SMART GROWTH ALTERNATIVES FOR THE CENTRAL DELAWARE COMMUNITIES: AVOIDING THE UNINTENDED IMPACTS OF BUILD-OUT

Prepared for: NJ Department of Environmental Protection
Prepared by: The Regional Planning Partnership
February 28, 2003

ACKNOWLEDGEMENTS

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This report was prepared for the New Jersey Department of Environmental Protection's Division of Watershed Management, Northwest Bureau, as part of New Jersey's Statewide watershed planning process begun in 2000.

The Regional Planning Partnership would like to acknowledge the contributions made to this report by: the WMA 11 Characterization and Assessment Committee; Pam V'Combe and Karen Reavey of the Delaware River Basin Commission; Caroline Armstrong, Hunterdon County Planning Board; Katrina Flagel, Mercer County Planning Division; the West Amwell Planning Board; Mayors' Breakfast attendees from WMA 11; and the NJDEP Division of Watershed Management, Northwest Bureau.

The alternatives described in this report were prepared as examples of how Smart Growth alternatives could work in WMA 11, as part of Phase One of the watershed planning process. The Watershed Action Plan for WMA 11 recommends that Phase Two of the watershed planning process should involve municipalities working together to refine Smart Growth alternatives to build-out where the impacts of build-out threaten water resources.

EXECUTIVE SUMMARY

This report was prepared for the New Jersey Department of Environmental Protection's (NJDEP) Division of Watershed Management, Northwest Bureau, as part of New Jersey's statewide watershed planning process begun in 2000. Throughout Phase One of the watershed planning process, local government officials, members of local advisory boards, members of watershed associations and other stakeholders asked for assistance in understanding the impact of their township's current zoning on the water resources in their communities.

This report summarizes the results of RPP's analysis of the impacts that would be produced by the build-out of the existing zoning in WMA 11. RPP's Goal Oriented Zoning (GOZ®) model was used to identify water resource impacts from build-out including: impervious cover, phosphorus, nitrogen, Biological Oxygen Demand, as well as water and wastewater demand. (See Appendix 1 for a listing of impacts by municipality.) A watershed vulnerability risk assessment was carried out for WMA 11 based on the build-out information (see Map 6). It identified that at build-out 72% of the Watershed Management Area would contain levels of impervious cover above the 10% threshold for maintaining healthy streams identified by Schueler (1994), EPA (1994), and Arnold (1996). This would represent a reversal of current conditions, based on 1995/95 land use/land cover data, where 65% of the watershed is below the 10% threshold.

The model also determined that most of the remaining available open land for new development is located in the north of the watershed in West Amwell, Delaware, Kingwood and Alexandria townships with open land also available for development in Lawrence, Washington and Upper Freehold townships. Kingwood Township was identified as the area where most of the very low density single family housing units in the watershed would be added at the build-out of current zoning. (See Appendix 2 for information on impacts associated with build-out other than water quality impacts, e.g., dwelling units, jobs, vehicle miles traveled, etc.)

In response to stakeholder interest, four sets of alternative scenarios to build-out at current zoning were developed for WMA 11 and their water resource impacts were compared. The preliminary results indicated a successful reduction in projected water resource impacts. The alternatives described in this report were prepared as examples of how Smart Growth alternatives could work in the Central Delaware communities. By refining various scenarios with local input, the zoning changes necessary to protect water resources in the WMA 11 communities could be developed.

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1.0) INTRODUCTION

This report on *Smart Growth Alternatives for the Central Delaware Communities: Avoiding the Unintended Consequences of Build-out* was prepared by RPP for the New Jersey Department of Environmental Protection's (NJDEP) Division of Watershed Management, Northwest Bureau.

The NJDEP established the watershed planning program for twenty watershed management areas in 2000. The goal of the program was to bring together all the issues and stakeholders that affect water resources to devise plans to better protect the state's water. A watershed approach was adopted to demonstrate the links between activities that usually are considered in isolation from each other (e.g., road selection and construction, farming practices, subdivision approval, disposal of pet waste), effects on water quality and supply, and ways to plan those activities to reduce their impacts on water resources.

Watershed Management Area 11 is made up of 24 municipalities located in western Hunterdon, Mercer and Monmouth counties (see Map 1.) Information on the water resource impacts and other impacts associated with the build-out of the current zoning are identified for each municipality by this report. The report also provides four alternative scenarios to current zoning, of increasing complexity, that were suggested by municipalities, counties and other interested stakeholders.

The alternatives described in this report were prepared as examples of how Smart Growth alternatives could work in the Central Delaware communities. The *Watershed Action Plan* for WMA 11 recommends that Phase Two of the watershed planning process involve municipalities working together to refine these and other Smart Growth alternatives that could be developed where the impacts of build-out threaten water resources.

2.0) SIGNIFICANCE OF BUILD-OUT FOR MUNICIPALITIES AND REGIONS

Identifying the cumulative impacts of building the amount of new development allowed by a municipality's zoning regulation is essential for understanding the future quality of life for that community. Municipalities need to know the answer to such water resource questions as:

- Do we have adequate water supplies for the population we expect to live here?

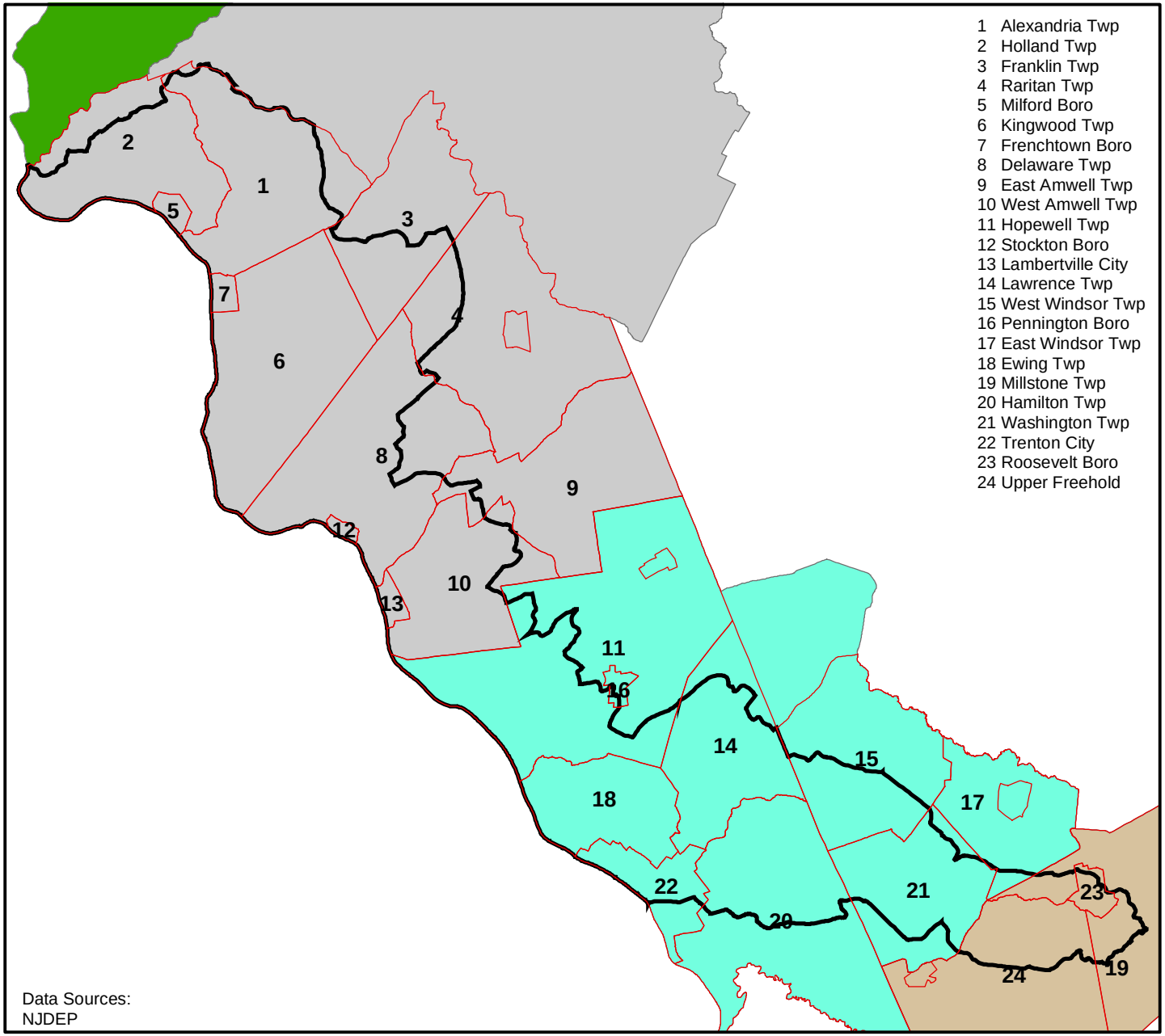
- How will our streams and groundwater be affected by the level and location of development we propose for our community?

A build-out analysis also provides answers to other capacity questions municipalities need to address to plan for their future:

Map 1

Watershed Management Area 11

Municipalities & Counties



1 Alexandria Twp
2 Holland Twp
3 Franklin Twp
4 Raritan Twp
5 Milford Boro
6 Kingwood Twp
7 Frenchtown Boro
8 Delaware Twp
9 East Amwell Twp
10 West Amwell Twp
11 Hopewell Twp
12 Stockton Boro
13 Lambertville City
14 Lawrence Twp
15 West Windsor Twp
16 Pennington Boro
17 East Windsor Twp
18 Ewing Twp
19 Millstone Twp
20 Hamilton Twp
21 Washington Twp
22 Trenton City
23 Roosevelt Boro
24 Upper Freehold

Municipalities
WMA 11

Counties

Hunterdon
Mercer
Monmouth
Warren

N
W E
S

Miles
0 2 4 6 8

Data Sources:
NJDEP

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The Regional Planning Partnership

- Have we zoned for an appropriate amount of housing given the amount of jobs we intend to locate in our community?

- Do we have an adequate amount of open space for the population we expect to live here?

- Do we have adequate concentrations of population to support transit use?

The answer to these questions relies on understanding build-out. Until recently such an analysis required laborious mapping and calculations. The possibility of analyzing alternative scenarios if the consequences of build-out were not what your community intended was very remote. However, new GIS-based tools have been developed to answer some of the above questions more rapidly.

While other impacts associated with build-out such as, new dwelling units, jobs, vehicle miles traveled, etc. are identified in Appendix 2, the focus of this report is on the water resources impacts associated with build-out for the Central Delaware communities.

3.0) BUILD-OUT IMPACTS IDENTIFIED FOR THE CENTRAL DELAWARE COMMUNITIES

Build-out impacts for WMA 11 were identified by RPP using its Goal Oriented Zoning (GOZ®) model and data on existing impervious cover provided by the Delaware River Basin Commission. (For details on how the GOZ® model works see Appendix 3. For information on the multipliers used to calculate impacts and the sources of the multipliers see Appendix 4.)

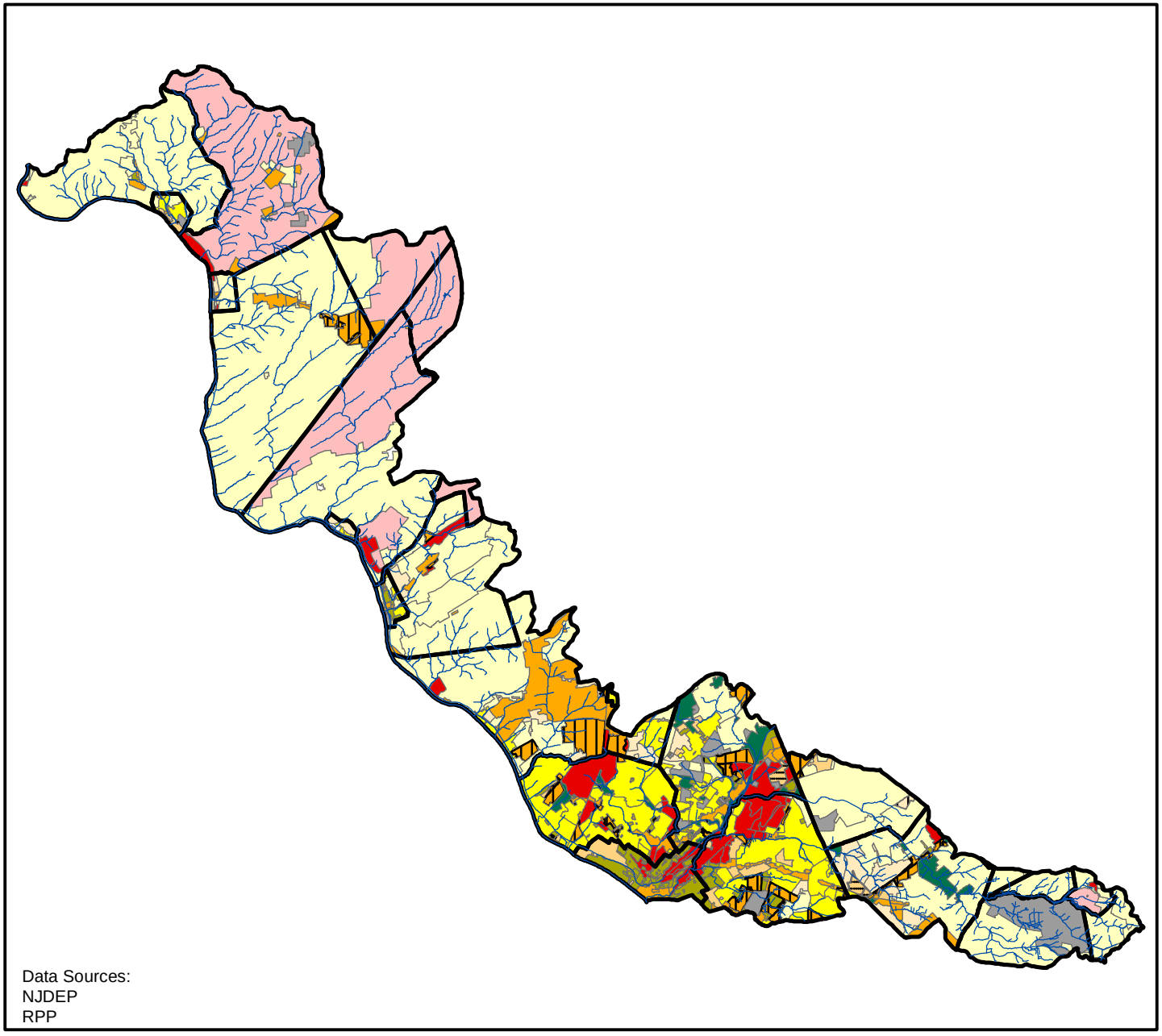
RPP used composite zones (representing the over 200 zones throughout WMA 11) to develop a comparison of the zones in use across WMA 11. This information (shown in Map 2) allows municipalities to identify how their zoning along stream corridors compares to the zoning used by neighboring municipalities. The composite zones also form the basis of the impact calculations.

