection

Using Natural Resource Protection to Limit Impervious Cover within Sub-watersheds of Southern New Castle County Delaware



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Background

This project was funded through a United States Environmental Protection Agency (US EPA) Wetland Program Grant to protect and enhance riparian corridors in Southern New Castle County, Delaware. The County retained the University of Delaware, Institute for Public Administration, Water Resources Agency to assist with the watershed-based approach to protecting natural resources

Objectives of this Project

1) **Evaluate the adequacy of the *New Castle County Unified Development Code (NCCUDC) natural resource protection standards in limiting impervious cover at full-buildout under current zoning**

2) **To create a method using GIS for determining priority watersheds that need greater protection from development in order to protect water resources and limit impervious cover**

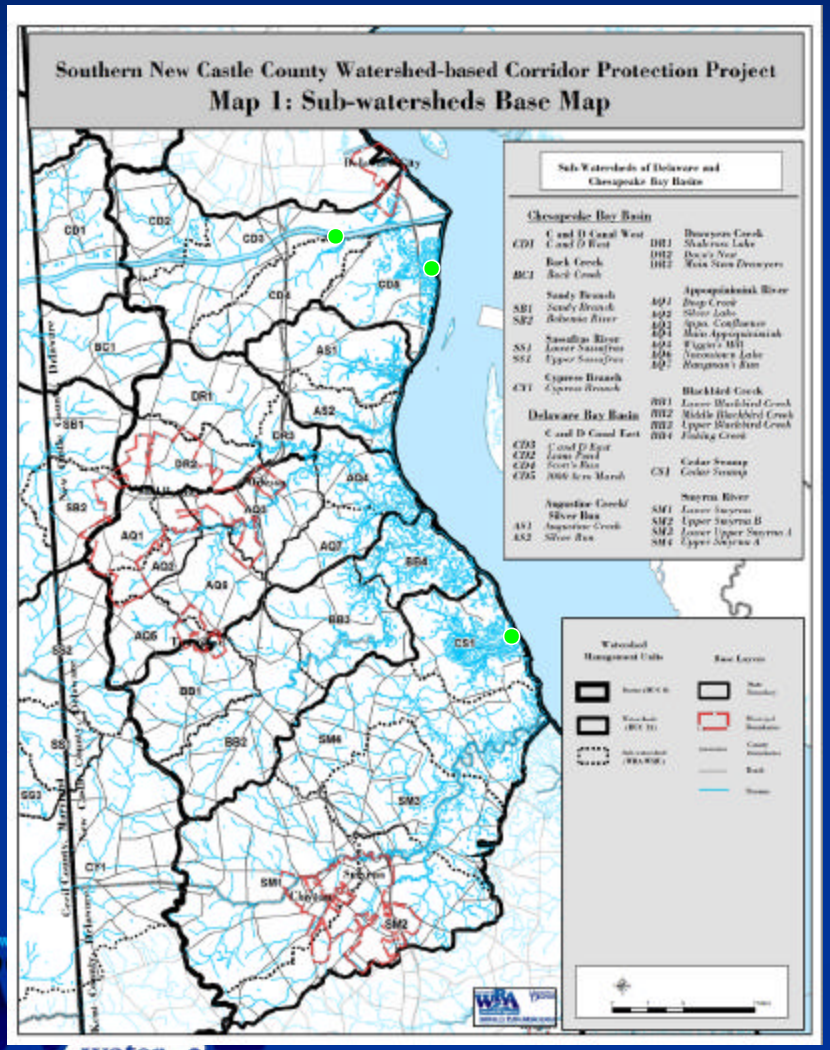
3) **Provide a watershed framework to assist planners when reviewing sub-division plans to minimize impacts on water resources.**

The New Castle County Unified Development Code (NCCUDC) under Article 10 sets Resource Protection Standards aimed at protecting Natural resources by requiring the preservation of a minimum amount of the resource as open space.

Methods

- Create sub-watersheds of manageable size to be used for water quality studies
- Conduct analysis, using GIS raster data, to review the UDC in order to determine its adequacy in limiting impervious cover
- Create a map series that paints a picture of the present and future "health" of each sub-watershed that will aid in planning development locations
- Determine if the UDC environmental standards limit impervious cover at full-buildout with current zoning
- Make recommendations about augmenting the UDC to best protect water resources

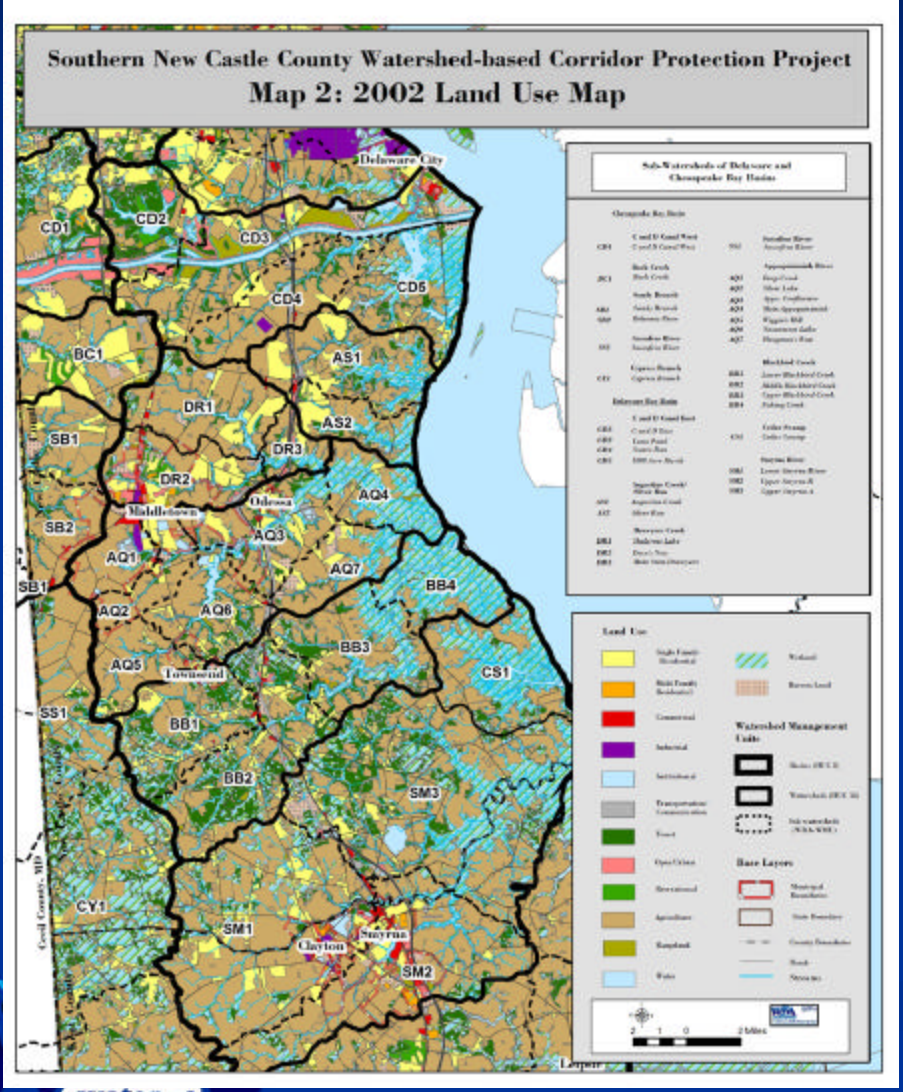
MAP 1. Sub-Watersheds 10 sq. miles or less were delineated from gauging station locations using 10 meter resolution digital elevation data.



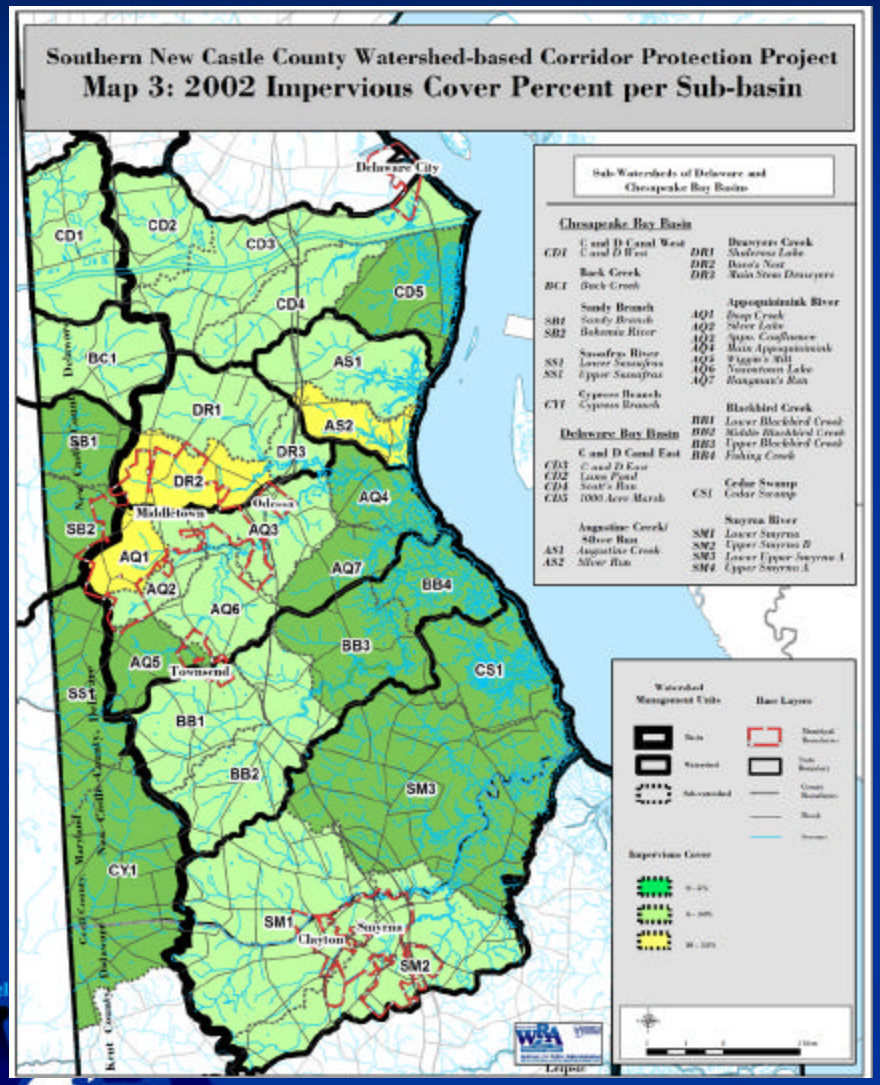
The sub-watersheds were edited to conform to the USGS Hydrologic Unit Codes