Selected results of the build-out analysis include: where the remaining land available for development is located in WMA 11 (that is, unbuilt land without natural constraints, such as steep slopes or wetlands, that is zoned for development); the number of housing units that would be added due to build-out; impervious surface at build-out; and water pollutants associated with build-out.

Map 2

Watershed Management Area 11

Composite Zoning



Municipalities
Streams

Composite Zoning

- Business/Commercial
- Office
- Industrial/Warehouse
- Government/Institution
- R - Multi-family
- R - Multi-family (Age-restricted)
- R - High Density
- Mixed Use
- R - Medium Density
- R - Low Density
- R - Low Density (Age-restricted)
- R - Very Low Density
- R - Rural Density
- Conservation

N
W E
S

0 2 4 6 8 Miles

Data Sources:
NJDEP
RPP

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3.1) Remaining Land Available for New Development

Although the GOZ® model does have a redevelopment feature, for the purposes of this study, redevelopment of areas already developed was not considered. Therefore, the model identified that most of the land available for new development in the watershed management area is located in the north in West Amwell, Delaware, Kingwood and Alexandria Townships with undeveloped land also available in Washington, Upper Freehold and Lawrence Townships. (See Map 3 and Appendix 2.)

These areas are the most environmentally sensitive (designated rural environmentally sensitive, environmentally sensitive or rural under the State Development and Redevelopment Plan) containing trout production and water supply streams in the north as well as unprotected Natural Heritage priority areas. Using census data RPP determined these areas also experienced the greatest increase in houses built in the watershed management area between 1992 and 1997 (RPP 2001).

3.2) Additional Housing Units at Build-out

Kingwood Township was identified by the GOZ® model as the area where the greatest number of very low density single family housing units in the watershed would be added at the build-out of current zoning - 2,487 units. Ewing Township would add the largest number of total housing units - 3, 274 – however, the units would range from medium density single family housing to multifamily units and would therefore consume less land. (See Map 4 and Appendix 2.)

Kingwood Township contains the majority of the reaches of the Lockatong Creek, a water supply stream that drains directly into the Delaware and Raritan Canal. Because of the natural imperviousness of the argillite rock underlying Kingwood Township, detectable degradation in the water quality of the headwaters of the Lockatong Creek has occurred when impervious surface due to development has increased as little as two percent (Lockatong and Wickecheoke Project, 2001). Additional housing development, therefore, requires careful consideration of its potential water resource impacts.

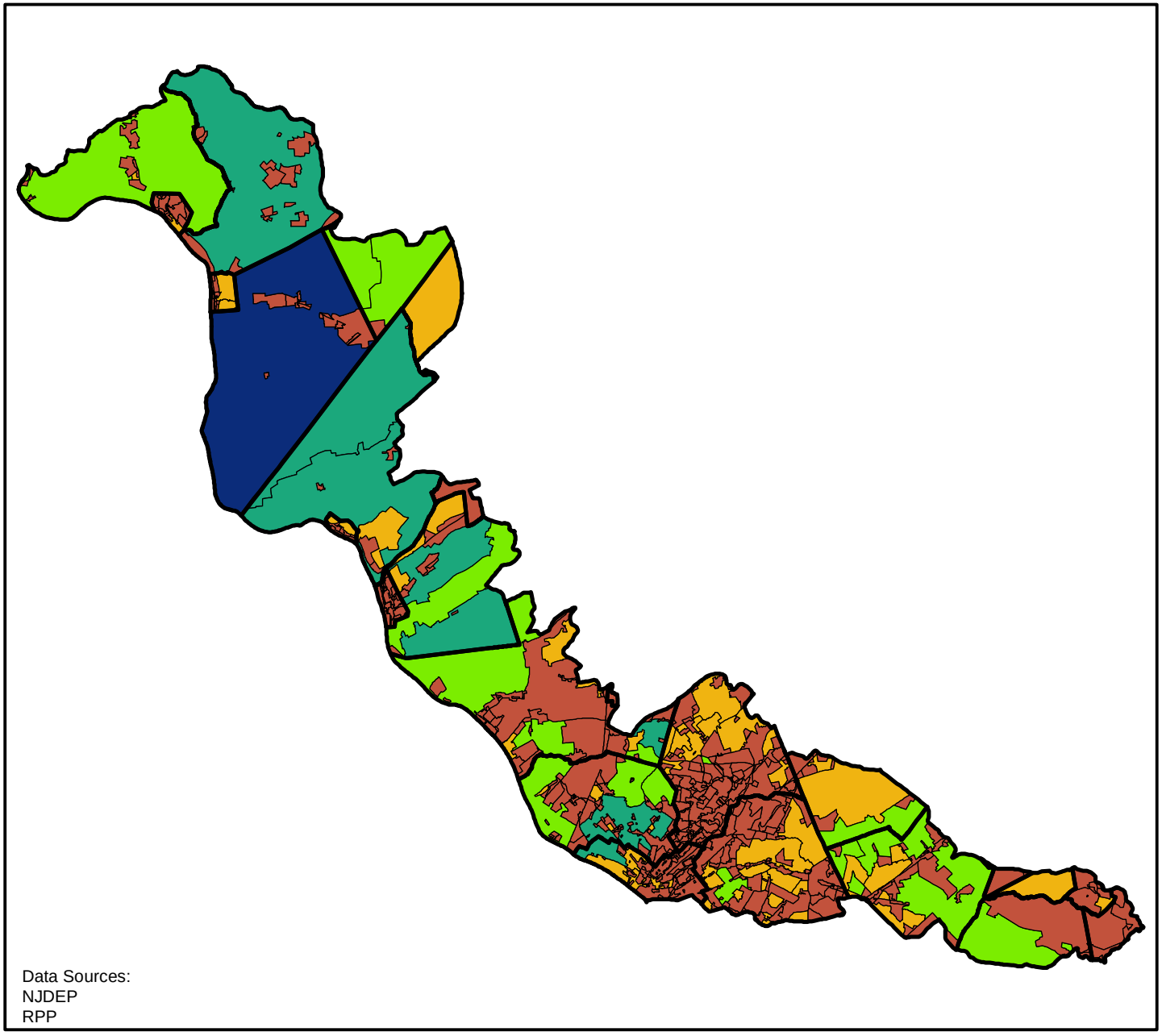
3.3) Impervious Surface

Impervious surface can be defined as any material that prevents the infiltration of water into the soil including roads, rooftops, sidewalks, patios, compacted soil (e.g., under lawns), and bedrock outcrops (Arnold, 1996). Existing impervious surface for WMA 11 is shown in Map 5 and impervious surface that would be added due to build-out is shown in Map 6. Most of the northern and southeastern parts of the watershed currently contain less than 10% impervious cover (based on 1995/1997 land use/land cover data).

Map 4

Watershed Management Area 11

Housing Units Added Due to Build-Out of Current Zoning



Municipalities

Housing Units by Zone

- 0 - 54
- 55 - 239
- 240 - 651
- 652 - 1310
- 1311 - 2478

N
W E
S

0 2 4 6 8 Miles

Data Sources:
NJDEP
RPP

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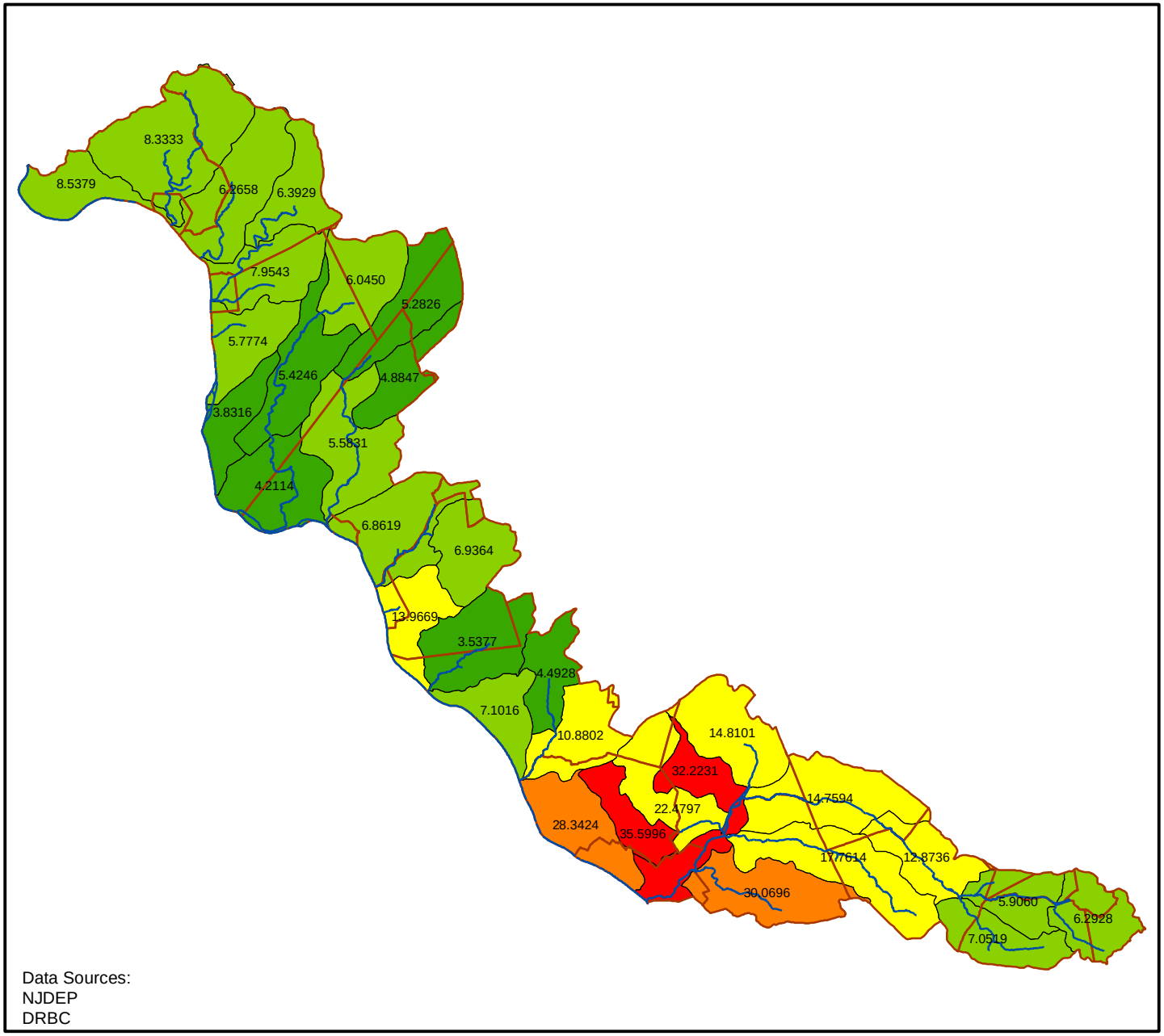
Map 5

Watershed Management Area 11

Impervious Surface (1995/97)



Municipalities
Rivers
Impervious Surface (%)
0 - 5
6 - 10
11 - 25
26 - 30
31 +

N
W
E
S

Miles
0 2 4 6 8

Data Sources:
NJDEP
DRBC

Prepared by
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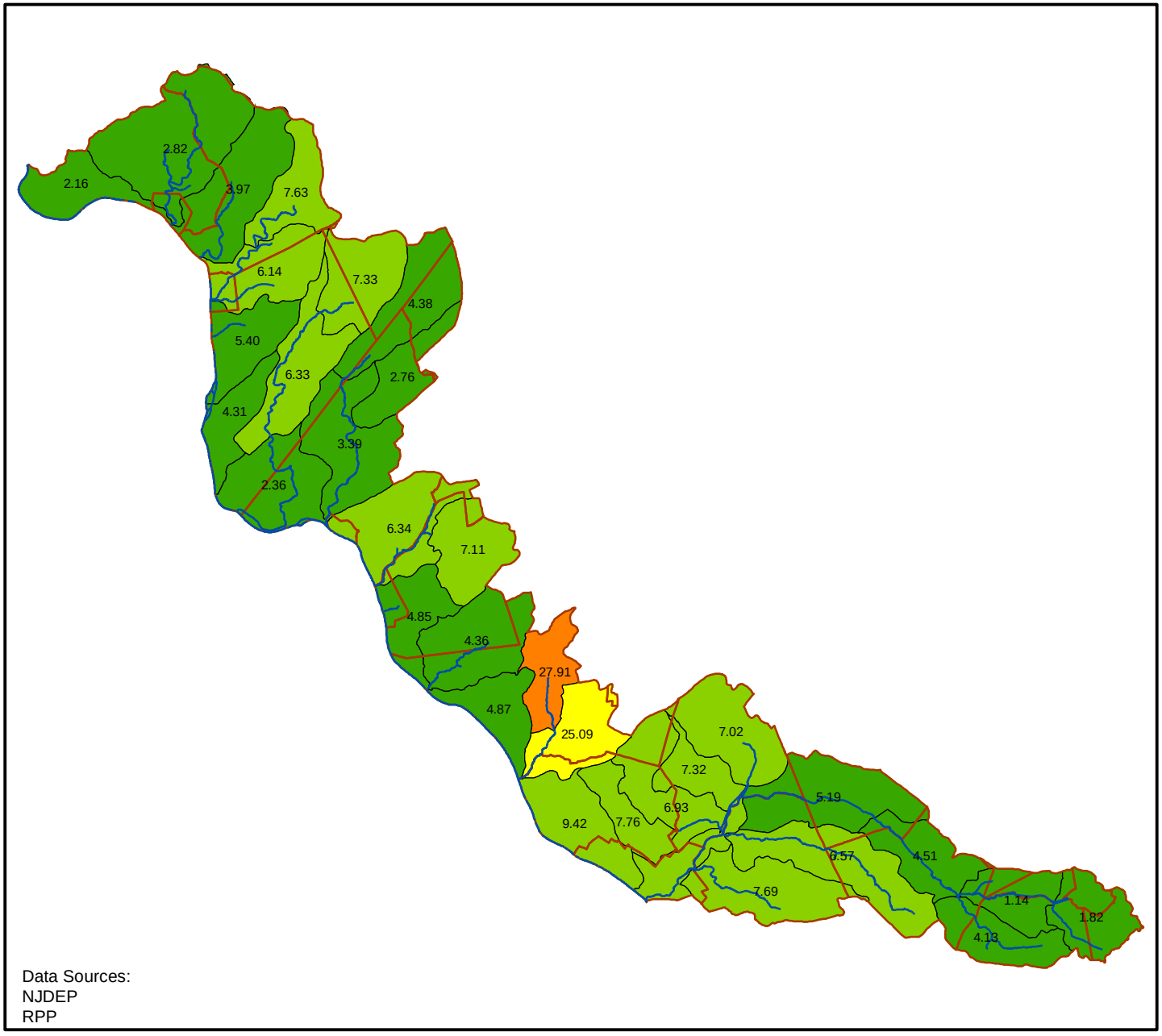
Map 6

Watershed Management Area 11

Additional Impervious Surface From Build-Out of Current Zoning



Municipalities

Rivers

Impervious Surface (%)

- 0 - 5
- 6 - 10
- 11- 25
- 26 - 30
- 31 +

N

W E

S

Miles

0 2 4 6 8

Data Sources:
NJDEP
RPP

Prepared by
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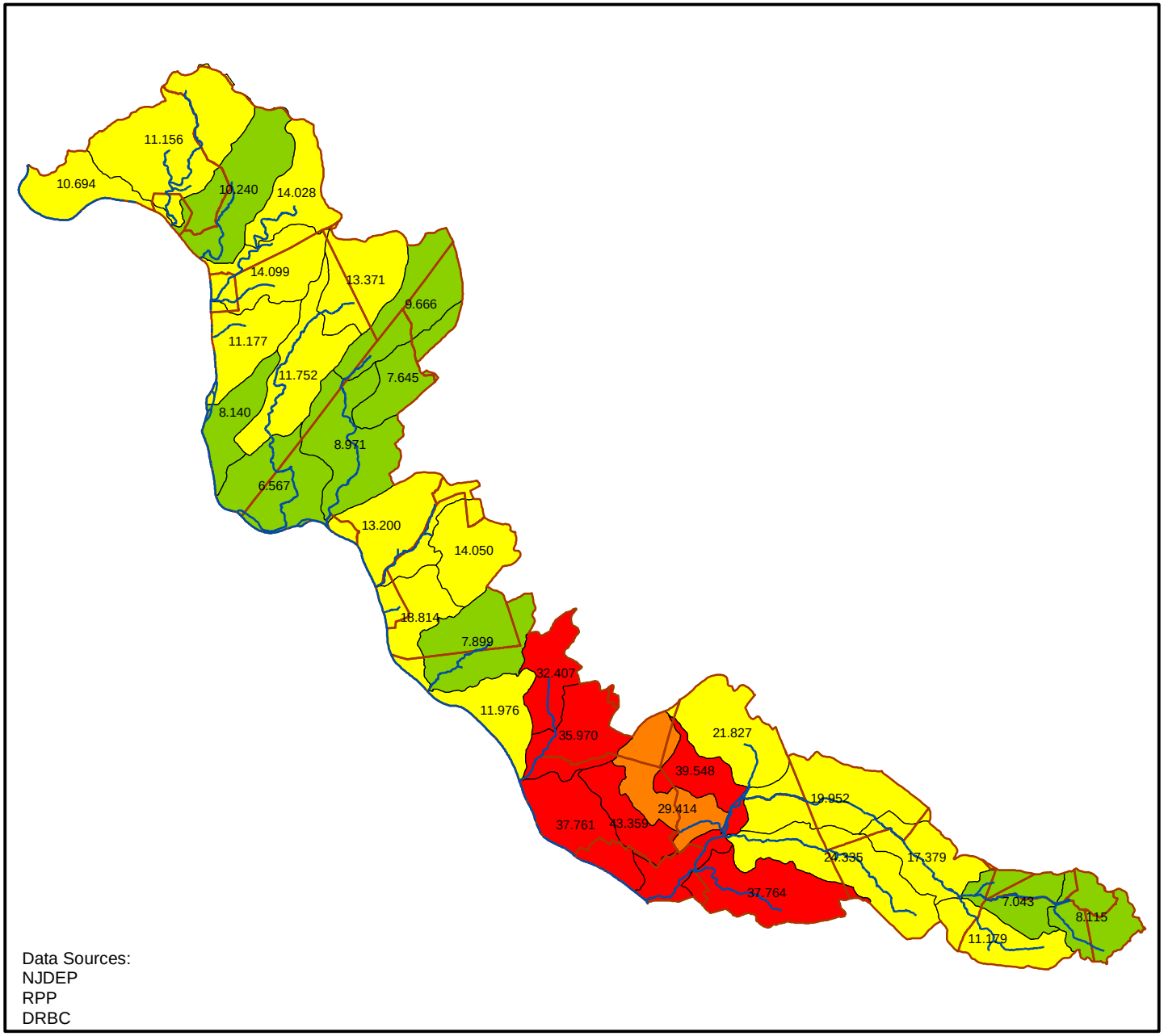
Map 7

Watershed Management Area 11

Vulnerability to Impervious Surface at Build-Out



Municipalities
Rivers
Impervious Surface (%)
0 - 5
6 - 10
11 - 25
26 - 30
31 +

N
W E
S

0 2 4 6 8 Miles

Data Sources:
NJDEP
RPP
DRBC

Prepared by
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This 10% figure is significant as it represents a threshold for maintaining healthy streams identified by Schueler (1994), EPA (1994), and Arnold (1996). Streams located in most parts of the United States, with the exception of the southwest, whose sub-watersheds contain less than 10% impervious cover are generally found to be healthy (though it must be remembered that each stream is unique and field checks are required when developing a specific plan for a particular stream.) Schueler identifies three categorizes for streams:

- sensitive - subwatershed contains 10% or less impervious cover,
- impacted - subwatershed contains between 11 and 25% impervious cover, and
- non-supporting - subwatershed contains greater than 25% impervious cover.

Impervious cover that would be added upon build-out of existing zoning ranges from a low of 1% in Roosevelt to a high of 27% in Hopewell Township. (The impacts of the total impervious surface at build-out are discussed below in Section 4.)

4.0) Analysis of Watershed Vulnerability to Impervious Cover for the Central Delaware Communities

One key piece of information local governments need in order to make sound decisions about water resource protection is an assessment of their streams' vulnerability to existing and projected impervious cover. Although impervious surfaces do not generate pollution they:

- Contribute to hydrologic changes that degrade waterways (by preventing recharge, thereby allowing more water to runoff the land at a faster rate than under natural conditions. This runoff leads to increased "flashiness" of peak discharges that widen and straighten stream channels (Arnold1996); increased erosion that destroys riparian and in-stream habitat (Scheuler 1992); as well as a reduced watertable and flow for well and stream flow (Dunne and Leopold 1978),
- Prevent natural pollutant processing in the soil by preventing percolation (Arnold 1996),
- Serve as an efficient conveyor of pollutants into waterways (EPA 1994).

Using Schueler's (1994) three general categories of streams (based on the amount of impervious cover in the stream's sub-watershed) as an indicator of stream health, RPP developed Map 7 as a risk assessment tool for identifying stream vulnerability to impervious surface at build-out of current zoning.

The results of RPP's analysis of watershed vulnerability for the Central Delaware communities are dramatic. While 65% of the watershed management

area is currently *below* the 10% threshold for healthy streams, based on 1995/97 land use/land cover data (DRBC 2002), at build-out under current zoning the condition of the watershed will be reversed. At build-out under current zoning, 72% of the watershed management area will be *above* the 10% threshold for maintaining healthy streams.

5.0) Alternative Scenarios Identified for the Central Delaware Communities

Throughout Phase One of the watershed planning process, various individual stakeholders, township planning boards and project team members expressed interest in developing alternative scenarios to the status quo of build-out. RPP undertook four alternative scenarios ranging in complexity from a simple buffering of stream corridors within two municipalities (one in the north and one in the south of the watershed management area) to a complex replacement of existing zones within an entire county by Goal Oriented Zones developed by RPP (based on the State Development and Redevelopment Plan Map Areas) that increased density in some areas and reduced density in others. In all cases, the impacts on water quality were reduced by the alternative scenarios. These alternatives are described below.

5.1) Stream Buffers: West Amwell and Lawrence Townships

RPP developed two scenarios to compare the difference in impacts between placing a 150 foot buffer along all the streams in the township of West Amwell, Hunterdon County, and build-out under existing zoning. In Map 8, Scenario One depicts constrained land (land that cannot be built upon) at build-out while Scenario Two depicts the slight increase in constrained land that would occur with the creation of a 150 foot buffer along the streams. The graph at the bottom of Map 8 indicates the resulting calculation by the GOZ® model of a reduction in impervious cover of 21 acres or 2%. This result seems almost insignificant at first. However, this number must be placed in the context of the scientific research discussed in section 3 above that has demonstrated a threshold of impact on stream health once 10% of a watershed is covered by impervious surface.

RPP developed a similar set of scenarios for Lawrence Township, Mercer County. Map 9 represents the differences in constrained land between Scenario One - build-out under existing zoning and Scenario Two - with stream buffers. In this case, the GOZ® model calculated a 5% reduction in impervious cover.

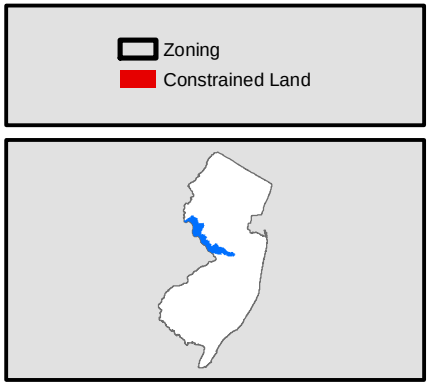
Map 8

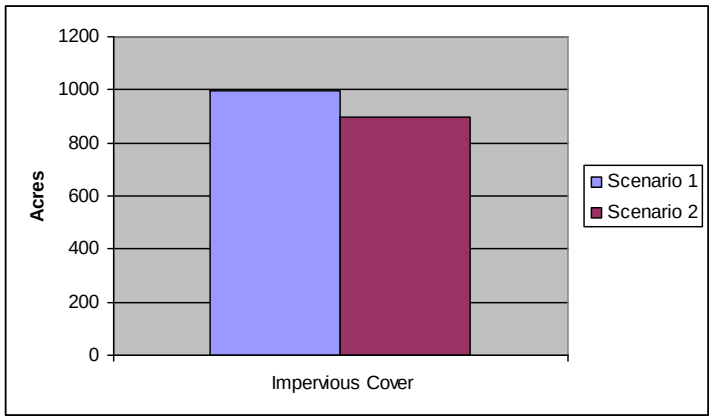
Watershed Management Area 11

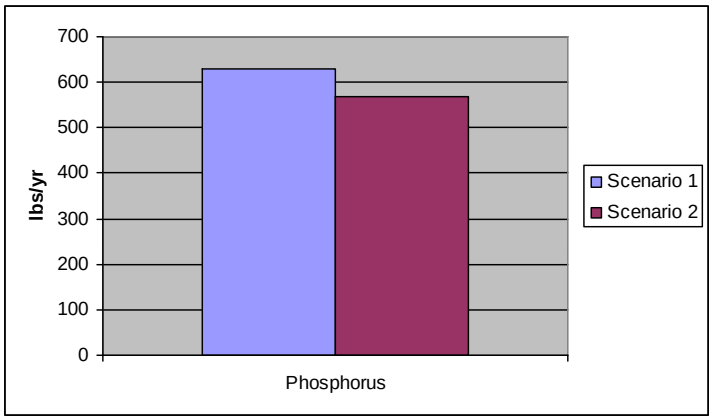
Proposed Stream Buffers for West Amwell

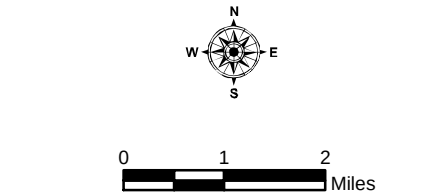
Scenario 1

Scenario 2









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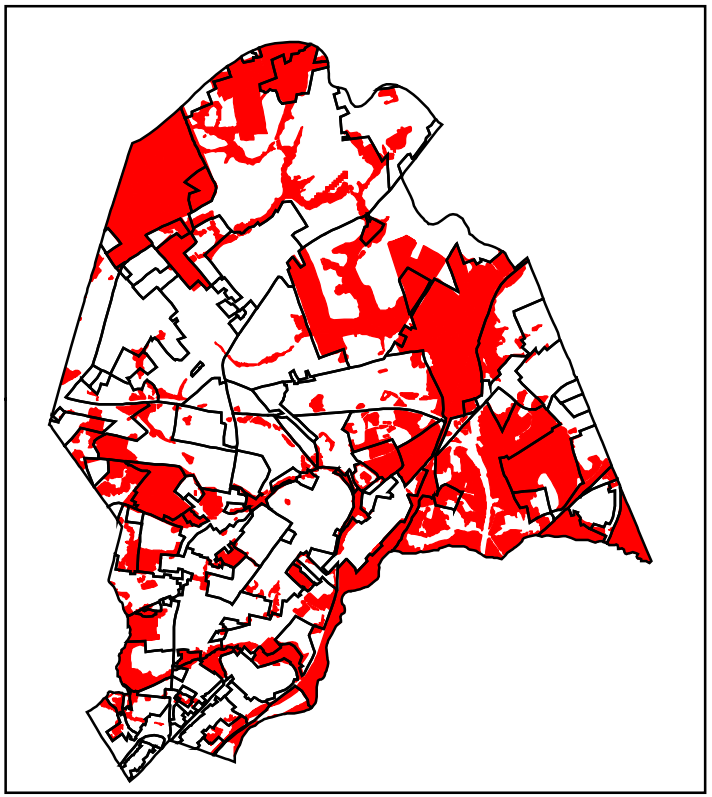
Data Source:
RPP