These became known as Water Resources Agency Watershed Management Units

MAP 2. A land use map is in the map series to get a feel for the distribution of land use within each sub-watershed.



MAP 3. 2002 Impervious Cover for each sub-watershed



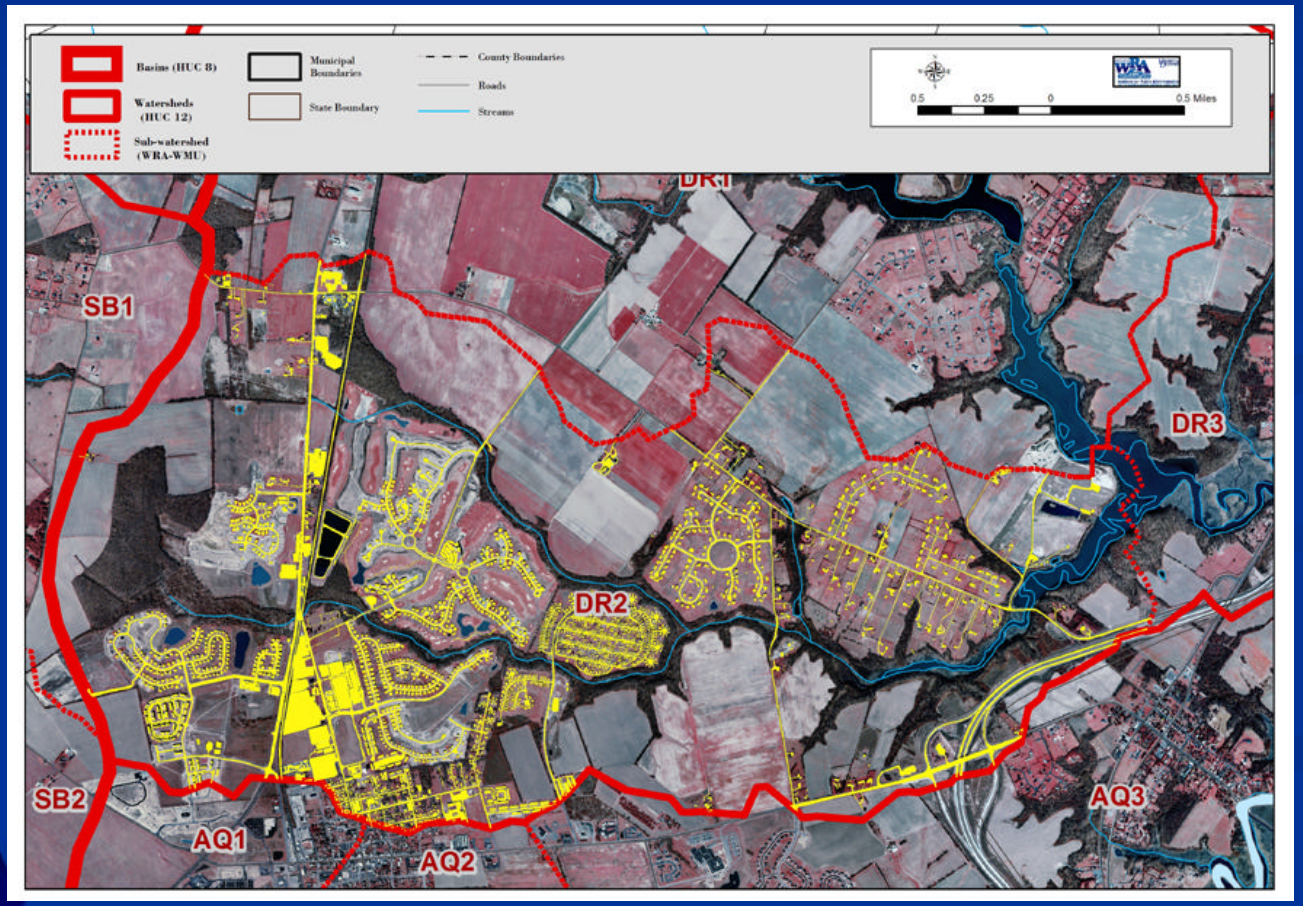
0 – 5 %

6 - 10 %

10 - 15 %

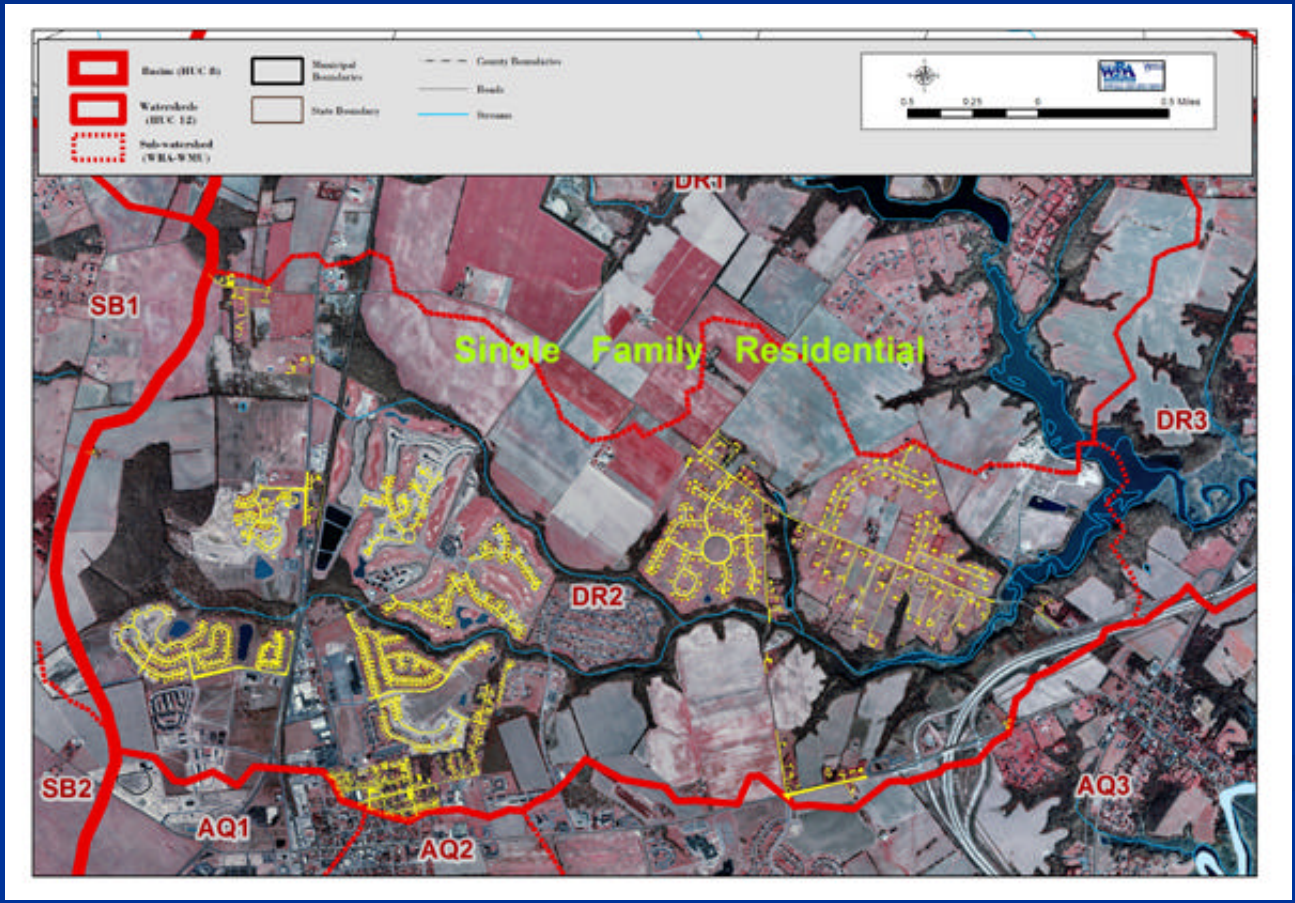
Method for Acquiring Impervious Cover Proxy Values

Impervious surfaces (sidewalks, driveways, rooftops and roads were hand digitized from .25 meter aerial photography at 1:2500 scale in order to derive percent values for each land use class.



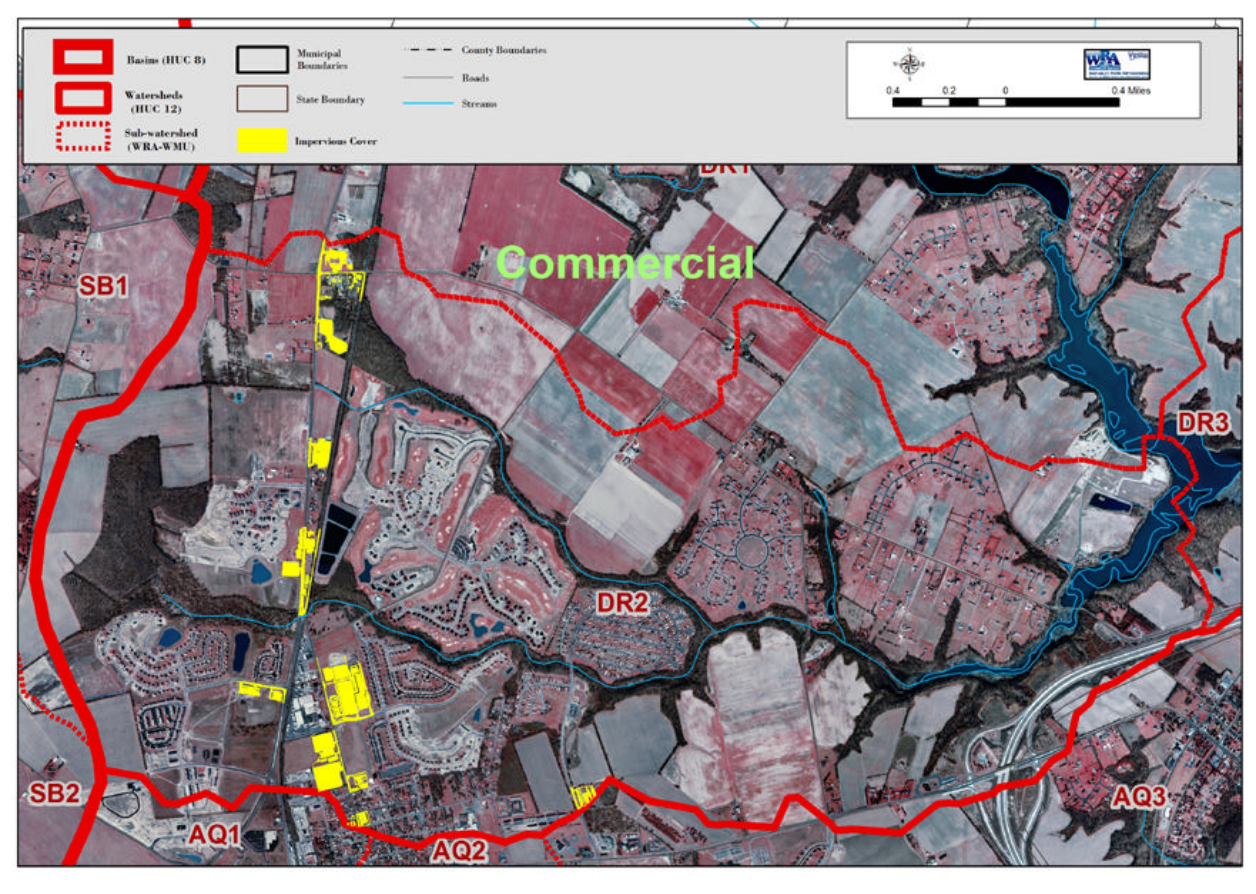
Method for Acquiring Impervious Cover Proxy Values

Individual Land use classes were extracted to obtain average values for each class. Single Family Residential is shown below.



Method for Acquiring Impervious Cover Proxy Values

Individual land use classes were extracted to obtain average values for each class. Commercial land is shown below.



Impervious cover values cross checked using the following methods:

- Automatic delineation from aerial photography using feature extraction software called Feature Analyst ©
- New Castle County Planning Department cross checked values with site plans and knowledge of building densities

Final Impervious Cover Values

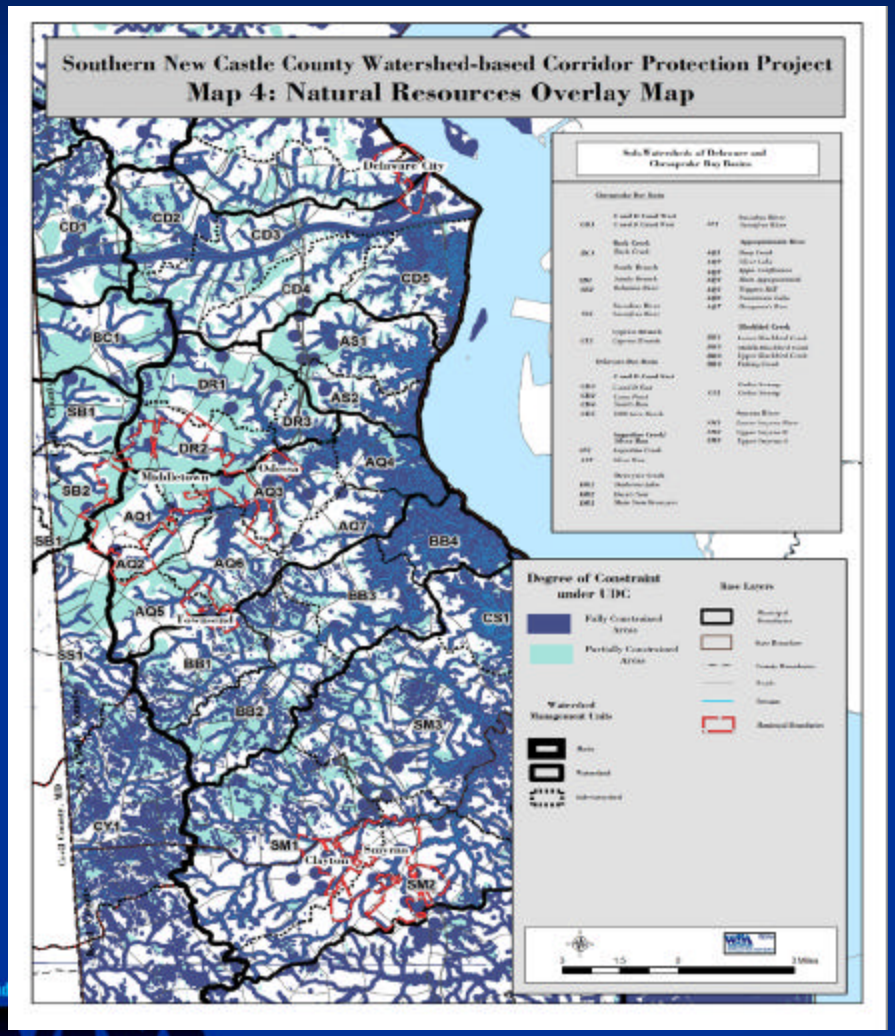
Land Use	Impervious Cover %
Single Family Residential	20
Multi-Family Residential	45
Commercial	70
Transportation	75
Institutional	30
Industrial	85
Agriculture	3

Obtaining impervious cover percents for each land use class allowed the modeling of future impervious cover scenarios. Using the impervious cover proxy values the Water Resources Agency's GIS researcher:

1. Modeled impervious cover at full-buildout without the Unified Development Code enforced, but with consideration of federal and state restriction already imposed on certain Natural Resources

2. Modeled impervious cover at full-buildout taking into account the Unified Development Code restrictions on impervious Cover for certain Natural Resources, as well as those restrictions already imposed.