Map 9

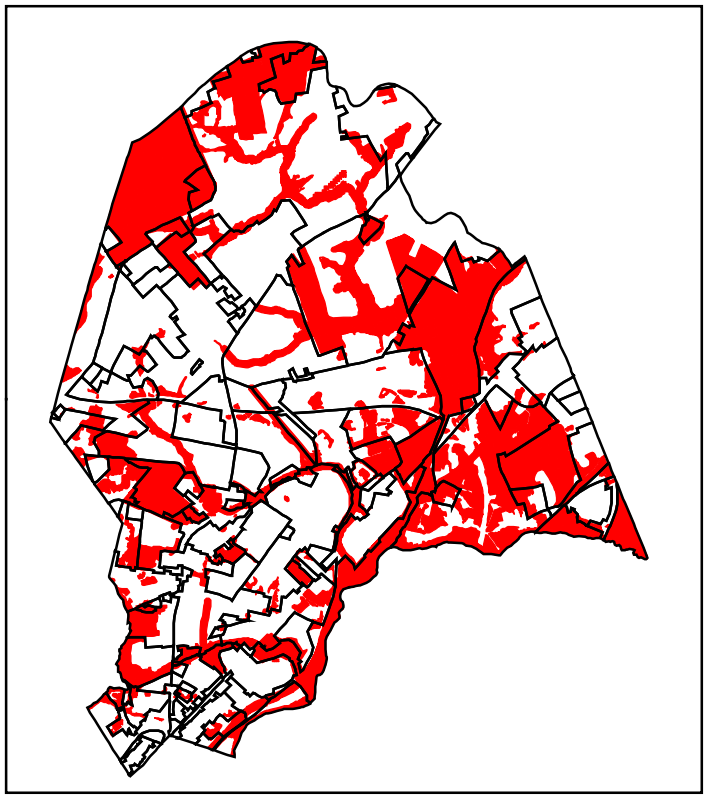
Watershed Management Area 11

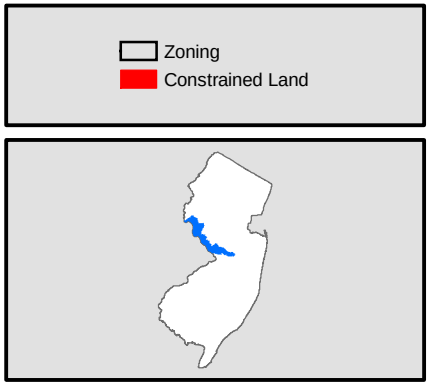
Proposed Stream Buffers for Lawrence Twp

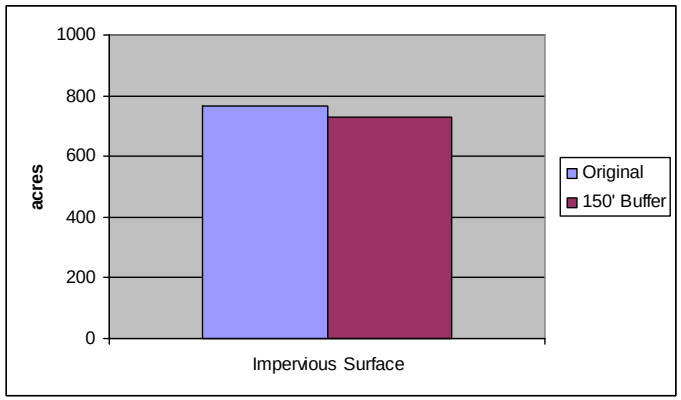
Scenario 1

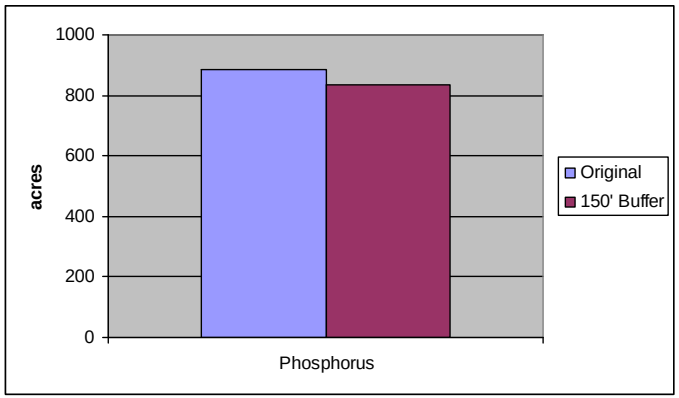


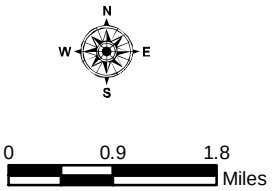
Scenario 2











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The Regional Planning Partnership

Data Source:
RPP

5.2) Watershed Based Zoning: Kingwood Township, Hunterdon County

Watershed based zoning is a concept developed by Schueler 1994 that uses existing impervious cover and projected impervious cover at build-out to determine if a municipality's zoning needs to be revised to reflect its goals for the water quality of a sub-watershed.

Kingwood Township was selected as an example of the watershed zoning concept as the GOZ® model identified it as the township anticipated to add the greatest number of very low density single family housing units upon build-out and it contains a water supply stream, the Lockatong Creek, that has proven sensitive to development impacts at low levels of impervious cover (Lockatong and Wickecheoke Group, 2001). In the table below, the sub-watersheds are identified by number moving in a clockwise direction around the township (see Map 10).

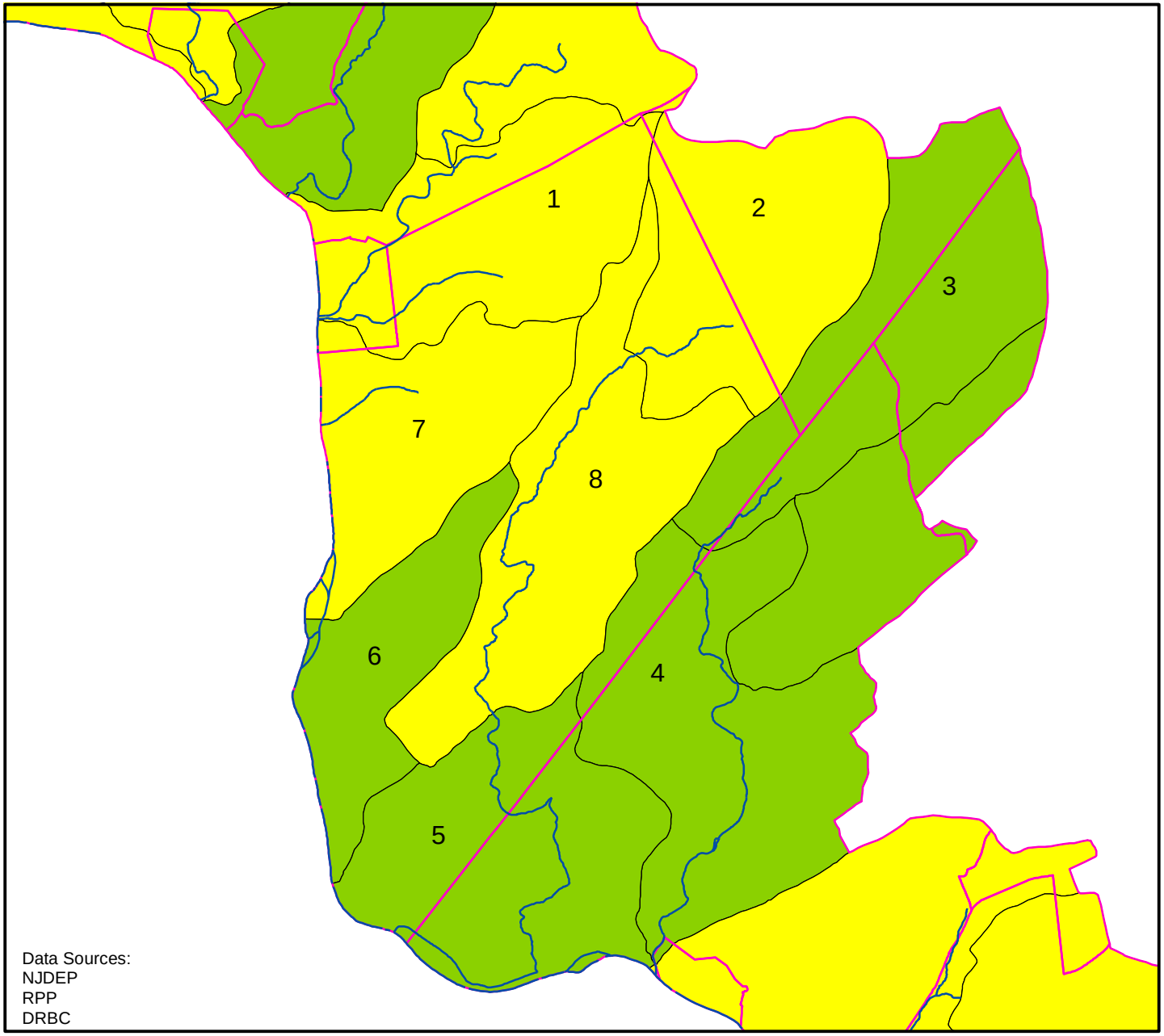
While the target impervious cover for the purpose of this exercise has been set at 10%, ideally an actual target impervious cover would be developed through a facilitated stakeholder process in the future of the watershed planning process. The argillite base rock in this area is itself nearly impervious and is particularly sensitive to the affects of additional impervious surface, therefore, the percentage threshold for impervious cover would require discussion for this area. Once a target impervious cover was established it could then be used to change current zoning ordinances, where necessary, to protect water resources.

The table clearly shows that the existing zoning in half of the sub-watersheds (in bold type) would require changing to prevent the 10% threshold of impervious surface from being exceeded upon build-out of existing zoning. After reviewing the information developed for this report, the Township of Kingwood could consider reducing impervious cover at build-out through cluster development, reducing densities through downzoning or introducing an overlay zone for water quality protection.

Map 10

Watershed Management Area 11

Impervious Surface at Build-Out for Kingwood Twp. Sub-watersheds



Municipalities
Rivers
Impervious Surface (%)
0 - 5
6 - 10
11 - 25
26 - 30
31 +

N
W
E
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Miles
0 0.7 1.4 2.1 2.8

Data Sources:
NJDEP
RPP
DRBC

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Table 1: Watershed-Based Zoning for Kingwood Twp. Sub-watersheds

Subwater-shed Name	Subwatershed Impervious Cover			Subwatershed Classification	Stream Protection Goal or Technique
	Current	Zoned	Target		
1	8.0%	**14.1%**	10%	Sensitive	Set impervious cap at 10% or less, protect current excellent riparian buffers
2	6.0%	**13.3%**	10%	Sensitive	Set impervious cap at 10% or less, rehabilitate degraded riparian buffers
3	5.3%	9.7%	10%	Sensitive	Set impervious cap at 10% or less, rehabilitate degraded riparian buffers
4	5.6%	9.0%	10%	Sensitive	Set impervious cap at 10% or less, rehabilitate degraded riparian buffers
5	4.2%	6.6%	10%	Sensitive	Set impervious cap at 10% or less, protect current excellent riparian buffers
6	3.8%	8.1%	10%	Sensitive	Set impervious cap at 10% or less, protect current excellent riparian buffers
7	5.8%	**11.2%**	10%	Sensitive	Set impervious cap at 10% or less, protect current excellent riparian buffers
8	5.4%	**11.7%**	10%	Sensitive	Set impervious cap at 10% or less, rehabilitate degraded riparian buffers

5.3) Centers: Upper Freehold, Monmouth County

Smart Growth principles have developed as a reaction against the problems associated with low density, auto-dependent, single use development known as sprawl – loss of open space, increased commute times and congestion, lack of affordable housing. At the core of the Smart Growth approach is the principle of creating mixed use centers. These centers of development would contain housing as well as retail and office uses within walking distances or linked by transit services in order to use less land and reduce congestion.

The Township of Upper Freehold expressed interest in a GOZ® model demonstration of the water quality impacts associated with build-out of their current zoning. These impacts were compared to those that would occur if the amount of development was kept the same but centered i.e.; density was increased in potential centers and decreased in surrounding zones.

RPP used a number of information sources to identify locations for potential centers including: GIS layers on natural attributes (e.g., wetlands, stream locations, slopes, Landscape Project areas of high value, etc.), current land uses within Upper Freehold and its neighboring municipalities, existing zoning ordinances, transportation corridors, and State Development and Redevelopment Plan Map areas.

Map 11 shows the two scenarios that were analyzed: existing zoning is shown in Scenario One and the alternative zoning with seven new centers is shown in Scenario Two. The total number of units is the same in each scenario, however, the location of the units changes between scenarios. The alternative scenario with increased density in centers and decreased density in surrounding zones reduced impervious cover by 25%.