MAP 4. The New Castle County Unified Development Code Restricts impervious cover on selected Natural Resources



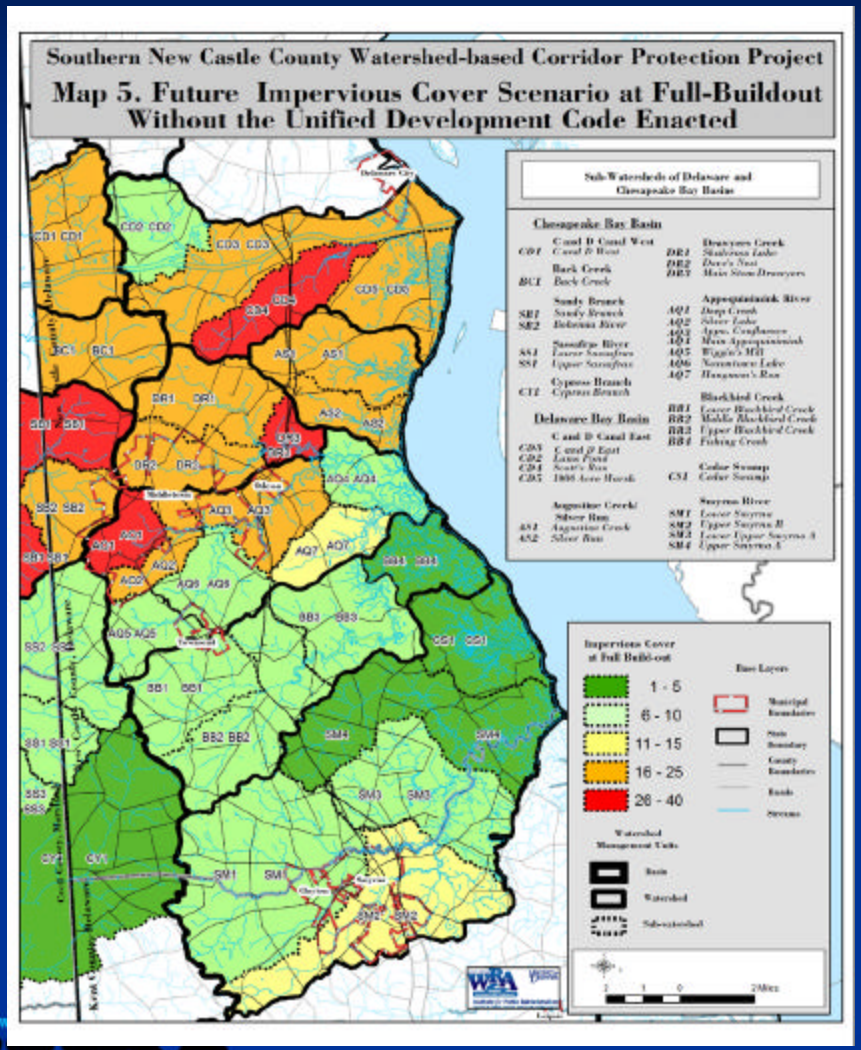
100% Protection

- Wetlands
- 100 year floodplains
- Riparian Buffers
- Slopes >25%
- Class A Wellheads

Partially Protected

- Forest
- Recharge Areas
- Slopes 15-25%
- Critical Natural Areas

MAP 5. Future Impervious Cover Estimates *Without* the Unified Development Code Enforced at Full-Buildout



0 – 5 %

6 - 10 %

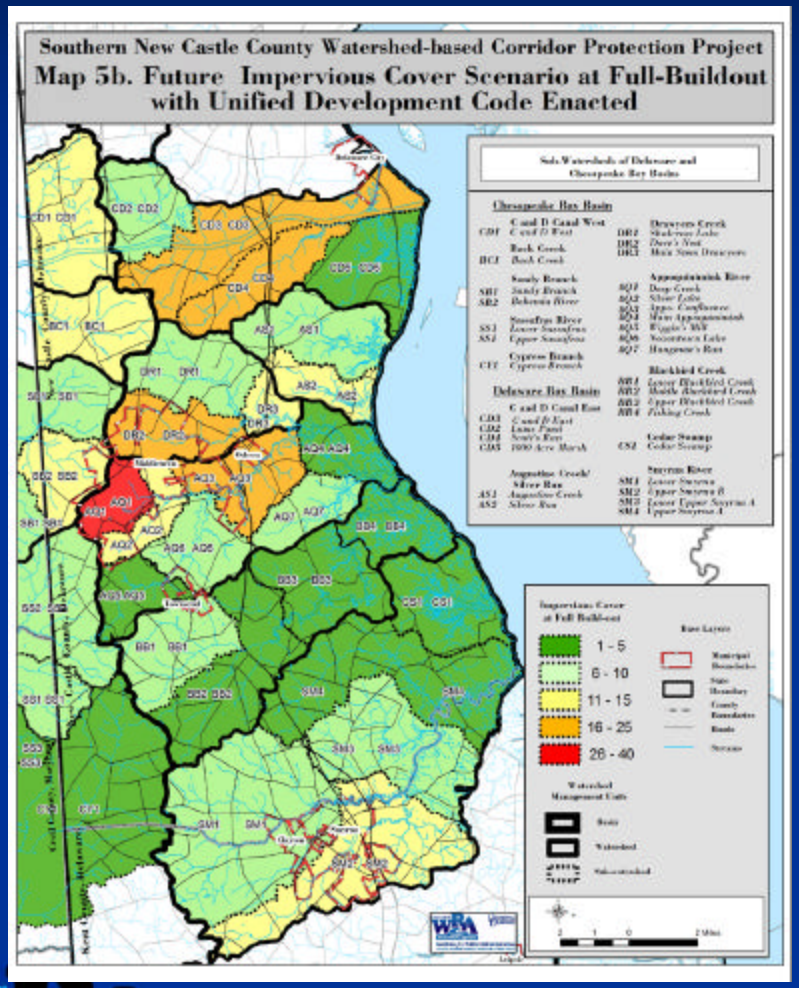
10 - 15 %

16 – 25%

25 – 40%

** Natural Resources that are protected under Federal or other local ordinances were considered in calculations

MAP 5b. Future Impervious Cover Estimates with the Unified Development Code Enforced at Full-buildout



0 – 5 %

6 - 10 %

10 - 15 %

16 – 25%

25 – 40%

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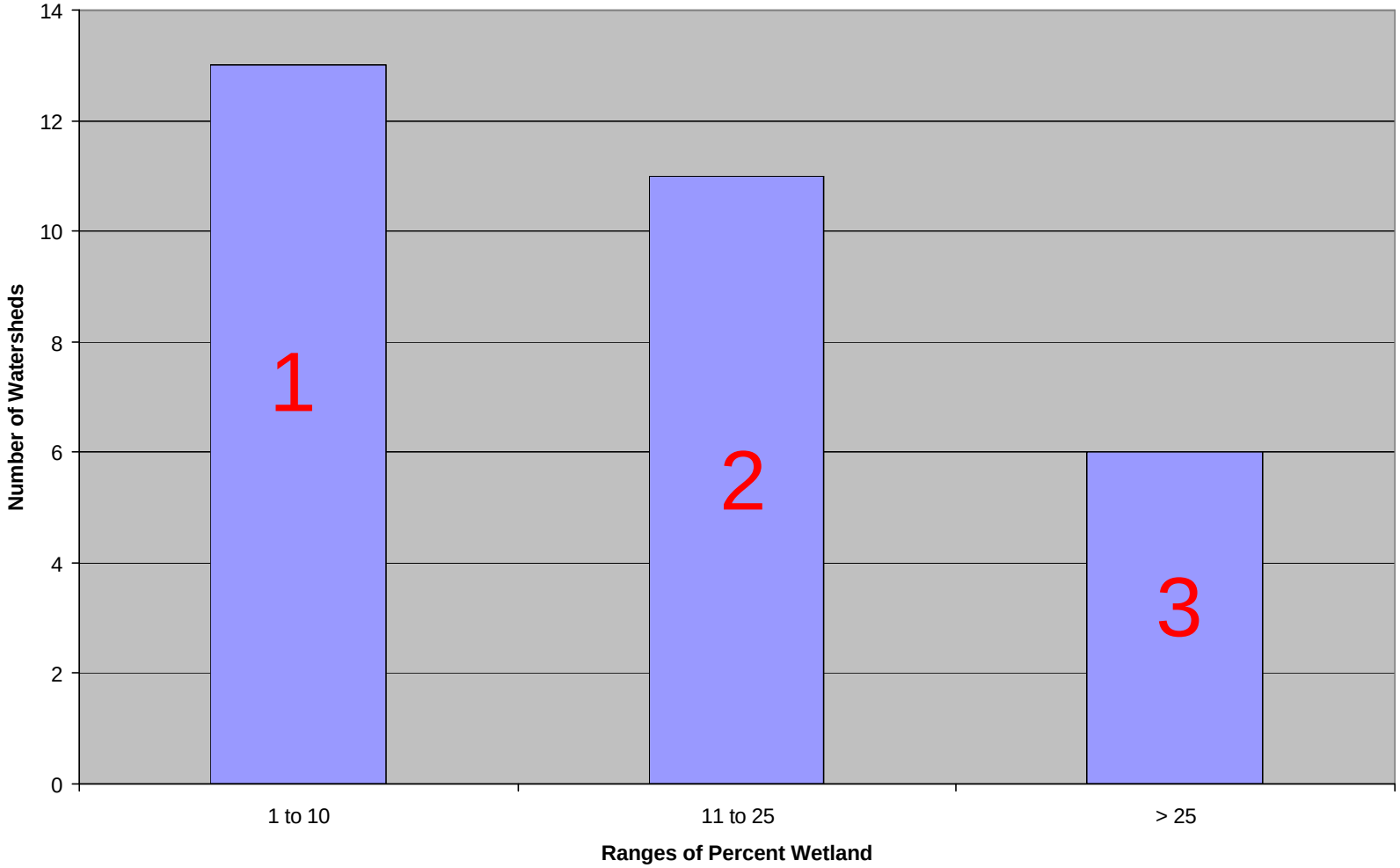
Sub-watersheds were scored based on percent of:

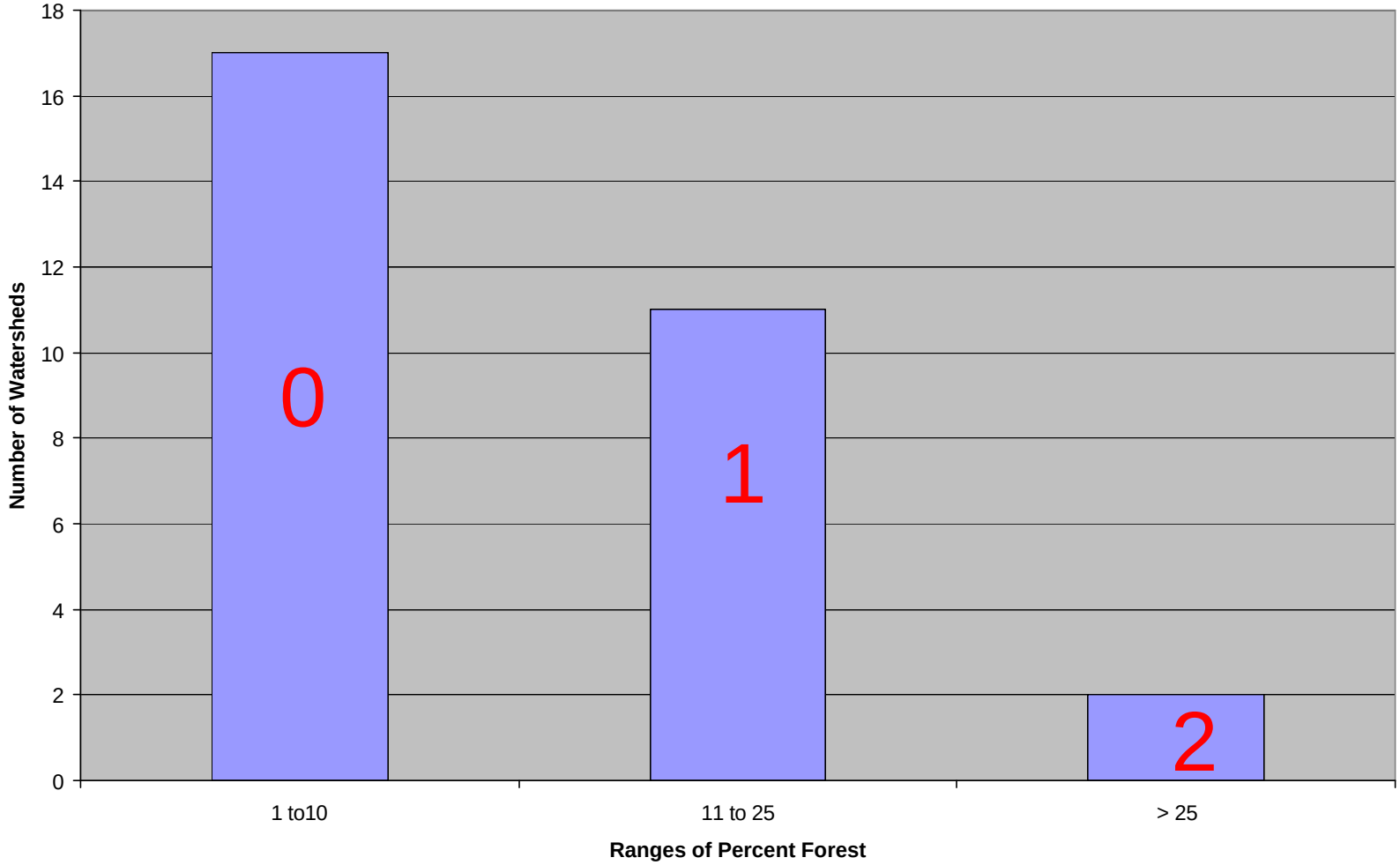
- Wetlands
- Forest
- % of Riparian Buffer Forest or Wetland
- Public/Private Open Space
- Impervious Cover

Percent Wetland per Sub-watershed and Appropriate Score.

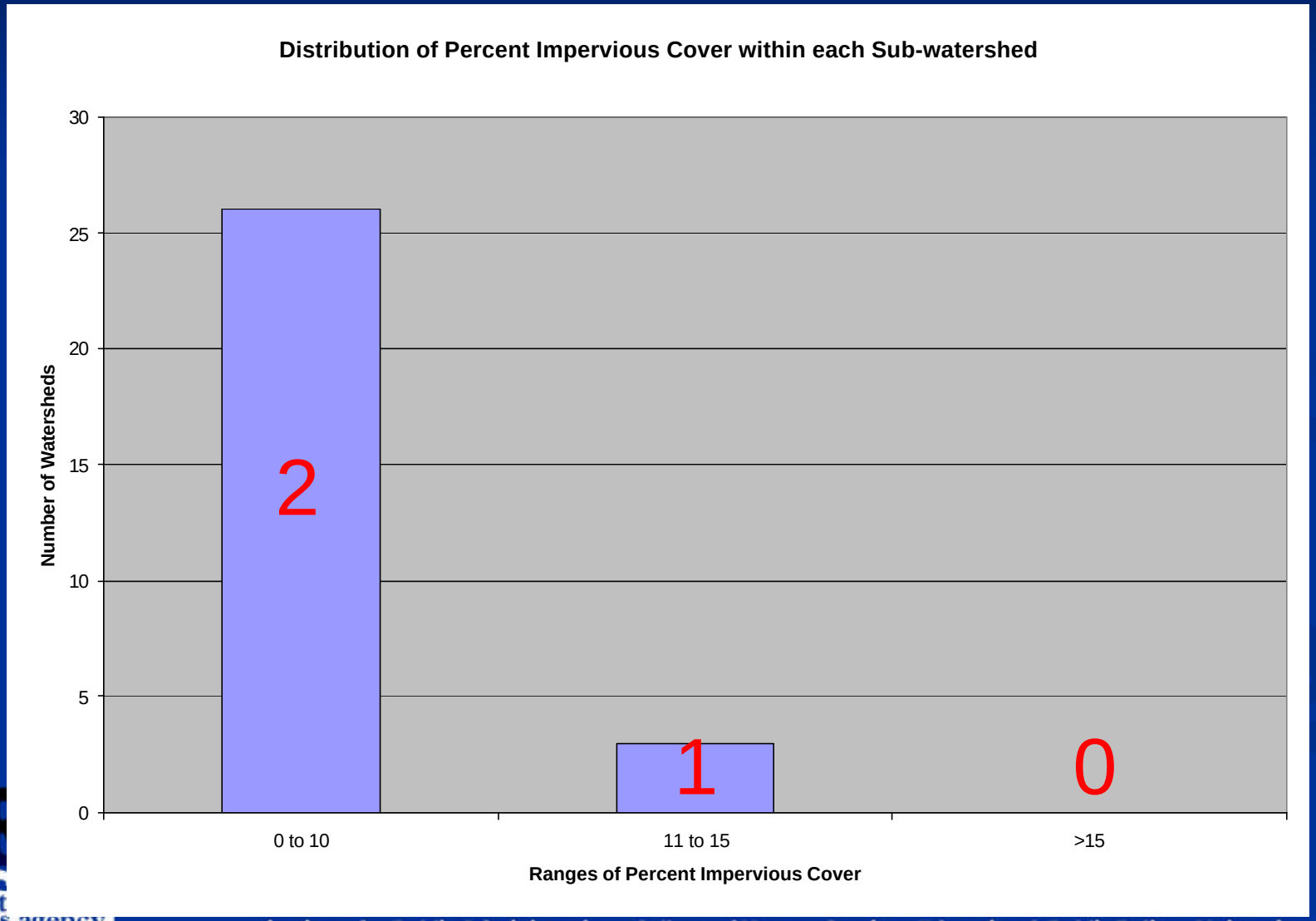
The higher the score the healthier the watershed (theoretically.)