5.4) Vision 2050 Goal-Oriented Zoning: Mercer County

The final alternative scenario developed in Phase One of the watershed planning process was the most complex to create as it covered all the WMA 11 municipalities within one county and involved the development of new zones. As Hunterdon County was already in the middle of the process for its master plan review, Mercer County was chosen as the focus of this final scenario.

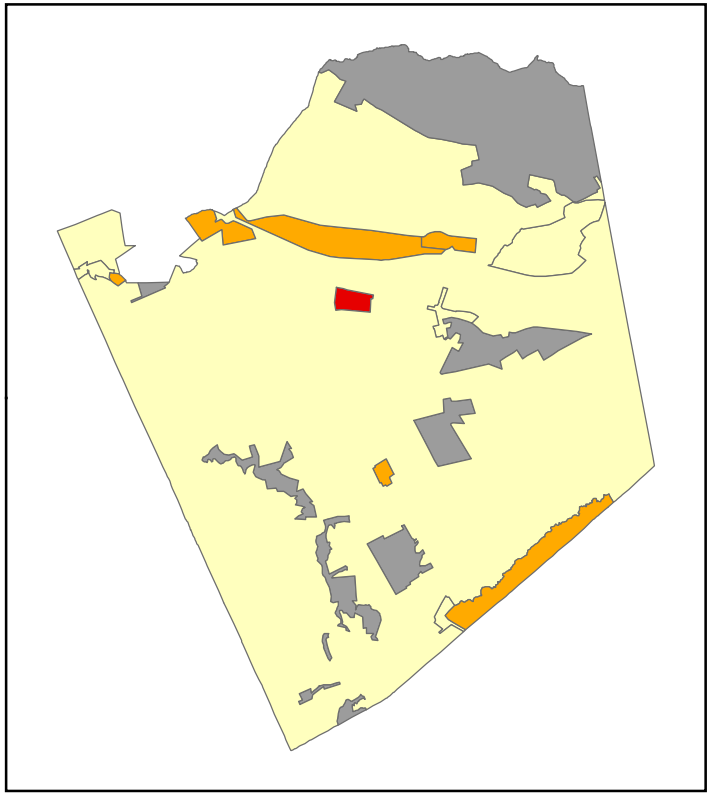
In 1997 RPP had used the GOZ® model to determine build-out for the municipalities in Mercer County and portions of Somerset and Middlesex Counties. (See Map 12 for the composite zones for Mercer County). The results of that analysis determined that the region would be built out in one generation – by 2020 (see Map 13). In fact the region would not be able to absorb the State Plan projections for its future population for 2020.

Map 11

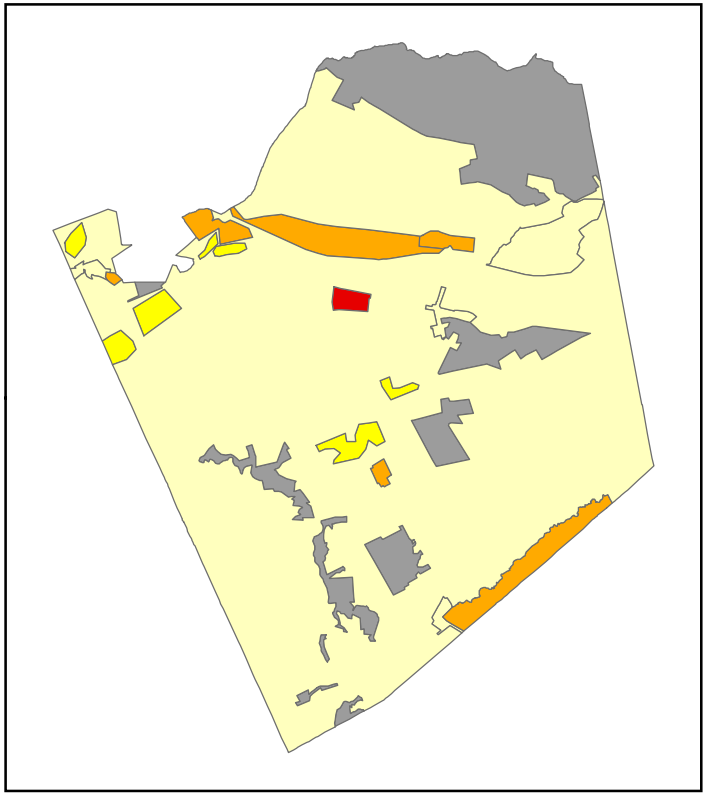
Watershed Management Area 11

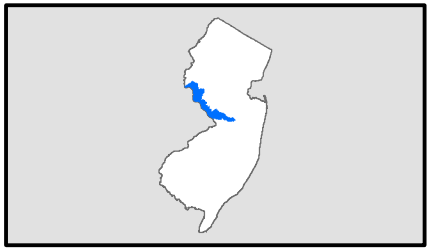
Proposed Centers For Upper Freehold

Existing Zoning

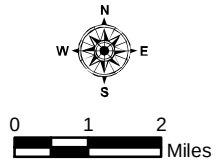


Alternative Zoning





	Existing	Alternative
Total Units	4857	4857
Impervious	1829	1377
Nitrogen	12019	1113
Phosphorous	1558	1442



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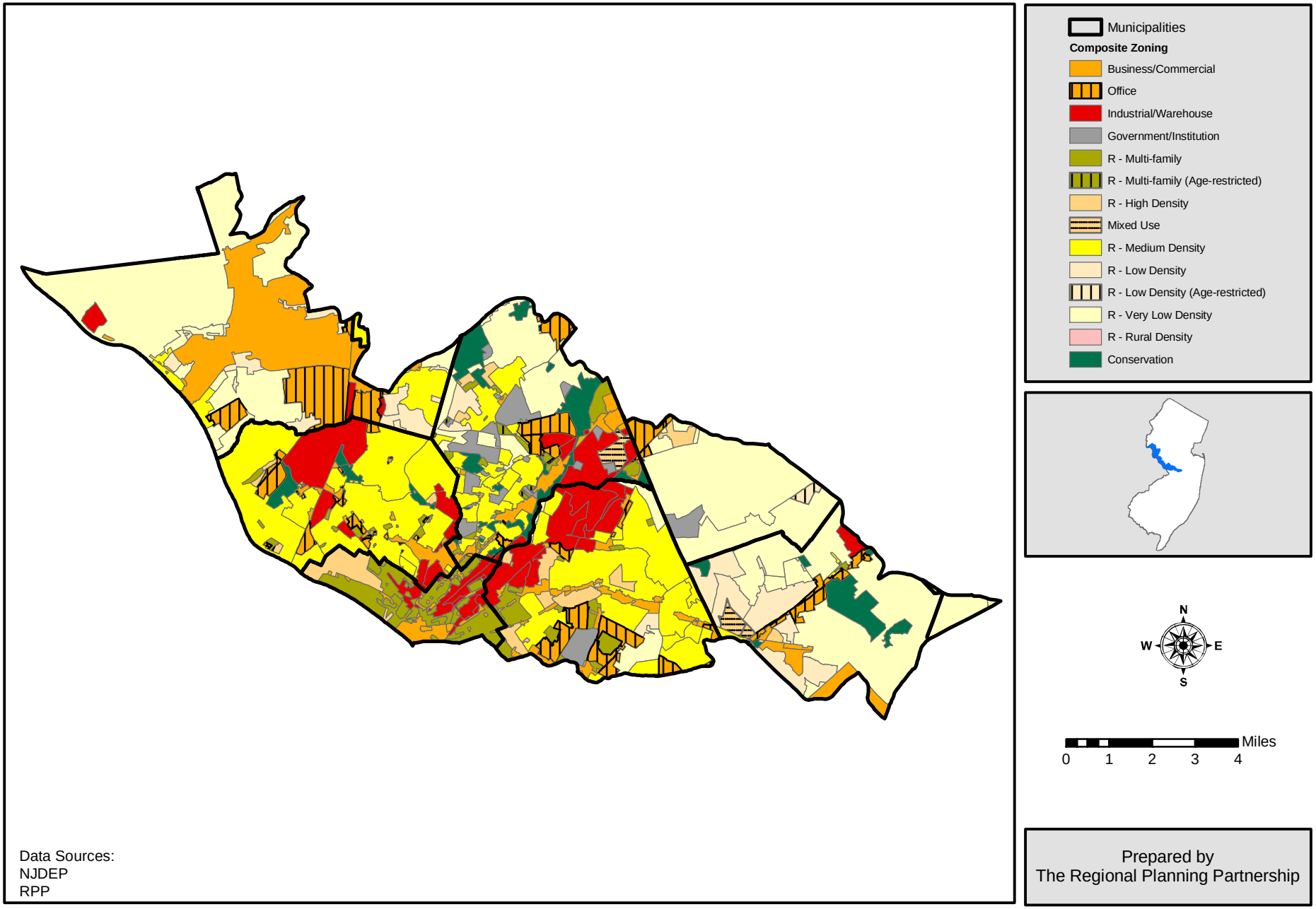
Map 12

Watershed Management Area 11

Mercer County Composite Zoning



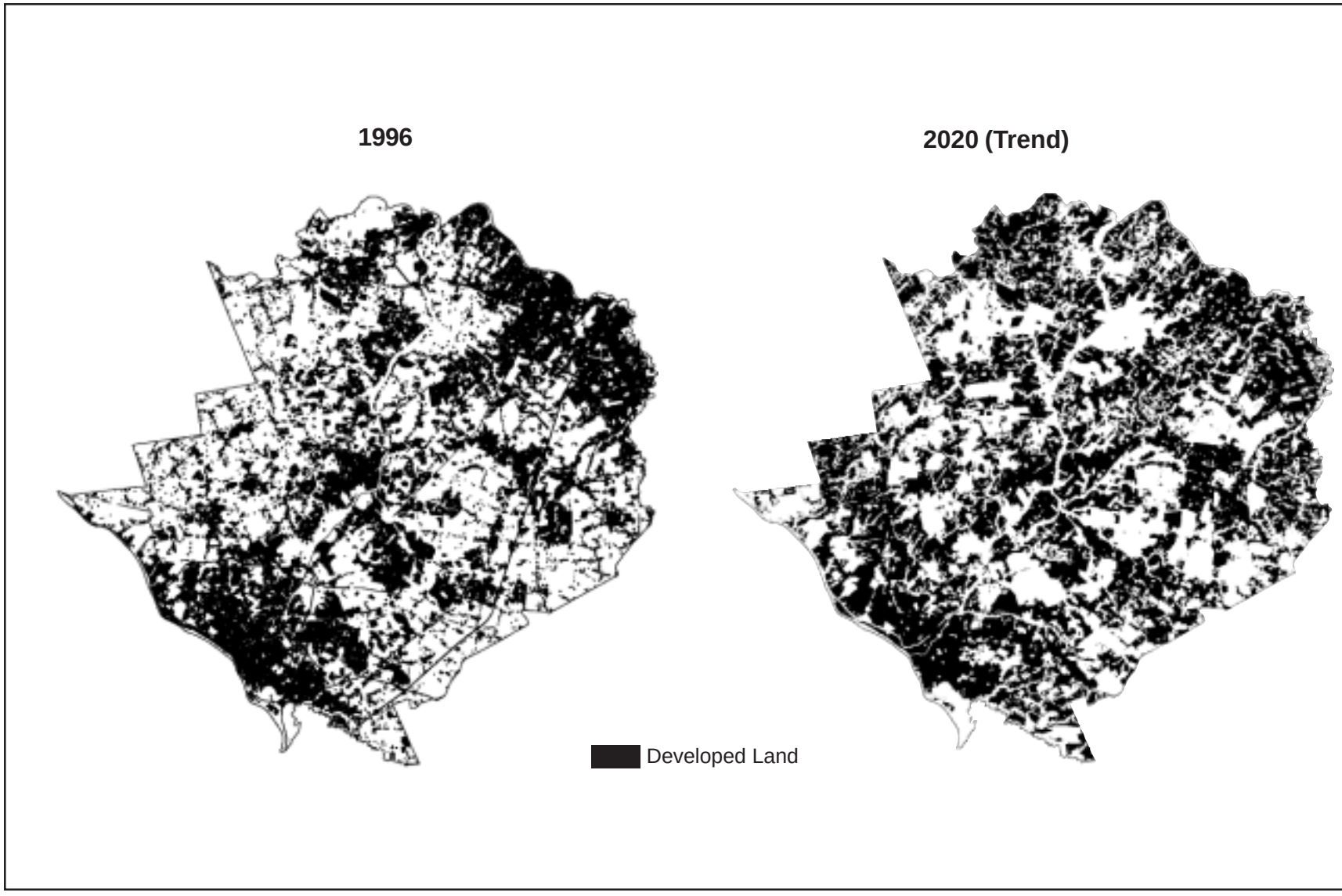
Data Sources:
NJDEP
RPP

Prepared by
The Regional Planning Partnership

Map 13

Watershed Managment Area 11

Build-Out Projection for RPP Region



RPP, therefore, had used the GOZ® model to create a Goal Oriented Zoning alternative to build-out for the region. This alternative created new zones for Mercer County based on State Plan areas and environs with center designations. The alternative was called Vision 2050, shown in Map 14, and looks very different from the map of existing composite zones for Mercer County (Map 12). Vision 2050 was based on RPP's 3-System approach to planning:

- Identify growth areas and targets,
- Identify transit corridors, and
- Protect watershed health.

With new data generated in Phase One of the watershed planning project, RPP re-evaluated its 1997 selection of Vision 2050 centers to identify possible conflicts with Water Resource Areas of excellent and high value (identified by NJRC&D 2002) and with Groundwater Stress Areas (identified by DRBC 2002). Three centers slightly overlapped with Water Resource Areas of high value (see Map 15). Also, part of Hamilton and Washington Townships contain areas of high groundwater stress near the location of two centers.

The GOZ® model was then used to make a comparison between the impacts of build-out under existing zoning and the impacts of build-out under the Goal-Oriented Zoning used in Vision 2050 (see Appendix 5 for a comparison of the two scenarios). Impervious cover was reduced by 45% in the Vision 2050 scenario.

6.0) Recommendations for Further Analysis

Two Mayors' Breakfasts were held in Phase One of the watershed planning project – one in Lambertville City for mayors in the north of the watershed and one in West Windsor Township for mayors in the south of the watershed. At these breakfast meetings the mayors were shown how their streams related regionally across municipalities. Possible regional groupings for further discussions were proposed (see Map 16 for one example).

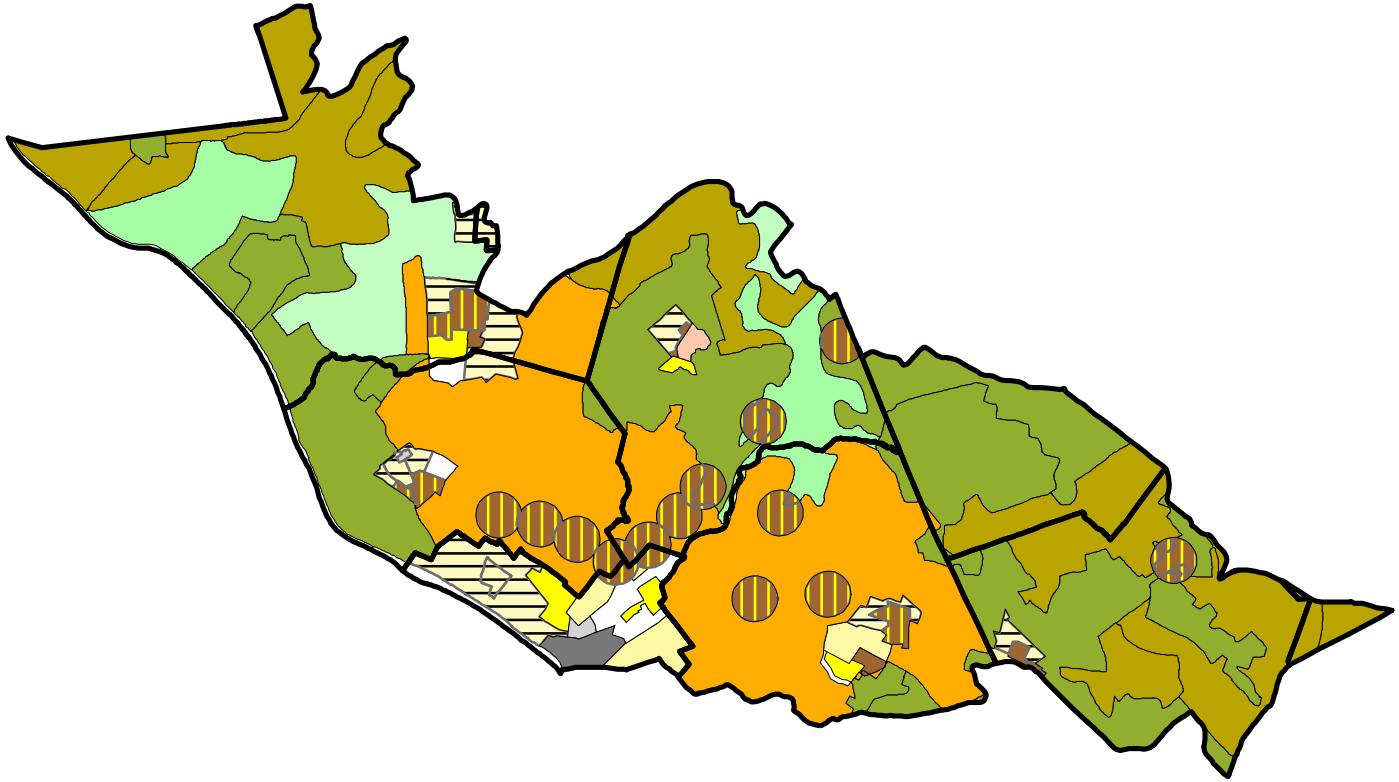
All the mayors recognized that they needed to work with mayors upstream and downstream of their municipalities. Some had already taken first steps in this direction (e.g., Ewing and Lawrence Townships in Mercer County and Kingwood and Delaware Townships in Hunterdon County). However, all the participants agreed that more needed to be done.

The mayors expressed interest in using the GOZ® model in regional sub-groups in a future Phase Two of the watershed planning process to help them develop alternative zoning scenarios to protect their water resources. Where alternative scenarios have been developed, they could be discussed and refined with local officials incorporating new information gathered in Phase One of the watershed planning process. In other areas of the watershed management area, alternative scenarios would need to be created for the first time.

Map 14

Watershed Management Area 11

Mercer County Vision 2050



- Municipalities
- Urban CBD
- Main Street Core
- Transit Core
- Neighborhood Core
- Mixed Use
- Special Use District I
- Center Neighborhood I
- Center Neighborhood II
- Center Neighborhood III
- Center Neighborhood IV
- Environmentally Sensitive Environs
- Fringe Environs
- Metropolitan Environs
- Rural Environs
- Suburban Environs

N
W E
S

0 1 2 3 4 Miles

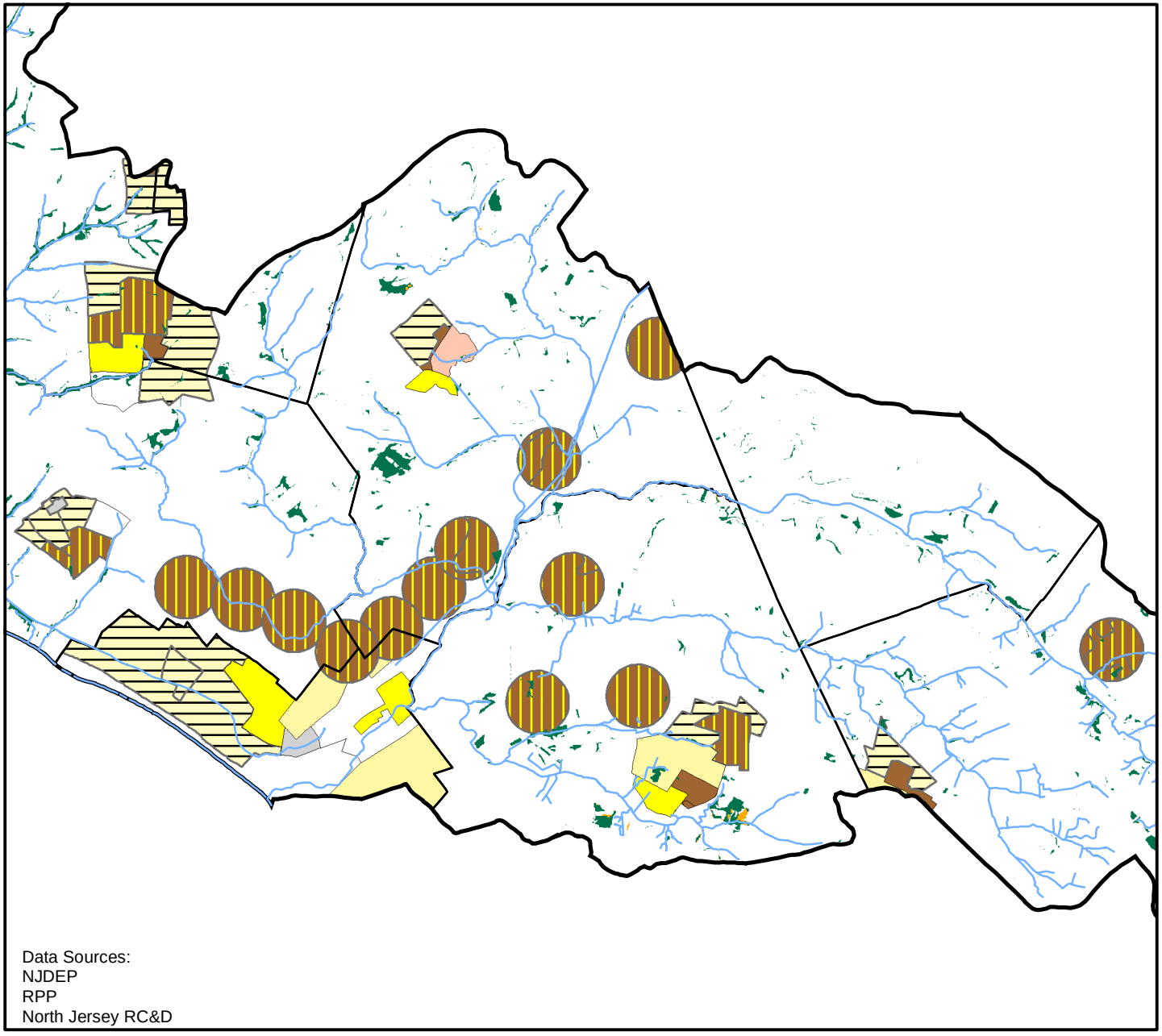
Data Sources:
NJDEP
RPP

Prepared by
The Regional Planning Partnership

Map 15

Watershed Management Area 11

Water Resource Areas and Vision 2050



Municipalities
Urban CBD
Main Street Core
Transit Core
Neighborhood Core
Mixed Use
Special Use District I
Center Neighborhood I
Center Neighborhood II
Center Neighborhood III
Center Neighborhood IV
Streams
WMA 11

Water Resource Evaluation System Scoring

2nd Highest Resource Value
Highest Resource Value

N
W E
S

Miles
0 0.7 1.4 2.1 2.8

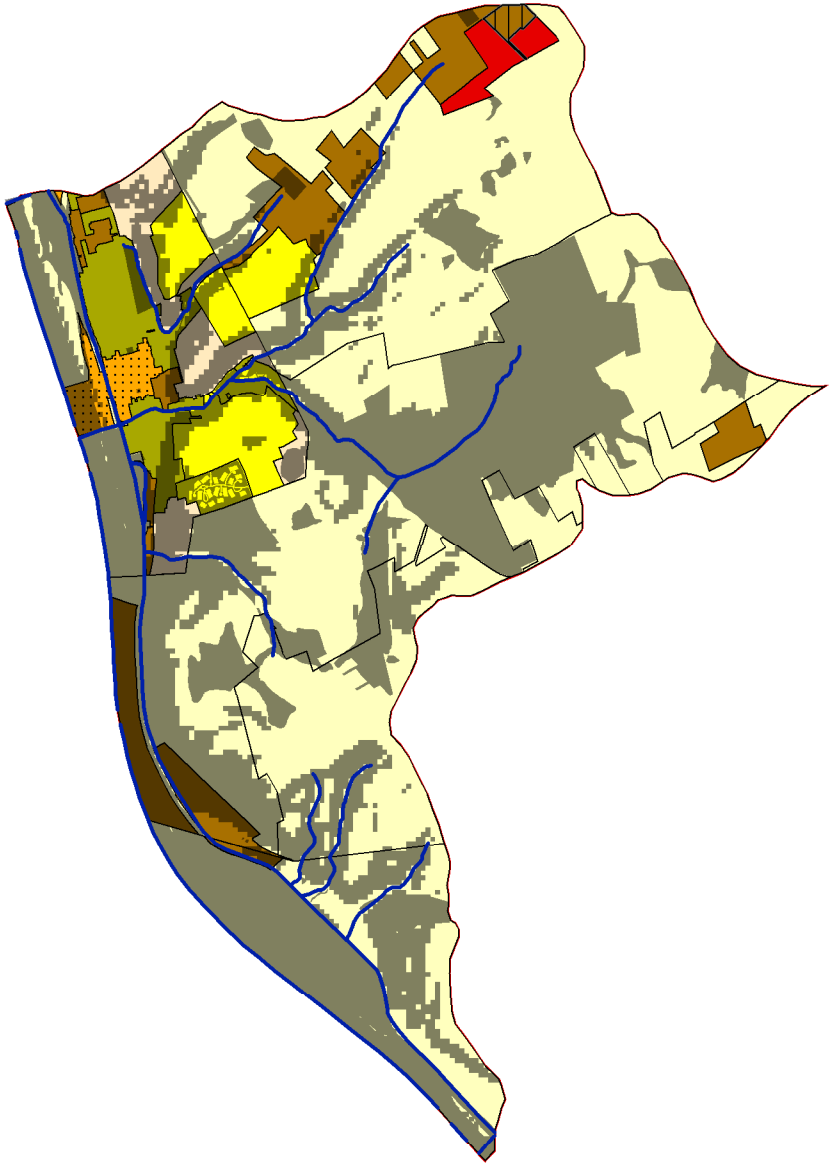
Data Sources:
NJDEP
RPP
North Jersey RC&D

Prepared by
The Regional Planning Partnership

Map 16

Watershed Management Area 11

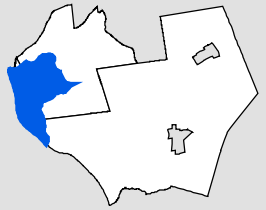
Rural Rolling Hills Subregion



Municipalities
Streams

Composite Zoning

- Business/Commercial
- Industrial/Warehouse
- Mixed Use
- Office
- R - High Density
- R - Low Density
- R - Medium Density
- R - Multi-family
- R - Very Low Density
- Constrained Land



N
W E
S

Miles
0 0.25 0.5 0.75 1

Data Sources:
NJDEP
RPP

Prepared by
The Regional Planning Partnership

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Appendix 1 Water Resource Impacts Associated with Build-Out of Current Zoning in WMA 11 by Municipality