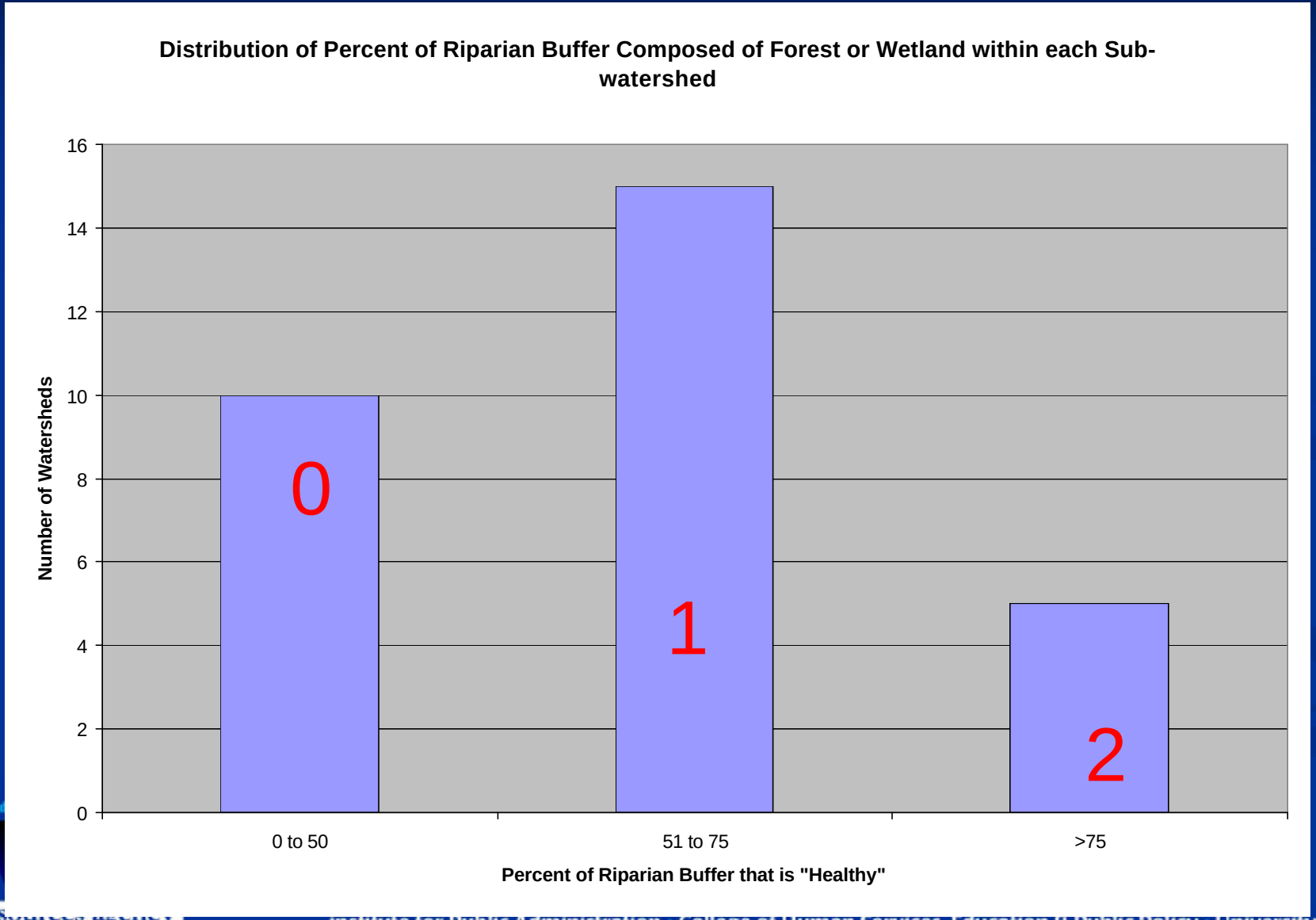
Percent Forest per Sub-watershed and Appropriate Score.
The higher the score the healthier the watershed (theoretically.)



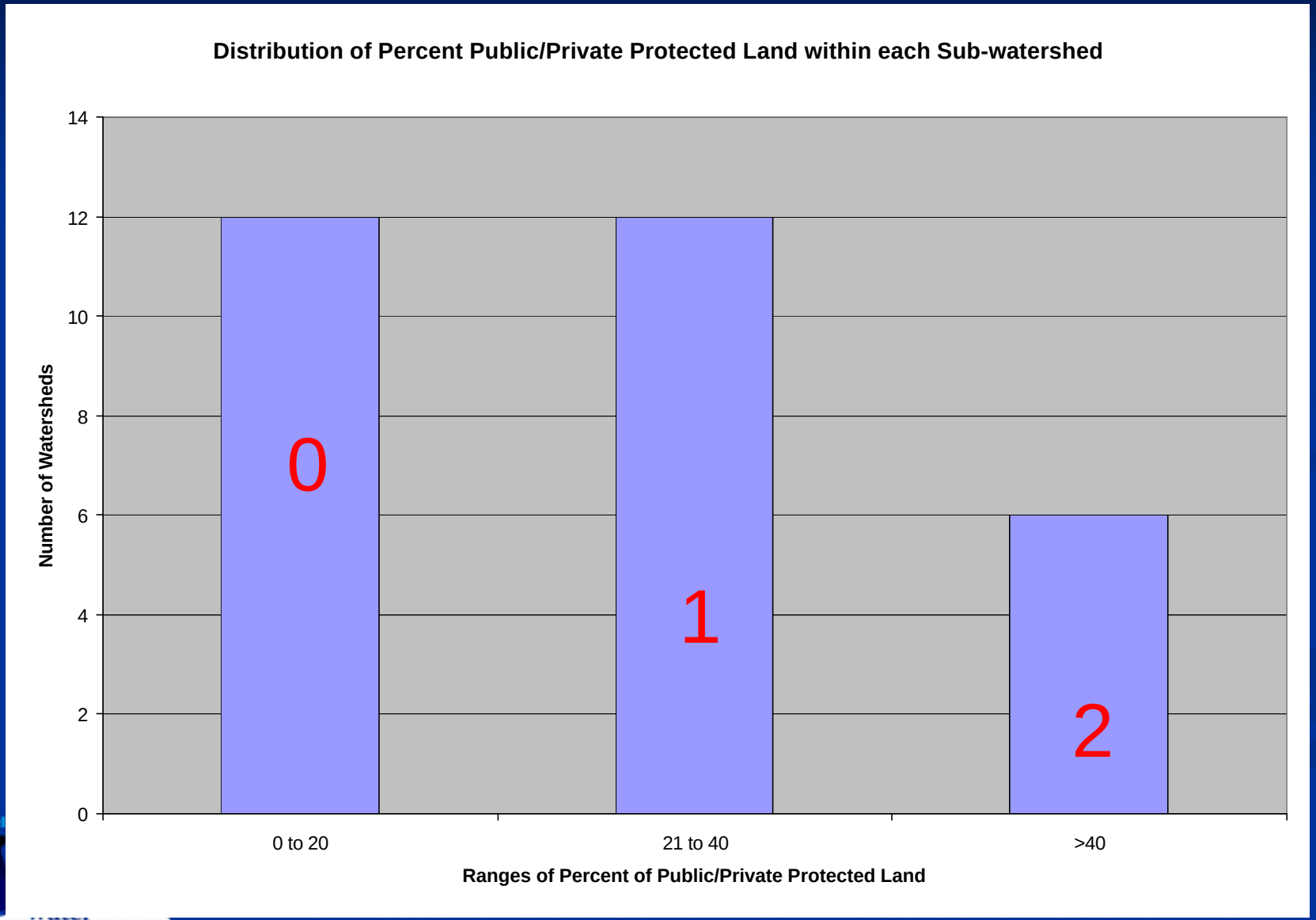
Percent Impervious Cover per Sub-watershed and appropriate Score. The lower the score the healthier the watershed (theoretically.)



Percent of Riparian Buffer Composed of Forest or Wetland per Sub-watershed and Appropriate Score. The higher the score the healthier the watershed (theoretically.)



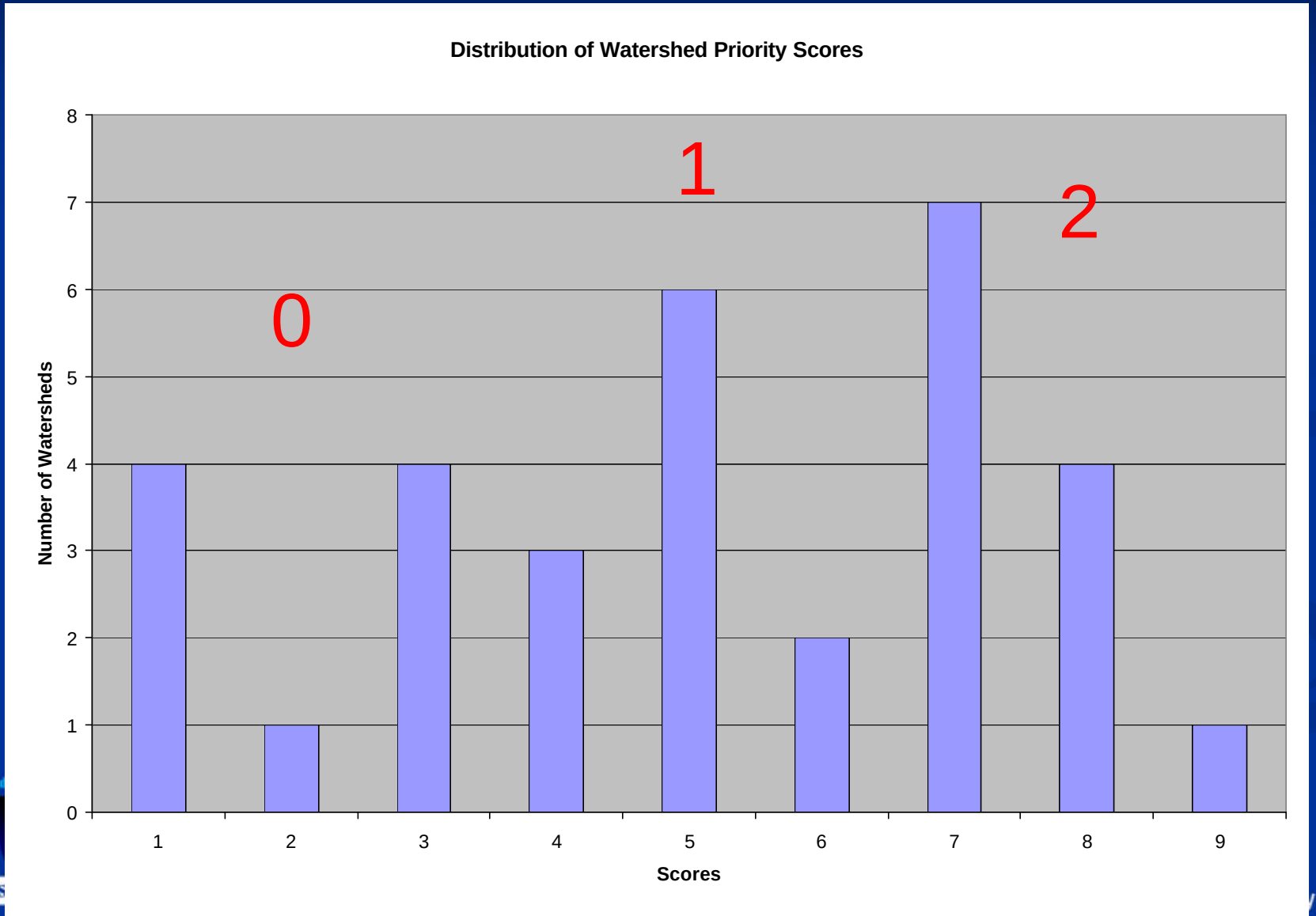
Percent Public/Private Protected Land per Sub-watershed and appropriate score. The higher the score the healthier the watershed.