7/18/2003

COMPOSITE ZONING TYPE	WATER DEMAND (GALS/DAY)			PARTICLE CONCENTRATIONS (LBS/YR)					AIR POLL INDEX (LBS/YR)		
	POTABLE WATER	WASTE WATER	SUMMER DEMAND	PHOS	NITRO	BOD	ZINC	LEAD	NMHC	NOX	CO
REGION Study Region											
COUNTY Hunterdon											
MUNY ALEXANDRIA TWP											
Business/Commercial	30,570	30,570	0	432	3,348	8,506	62	28	172,266	142,491	1,116,536
Government/Institution	0	0	0	128	984	2,519	18	9	0	0	0
Industrial/Warehouse	20,750	20,750	0	50	385	987	7	4	56,231	46,512	364,457
R - Rural Density	212,273	212,273	477,499	54	430	1,074	8	3	127,125	105,153	823,960
R - Very Low Density	17,903	17,903	41,840	7	55	141	0	0	10,721	8,868	69,491
ALEXANDRIA TWP	281,496	281,496	519,339	671	5,202	13,227	95	44	366,343	303,024	2,374,444
MUNY DELAWARE TWP											
	0	0	0	0	0	0	0	0	0	0	0
Business/Commercial	3,025	3,025	0	5	35	89	1	0	17,045	14,099	110,479
Industrial/Warehouse	0	0	0	85	647	1,659	12	6	0	0	0
R - Rural Density	188,558	188,558	424,153	47	381	953	7	2	112,923	93,406	731,907
R - Very Low Density	304,808	304,808	685,653	119	913	2,303	16	8	182,542	150,992	1,183,144
DELAWARE TWP	496,391	496,391	1,109,806	256	1,976	5,004	36	16	312,510	258,497	2,025,530
MUNY EAST AMWELL TWP											
R - Rural Density	8,370	8,370	18,828	4	29	72	1	0	5,013	4,146	32,489
R - Very Low Density	0	0	0	0	0	0	0	0	0	0	0
EAST AMWELL TWP	8,370	8,370	18,828	4	29	72	1	0	5,013	4,146	32,489
MUNY FRANKLIN TWP											
Business/Commercial	18,916	18,916	0	113	873	2,217	16	8	106,592	88,169	690,875
R - Rural Density	62,310	62,310	140,164	19	153	382	3	1	37,316	30,866	241,863
R - Very Low Density	84,398	84,398	189,849	33	253	638	4	2	50,544	41,808	327,598
FRANKLIN TWP	165,624	165,624	330,013	165	1,279	3,237	23	11	194,452	160,843	1,260,336
MUNY FRENCHTOWN BORO											
Business/Commercial	0	0	0	3	18	45	0	0	0	0	0
Government/Institution	0	0	0	0	1	4	0	0	0	0	0
Industrial/Warehouse	6,606	6,606	0	6	47	119	0	0	17,901	14,808	116,029
R - Low Density	465	465	314	0	1	4	0	0	278	230	1,805
R - Very Low Density	32,551	32,551	73,220	4	32	81	0	0	19,494	16,124	126,346
FRENCHTOWN BORO	39,622	39,622	73,534	13	99	253	0	0	37,673	31,162	244,180
MUNY HOLLAND TWP											
Business/Commercial	8,875	8,875	0	41	316	802	6	3	50,011	41,366	324,144
Industrial/Warehouse	4,821	4,821	0	6	49	124	1	0	13,064	10,806	84,674
R - Multi-family	12,041	12,041	5,440	8	61	156	1	1	9,182	7,595	59,512
R - Very Low Density	158,800	158,800	357,209	99	764	1,926	13	7	95,100	78,664	616,389
HOLLAND TWP	184,537	184,537	362,649	154	1,190	3,008	21	11	167,357	138,431	1,084,719
MUNY KINGWOOD TWP											
Business/Commercial	95,661	95,661	0	364	2,813	7,141	51	24	539,067	445,895	3,493,955
Office	210,068	210,068	0	353	2,714	6,952	51	24	362,940	300,209	2,352,386
R - Very Low Density	578,228	578,228	1,300,701	297	2,283	5,755	40	20	346,287	286,436	2,244,455
KINGWOOD TWP	883,957	883,957	1,300,701	1,014	7,810	19,848	142	68	1,248,294	1,032,540	8,090,796
MUNY LAMBERTVILLE CITY											

Appendix 1 Water Resource Impacts Associated with Build-Out of Current Zoning in WMA 11 by Municipality

7/18/2003	WATER DEMAND (GALS/DAY)			PARTICLE CONCENTRATIONS (LBS/YR)					AIR POLL INDEX (LBS/YR)		
	POTABLE WATER	WASTE WATER	SUMMER DEMAND	PHOS	NITRO	BOD	ZINC	LEAD	NMHC	NOX	CO
COMPOSITE ZONING TYPE											
Business/Commercial	2,732	2,732	0	3	20	50	0	0	15,397	12,736	99,797
Government/Institution	0	0	0	0	3	6	0	0	0	0	0
R - Medium Density	17,082	17,082	12,717	4	29	74	0	0	10,630	8,793	68,902
R - Multi-family	12,399	12,399	5,504	4	28	70	0	0	9,415	7,788	61,027
R - Very Low Density	5,117	5,117	11,506	1	12	28	0	0	3,063	2,534	19,853
LAMBERTVILLE CITY	37,330	37,330	29,727	12	92	228	0	0	38,505	31,851	249,579
MUNY MILFORD BORO											
Business/Commercial	804	804	0	1	13	32	0	0	4,526	3,744	29,338
Government/Institution	505	505	0	0	3	7	0	0	873	722	5,658
Office	0	0	0	0	2	6	0	0	0	0	0
R - High Density	34,466	34,466	10,560	12	94	236	2	1	21,712	17,959	140,722
R - Medium Density	6,081	6,081	4,396	3	25	63	0	0	3,775	3,123	24,471
R - Very Low Density	4,651	4,651	10,460	1	16	42	0	0	2,785	2,304	18,049
MILFORD BORO	46,507	46,507	25,416	17	153	386	2	1	33,671	27,852	218,238
MUNY RARITAN TWP											
R - Rural Density	49,523	49,523	111,399	12	100	250	2	1	29,658	24,532	192,227
R - Very Low Density	930	930	2,092	0	2	4	0	0	557	461	3,610
RARITAN TWP	50,453	50,453	113,491	12	102	254	2	1	30,215	24,993	195,837
MUNY STOCKTON BORO											
	0	0	0	0	0	0	0	0	0	0	0
Government/Institution	0	0	0	0	0	1	0	0	0	0	0
R - Low Density	13,718	13,718	9,263	5	41	104	1	0	8,215	6,795	53,246
R - Medium Density	1,753	1,753	1,413	1	6	16	0	0	1,083	896	7,020
STOCKTON BORO	15,471	15,471	10,676	6	47	121	1	0	9,298	7,691	60,266
MUNY WEST AMWELL TWP											
Business/Commercial	79,678	79,678	0	159	1,229	3,122	22	10	448,999	371,395	2,910,187
Industrial/Warehouse	51,899	51,899	0	159	1,220	3,126	23	11	140,641	116,333	911,561
Office	39,544	39,544	0	45	349	893	6	3	68,321	56,513	442,821
R - Low Density	30,923	30,923	20,881	12	91	229	2	1	18,518	15,318	120,030
R - Very Low Density	574,742	574,742	1,292,856	167	1,282	3,232	22	11	344,199	284,708	2,230,918
WEST AMWELL TWP	776,786	776,786	1,313,737	542	4,171	10,602	75	36	1,020,678	844,267	6,615,517
Hunterdon	2,986,544	2,986,544	5,207,917	2,866	22,150	56,240	398	188	3,464,009	2,865,297	22,451,931
COUNTY Mercer											
MUNY East Windsor											
R - Very Low Density	4,418	4,418	9,937	2	18	44	0	0	2,646	2,189	17,147
East Windsor	4,418	4,418	9,937	2	18	44	0	0	2,646	2,189	17,147
MUNY Ewing											
Business/Commercial	189,318	189,318	0	81	627	1,589	9	5	1,066,842	882,449	6,914,725
Conservation	0	0	0	0	0	0	0	0	0	0	0
Industrial/Warehouse	881,671	881,671	0	568	4,363	11,178	81	41	2,389,272	1,976,309	15,486,014
Office	251,989	251,989	0	140	1,079	2,771	20	9	435,364	360,117	2,821,809
R - High Density	19,460	19,460	5,888	8	54	138	1	0	12,256	10,138	79,437
R - Medium Density	602,953	602,953	440,071	230	1,802	4,567	32	18	376,087	311,084	2,437,601
R - Multi-family	54,068	54,068	24,576	28	221	567	3	1	41,242	34,114	267,309

Appendix 1 Water Resource Impacts Associated with Build-Out of Current Zoning in WMA 11 by Municipality

7/18/2003	WATER DEMAND (GALS/DAY)			PARTICLE CONCENTRATIONS (LBS/YR)					AIR POLL INDEX (LBS/YR)		
	POTABLE WATER	WASTE WATER	SUMMER DEMAND	PHOS	NITRO	BOD	ZINC	LEAD	NMHC	NOX	CO
COMPOSITE ZONING TYPE											
Ewing	1,999,459	1,999,459	470,535	1,055	8,146	20,810	146	74	4,321,063	3,574,211	28,006,895
MUNY Hamilton											
Business/Commercial	90,023	90,023	0	150	1,163	2,950	19	10	507,299	419,618	3,288,055
Government/Institution	17,124	17,124	0	20	151	387	3	1	29,586	24,473	191,762
Industrial/Warehouse	187,706	187,706	0	344	2,647	6,785	49	25	508,670	420,752	3,296,934
Office	347,020	347,020	0	237	1,835	4,704	35	19	599,555	495,929	3,886,008
R - High Density	28,493	28,493	8,640	11	89	226	1	1	17,966	14,861	116,449
R - Low Density	21,390	21,390	14,444	5	40	101	1	0	12,810	10,596	83,028
R - Medium Density	287,778	287,778	210,537	94	733	1,858	14	6	179,471	148,451	1,163,235
R - Multi-family	140,749	140,749	63,808	77	589	1,511	10	3	107,455	88,883	696,474
R - Rural Density	0	0	0	0	0	0	0	0	0	0	0
R - Very Low Density	2,094	2,094	4,707	1	9	22	0	0	1,253	1,037	8,121
Hamilton	1,122,377	1,122,377	302,136	939	7,256	18,544	132	65	1,964,065	1,624,600	12,730,066
MUNY Hopewell Twp											
Business/Commercial	1,211,281	1,211,281	0	2,416	18,675	47,431	339	163	6,825,767	5,646,004	44,241,090
Industrial/Warehouse	17,082	17,082	0	47	363	930	7	3	46,290	38,290	300,032
Office	886,892	886,892	0	797	6,115	15,669	115	57	1,532,311	1,267,467	9,931,639
R - Low Density	137,411	137,411	92,787	28	225	568	3	1	82,290	68,067	533,363
R - Medium Density	204,340	204,340	148,993	51	401	1,015	7	3	127,461	105,431	826,140
R - Very Low Density	242,964	242,964	546,535	81	611	1,541	10	5	145,505	120,355	943,088
Hopewell Twp	2,699,970	2,699,970	788,315	3,420	26,390	67,154	481	232	8,759,624	7,245,614	56,775,352
MUNY Lawrence											
Business/Commercial	162,742	162,742	0	162	1,254	3,189	21	10	917,088	758,580	5,944,090
Conservation	0	0	0	0	0	0	0	0	0	0	0
Government/Institution	225,477	225,477	0	193	1,489	3,820	28	12	389,557	322,227	2,524,906
Industrial/Warehouse	40,597	40,597	0	135	1,044	2,676	19	10	110,020	91,003	713,085
Mixed Use	51,650	51,650	0	20	156	400	3	1	180,763	149,520	1,171,612
Office	269,350	269,350	0	256	1,964	5,032	36	17	465,365	384,932	3,016,256
R - High Density	38,686	38,686	11,776	17	126	319	2	2	24,374	20,160	157,974
R - Low Density	31,853	31,853	21,509	7	52	132	1	0	19,075	15,779	123,639
R - Medium Density	77,001	77,001	56,991	30	242	610	3	1	47,983	39,691	311,013
R - Multi-family	36,873	36,873	16,768	23	170	438	2	1	28,169	23,301	182,573
R - Multi-family (Age-restricted)	81,163	81,163	41,472	34	267	684	4	2	64,805	53,603	420,030
R - Very Low Density	83,704	83,704	188,280	23	188	477	3	2	50,124	41,462	324,890
Lawrence	1,099,096	1,099,096	336,796	900	6,952	17,777	122	58	2,297,323	1,900,258	14,890,068
MUNY Pennington											
R - Medium Density	11,000	11,000	8,164	4	29	74	1	0	6,855	5,670	44,431
Pennington	11,000	11,000	8,164	4	29	74	1	0	6,855	5,670	44,431
MUNY Trenton											
Business/Commercial	706,996	706,996	0	53	407	1,040	6	3	3,984,042	3,295,445	25,822,506
Industrial/Warehouse	216,602	216,602	0	96	734	1,880	13	6	586,978	485,526	3,804,486
R - High Density	145,624	145,624	44,160	51	396	1,004	7	4	91,829	75,957	595,191
R - Multi-family	108,905	108,905	49,408	54	399	1,021	6	1	83,142	68,771	538,880
Trenton	1,178,127	1,178,127	93,568	254	1,936	4,945	32	14	4,745,991	3,925,699	30,761,063
MUNY Washington											

Appendix 1 Water Resource Impacts Associated with Build-Out of Current Zoning in WMA 11 by Municipality