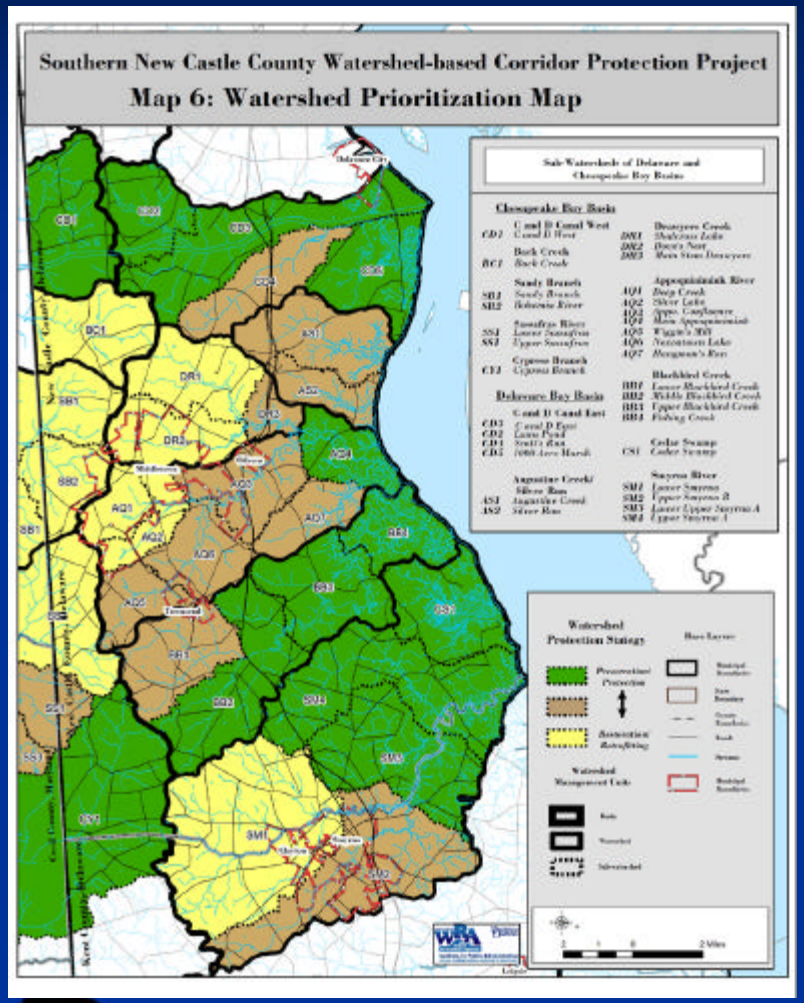
Scores were given to each sub-watershed in each of the 5 natural resource categories and a final score was given.

		NATURAL RESOURCES PERCENT (SCORE)										
		No.	Drainage Extent	Subwatershed	Drainage Area		Wetland	Forest	Riparian Buffer with Forest or Wetland	Percent Public/Private Open Space	Impervious Cover	SCORE
					(Acres)	(Sq.Mi.)						
			Chesapeake									
	C and D Canal	1	CD1	C and D Canal West	6150.19	9.61	18 (1)	20 (1)	65 (1)	33(2)	7 (2)	7
	Back Creek	2	BC1	Back Creek	4821.85	7.53	6 (0)	4 (0)	37 (0)	10(0)	8 (1)	1
	Sandy Branch	3	SB1	Bohemia River	3056.04	4.78	7 (0)	7 (0)	44 (0)	1(0)	8 (1)	1
		4	SB2	Sandy Branch	2785.70	4.35	4 (0)	7 (0)	49 (0)	0(0)	4 (2)	2
	Sassafras River	5	SS1	Sassafras River	1047.21	8.30	45(2)	16(1)	43(0)	3(0)	1(2)	5
		6	SS2	Upper Sassafras River	4265.33		11(1)	8(0)	16(0)	2(0)	2(2)	3
	Cypress Branch	7	CY1	Cypress Branch	10219.89	15.97	46 (2)	17 (1)	78 (2)	32(2)	3 (2)	9
			Delaware									
	C&D Canal East	8	CD2	Lums Pond	3817.66	5.97	13 (1)	30 (2)	59 (1)	72(2)	6 (2)	8
		9	CD3	C and D Canal East	7939.01	12.40	19 (1)	11 (1)	60 (1)	39(2)	6 (2)	7
		10	CD4	Scott's Run	4168.14	6.51	8 (0)	11 (1)	61 (1)	5(0)	7 (2)	4
		11	CD5	1000 Acre Marsh	4788.19	7.48	49 (2)	9 (0)	84 (2)	26(1)	2 (2)	7
	Augustine /Silver Run	12	AS1	Augustine Creek	5051.46	7.89	23 (1)	9 (0)	74 (1)	25(1)	7 (2)	5
		13	AS2	Silver Run	2370.03	3.70	30 (2)	5 (0)	73 (1)	42(2)	11 (1)	6
	Drawyers Creek	14	DR1	Shallcross Lake	4658.41	7.28	10 (1)	9 (0)	65 (1)	15(0)	9 (1)	3
		15	DR2	Dove's Nest	3902.13	6.10	10 (1)	6 (0)	59 (1)	13(0)	13 (1)	3
		16	DR3	Main Stem Drawyer's	1313.76	2.05	19 (1)	13 (1)	66 (1)	15(0)	7 (2)	5
	Appoquinimink Creek	17	AQ1	Deep Creek	2170.47	3.39	5 (0)	3 (0)	48 (0)	2(0)	14 (1)	1
		18	AQ2	Silver Lake	2009.3	3.14	5 (0)	6 (0)	49 (0)	7(0)	8 (1)	1
		19	AQ3	Appo. Confluence	4277.63	6.68	18 (1)	11 (1)	68 (1)	23(1)	10 (1)	5
		20	AQ4	Main Appoquinimink	3016.41	4.71	58 (2)	1 (0)	77 (2)	50(2)	2 (2)	8
		21	AQ5	Wiggin's Mill	2688.31	4.20	5 (0)	9 (1)	50 (1)	14(0)	5 (2)	4
		22	AQ6	Noxontown Lake	3511.53	5.49	15 (1)	18 (1)	68 (1)	<1(0)	6 (2)	5
		23	AQ7	Hangman's Run	2695.22	4.21	24 (1)	4 (0)	63 (1)	18(1)	4 (2)	5
	Blackbird Creek	24	BB1	Lower Blackbird Creek	4749.72	7.42	21 (1)	15 (1)	69 (1)	20(1)	6 (2)	6
		25	BB2	Middle Blackbird Creek	7098.01	11.09	20 (1)	28 (2)	70 (1)	26(1)	7 (2)	7
		26	BB3	Upper Blackbird Creek	5343.18	8.35	26 (2)	14 (1)	26 (0)	48(2)	3 (2)	7
		27	BB4	Fishing Creek	3445.87	5.38	75 (2)	2 (0)	85 (2)	89(2)	1 (2)	8
	Cedar Swamp	28	CS1	Cedar Swamp	5248.13	8.20	56 (2)	5 (0)	81 (2)	93(2)	1 (2)	8
	Smyrna River	29	SM1	Lower Smyrna	13631.39	21.30	11 (1)	5 (0)	46 (0)	12(0)	7 (2)	3
		30	SM2	Upper Smyrna B	17576.70	27.46	29(2)	19(1)	45(0)	15(0)	8 (1)	4
		31	SM3	Lower Upper Smyrna A	7568.01	11.83	26(2)	12(1)	32(0)	26(1)	4(2)	7
		32	SM4	Upper Smyrna A	10008.68	15.64	38(2)	19(1)	45(0)	37(2)	2(2)	7

In keeping with the 0,1,2 scoring system sub-watersheds that scored a 1, 2 or 3 received a final score of 0. Sub-watersheds that scored 4, 5, or 6 received a final score of 1. Sub-watersheds that scored a 7, 8 or 9 received a final score of 2.



MAP 6. Watershed Preservation/Restoration Strategy



(Corresponding Final Score)

Preservation/ Protection — 2

1

Restoration/ Retrofitting — 0

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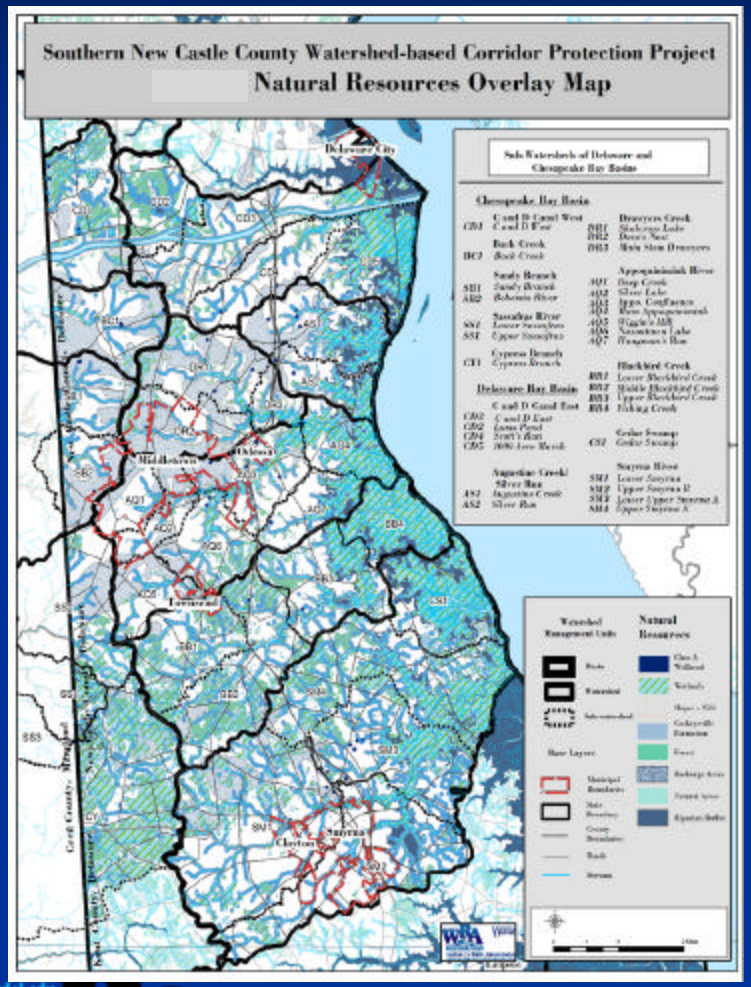
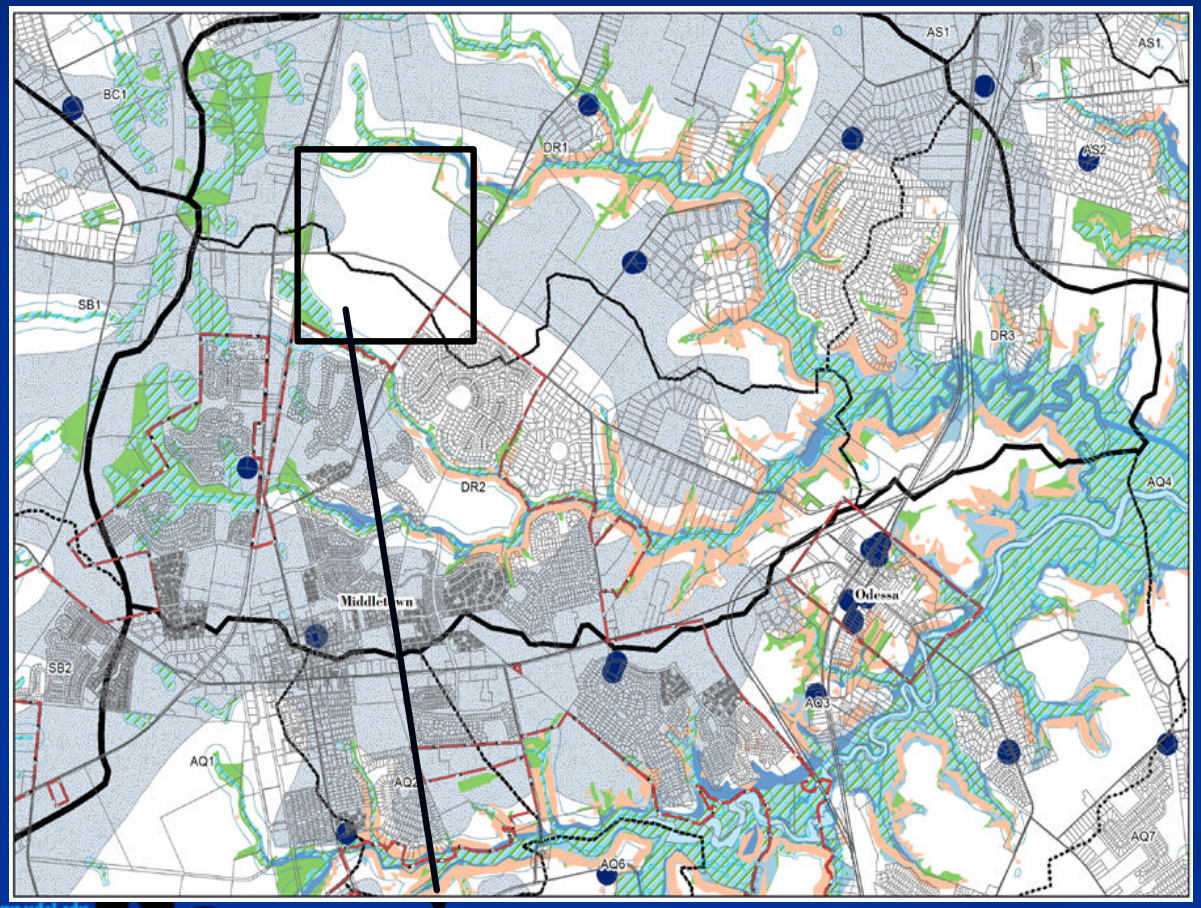
Map of Natural Resources Per Sub-watershed. The Natural Resources depicted in the map are those protected under the Unified Development Code.

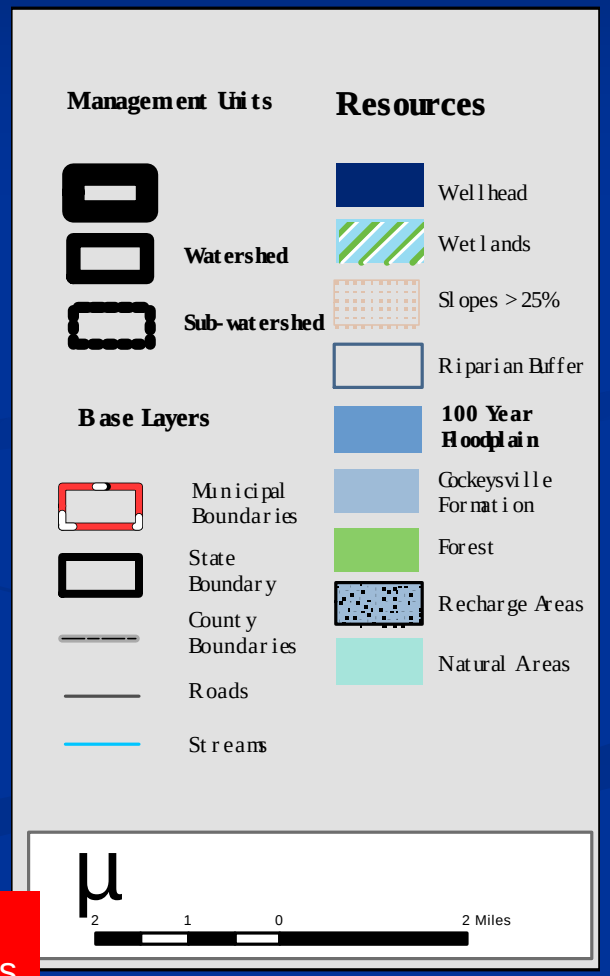


White areas on the map show locations with no restrictions on amount of impervious surface allowed.

Areas of Natural Resources have varying degrees of protection in the form of restrictions on percent of Impervious cover allowed.

Overlying parcels on Natural Resource map allows planners to view where to redirect impervious surface to protect water resources and to protect watershed from exceeding impervious cover thresholds.





Potential relocation of large Sub-division project outside of Middletown, DE. This location would best protect water resources.

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Strengths

- Can be replicated with limited data needs, so that departments with limited research capabilities can duplicate
- Can test the adequacy of various natural resource regulations to see if the restrictions maintain impervious cover within a watershed below threshold
- Once sub-watersheds are created, various analysis and modeling can be conducted on these units

Limitations

- The results are limited by the accuracy of the land use data

- Impervious cover proxy values must be calibrated for the study area
  (general values such as documented by the USDA may not work for all locations since building densities vary between municipalities)

Contact Information

For information regarding this project and the methodology please contact:

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