7/18/2003	WATER DEMAND (GALS/DAY)			PARTICLE CONCENTRATIONS (LBS/YR)					AIR POLL INDEX (LBS/YR)		
	POTABLE WATER	WASTE WATER	SUMMER DEMAND	PHOS	NITRO	BOD	ZINC	LEAD	NMHC	NOX	CO
COMPOSITE ZONING TYPE											
Business/Commercial	452,399	452,399	0	379	2,925	7,426	54	25	2,549,344	2,108,717	16,523,528
Conservation	0	0	0	0	0	0	0	0	0	0	0
Industrial/Warehouse	38,577	38,577	0	44	340	871	6	3	104,540	86,472	677,577
Mixed Use	360,700	360,700	0	97	743	1,901	14	7	1,679,324	1,389,070	10,884,507
Office	117,263	117,263	0	101	774	1,987	14	7	202,600	167,583	1,313,146
R - High Density	17,117	17,117	5,248	7	56	142	1	1	10,786	8,922	69,910
R - Low Density	169,262	169,262	114,296	47	369	933	7	4	101,365	83,846	657,002
R - Medium Density	20,944	20,944	15,543	6	51	130	1	0	13,044	10,790	84,548
R - Multi-family	1,592	1,592	640	1	6	15	0	0	1,198	991	7,766
R - Very Low Density	203,207	203,207	457,102	50	386	977	6	3	121,695	100,662	788,762
Washington	1,381,061	1,381,061	592,829	732	5,650	14,382	103	50	4,783,896	3,957,053	31,006,746
MUNY West Windsor											
Government/Institution	70,055	70,055	0	80	618	1,583	12	6	121,036	100,116	784,493
Office	162,063	162,063	0	127	974	2,496	18	9	280,001	231,606	1,814,827
R - High Density	50,420	50,420	15,296	21	163	414	3	2	31,801	26,305	206,121
R - Low Density	6,227	6,227	7,536	3	25	64	0	0	5,028	4,159	32,588
R - Very Low Density	93,234	93,234	209,723	23	177	444	3	1	55,835	46,185	361,893
West Windsor	381,999	381,999	232,555	254	1,957	5,001	36	18	493,701	408,371	3,199,922
Mercer	9,877,507	9,877,507	2,834,835	7,560	58,334	148,731	1,053	511	27,375,164	22,643,665	177,431,690
COUNTY Monmouth											
MUNY MILLSTONE TWP											
R - Very Low Density	44,875	44,875	100,939	16	128	323	1	0	26,873	22,229	174,177
MILLSTONE TWP	44,875	44,875	100,939	16	128	323	1	0	26,873	22,229	174,177
MUNY ROOSEVELT BORO											
Business/Commercial	0	0	0	0	3	7	0	0	0	0	0
Industrial/Warehouse	0	0	0	13	101	260	2	1	0	0	0
R - Low Density	15,345	15,345	10,362	6	46	116	1	0	9,190	7,601	59,563
R - Rural Density	698	698	1,569	0	2	5	0	0	418	346	2,707
R - Very Low Density	10,929	10,929	24,581	3	23	57	0	0	6,544	5,414	42,416
ROOSEVELT BORO	26,972	26,972	36,512	22	175	445	3	1	16,152	13,361	104,686
MUNY UPPER FREEHOLD TWP											
Business/Commercial	412	412	0	0	5	12	0	0	2,317	1,917	15,019
Government/Institution	4,872	4,872	0	4	32	83	1	0	8,417	6,962	54,555
R - Very Low Density	89,513	89,513	201,355	23	179	449	3	2	53,606	44,341	347,453
UPPER FREEHOLD TWP	94,797	94,797	201,355	27	216	544	4	2	64,340	53,220	417,027
Monmouth	166,644	166,644	338,806	65	519	1,312	8	3	107,365	88,810	695,890
Study Region	13,030,695	13,030,695	8,381,558	10,491	81,003	206,283	1,459	702	30,946,538	25,597,772	200,579,511

Existing Zoning Impacts Appendix 2 - Other Impacts Associated With Build-Out in WMA 11 by Municipality

7/18/2003

DISTRICT ZONE	TOTAL ACRES	LAND AVAIL	NUMBER OF UNITS FROM IMPACTS					SQUARE FEET FROM IMPACTS		
			UNITS	4 BD	3 BD	2 BD	1 BD	IND/WARE	COMM	OFFICE
REGION Study Region										
COUNTY Hunterdon										
MUNY ALEXANDRIA TWP										
Business/Commercial	641	332	0	0	0	0	0	0	305,697	0
Government/Institution	507	171	0	0	0	0	0	0	0	0
Industrial/Warehouse	331	67	0	0	0	0	0	553,327	0	0
R - Rural Density	13,595	5,371	913	730	183	0	0	0	0	0
R - Very Low Density	417	243	80	64	16	0	0	0	0	0
ALEXANDRIA TWP	**15,492**	**6,184**	**993**	**794**	**199**	**0**	**0**	**553,327**	**305,697**	**0**
MUNY DELAWARE TWP										
	104	13	0	0	0	0	0	0	0	0
Business/Commercial	15	3	0	0	0	0	0	0	30,248	0
Industrial/Warehouse	320	112	0	0	0	0	0	0	0	0
R - Rural Density	8,946	4,767	811	649	162	0	0	0	0	0
R - Very Low Density	9,296	3,971	1,311	1,049	262	0	0	0	0	0
DELAWARE TWP	**18,681**	**8,867**	**2,122**	**1,698**	**424**	**0**	**0**	**0**	**30,248**	**0**
MUNY EAST AMWELL TWP										
R - Rural Density	783	362	36	29	7	0	0	0	0	0
R - Very Low Density	0	0	0	0	0	0	0	0	0	0
EAST AMWELL TWP	**783**	**362**	**36**	**29**	**7**	**0**	**0**	**0**	**0**	**0**
MUNY FRANKLIN TWP										
Business/Commercial	182	87	0	0	0	0	0	0	189,155	0
R - Rural Density	3,618	1,911	268	214	54	0	0	0	0	0
R - Very Low Density	1,830	1,101	363	290	73	0	0	0	0	0
FRANKLIN TWP	**5,630**	**3,098**	**631**	**504**	**127**	**0**	**0**	**0**	**189,155**	**0**
MUNY FRENCHTOWN BORO										
Business/Commercial	28	2	0	0	0	0	0	0	0	0
Government/Institution	60	0	0	0	0	0	0	0	0	0
Industrial/Warehouse	35	8	0	0	0	0	0	176,156	0	0
R - Low Density	67	2	2	1	1	0	0	0	0	0
R - Very Low Density	592	140	140	112	28	0	0	0	0	0
FRENCHTOWN BORO	**782**	**152**	**142**	**113**	**29**	**0**	**0**	**176,156**	**0**	**0**
MUNY HOLLAND TWP										
Business/Commercial	122	31	0	0	0	0	0	0	88,748	0
Industrial/Warehouse	22	8	0	0	0	0	0	128,554	0	0
R - Multi-family	34	11	85	0	13	41	31	0	0	0
R - Very Low Density	11,860	3,322	683	546	137	0	0	0	0	0
HOLLAND TWP	**12,038**	**3,373**	**768**	**546**	**150**	**41**	**31**	**128,554**	**88,748**	**0**
MUNY KINGWOOD TWP										

Existing Zoning Impacts Appendix 2 - Other Impacts Associated With Build-Out in WMA 11 by Municipality

7/18/2003	TOTAL ACRES	LAND AVAIL	NUMBER OF UNITS FROM IMPACTS					SQUARE FEET FROM IMPACTS		
DISTRICT ZONE			UNITS	4 BD	3 BD	2 BD	1 BD	IND/WARE	COMM	OFFICE
Business/Commercial	536	279	0	0	0	0	0	0	956,613	0
Office	954	471	0	0	0	0	0	0	0	2,100,672
R - Very Low Density	21,414	9,924	2,487	1,989	498	0	0	0	0	0
KINGWOOD TWP	**22,904**	**10,674**	**2,487**	**1,989**	**498**	**0**	**0**	**0**	**956,613**	**2,100,672**
MUNY LAMBERTVILLE CITY										
Business/Commercial	74	2	0	0	0	0	0	0	27,324	0
Government/Institution	93	0	0	0	0	0	0	0	0	0
R - Medium Density	153	14	79	20	47	12	0	0	0	0
R - Multi-family	172	5	87	0	14	41	32	0	0	0
R - Very Low Density	283	49	22	17	5	0	0	0	0	0
LAMBERTVILLE CITY	**775**	**70**	**188**	**37**	**66**	**53**	**32**	**0**	**27,324**	**0**
MUNY MILFORD BORO										
Business/Commercial	31	1	0	0	0	0	0	0	8,032	0
Government/Institution	68	0	0	0	0	0	0	0	0	5,053
Office	10	0	0	0	0	0	0	0	0	0
R - High Density	159	23	163	32	99	32	0	0	0	0
R - Medium Density	291	12	28	7	17	4	0	0	0	0
R - Very Low Density	250	71	20	16	4	0	0	0	0	0
MILFORD BORO	**808**	**108**	**211**	**55**	**120**	**36**	**0**	**0**	**8,032**	**5,053**
MUNY RARITAN TWP										
R - Rural Density	3,119	1,249	213	170	43	0	0	0	0	0
R - Very Low Density	17	7	4	3	1	0	0	0	0	0
RARITAN TWP	**3,136**	**1,256**	**217**	**173**	**44**	**0**	**0**	**0**	**0**	**0**
MUNY STOCKTON BORO										
	34	0	0	0	0	0	0	0	0	0
Government/Institution	91	0	0	0	0	0	0	0	0	0
R - Low Density	198	54	59	24	35	0	0	0	0	0
R - Medium Density	60	3	8	2	5	1	0	0	0	0
STOCKTON BORO	**383**	**58**	**67**	**26**	**40**	**1**	**0**	**0**	**0**	**0**
MUNY WEST AMWELL TWP										
Business/Commercial	288	122	0	0	0	0	0	0	796,781	0
Industrial/Warehouse	358	212	0	0	0	0	0	1,383,954	0	0
Office	96	61	0	0	0	0	0	0	0	395,437
R - Low Density	305	119	133	54	79	0	0	0	0	0
R - Very Low Density	11,060	5,571	2,472	1,978	494	0	0	0	0	0
WEST AMWELL TWP	**12,107**	**6,084**	**2,605**	**2,032**	**573**	**0**	**0**	**1,383,954**	**796,781**	**395,437**
Hunterdon	93,518	40,285	10,467	7,996	2,277	131	63	2,241,991	2,402,598	2,501,162

Existing Zoning Impacts Appendix 2 - Other Impacts Associated With Build-Out in WMA 11 by Municipality

7/18/2003	TOTAL ACRES	LAND AVAIL	NUMBER OF UNITS FROM IMPACTS					SQUARE FEET FROM IMPACTS		
DISTRICT ZONE			UNITS	4 BD	3 BD	2 BD	1 BD	IND/WARE	COMM	OFFICE
COUNTY Mercer										
MUNY East Windsor										
R - Very Low Density	541	75	19	15	4	0	0	0	0	0
East Windsor	**541**	**75**	**19**	**15**	**4**	**0**	**0**	**0**	**0**	**0**
MUNY Ewing										
Business/Commercial	440	62	0	0	0	0	0	0	1,893,188	0
Conservation	367	104	0	0	0	0	0	0	0	0
Industrial/Warehouse	1,869	757	0	0	0	0	0	23,511,214	0	0
Office	616	188	0	0	0	0	0	0	0	2,519,866
R - High Density	100	13	92	18	56	18	0	0	0	0
R - Medium Density	6,548	858	2,800	728	1,624	448	0	0	0	0
R - Multi-family	196	38	382	0	58	184	140	0	0	0
Ewing	**10,136**	**2,021**	**3,274**	**746**	**1,738**	**650**	**140**	**23,511,214**	**1,893,188**	**2,519,866**
MUNY Hamilton										
Business/Commercial	795	115	0	0	0	0	0	0	900,238	0
Government/Institution	290	26	0	0	0	0	0	0	0	171,243
Industrial/Warehouse	2,046	460	0	0	0	0	0	5,005,480	0	0
Office	1,149	319	0	0	0	0	0	0	0	3,470,193
R - High Density	730	22	135	27	81	27	0	0	0	0
R - Low Density	122	53	92	37	55	0	0	0	0	0
R - Medium Density	4,909	349	1,336	347	776	213	0	0	0	0
R - Multi-family	745	102	997	0	148	478	371	0	0	0
R - Rural Density	6	2	0	0	0	0	0	0	0	0
R - Very Low Density	667	39	9	7	2	0	0	0	0	0
Hamilton	**11,458**	**1,487**	**2,569**	**418**	**1,062**	**718**	**371**	**5,005,480**	**900,238**	**3,641,436**
MUNY Hopewell Twp										
Business/Commercial	4,602	1,853	0	0	0	0	0	0	12,112,798	0
Industrial/Warehouse	259	63	0	0	0	0	0	455,515	0	0
Office	1,685	1,062	0	0	0	0	0	0	0	8,868,921
R - Low Density	1,113	296	591	236	355	0	0	0	0	0
R - Medium Density	962	191	949	247	550	152	0	0	0	0
R - Very Low Density	7,846	2,655	1,045	837	208	0	0	0	0	0
Hopewell Twp	**16,467**	**6,119**	**2,585**	**1,320**	**1,113**	**152**	**0**	**455,515**	**12,112,798**	**8,868,921**
MUNY Lawrence										
Business/Commercial	829	125	0	0	0	0	0	0	1,627,437	0
Conservation	1,594	53	0	0	0	0	0	0	0	0
Government/Institution	1,166	259	0	0	0	0	0	0	0	2,254,735
Industrial/Warehouse	987	181	0	0	0	0	0	1,082,623	0	0
Mixed Use	229	27	114	18	55	18	23	0	295,424	0
Office	806	341	0	0	0	0	0	0	0	2,693,506
R - High Density	153	31	183	36	111	36	0	0	0	0
R - Low Density	305	69	137	55	82	0	0	0	0	0

Existing Zoning Impacts Appendix 2 - Other Impacts Associated With Build-Out in WMA 11 by Municipality

7/18/2003	TOTAL ACRES	LAND AVAIL	NUMBER OF UNITS FROM IMPACTS					SQUARE FEET FROM IMPACTS		
DISTRICT ZONE			UNITS	4 BD	3 BD	2 BD	1 BD	IND/WARE	COMM	OFFICE
R - Medium Density	2,230	115	357	92	209	56	0	0	0	0
R - Multi-family	490	30	261	0	39	127	95	0	0	0
R - Multi-family (Age-res	94	46	648	0	0	260	388	0	0	0
R - Very Low Density	2,642	821	360	290	70	0	0	0	0	0
Lawrence	**11,524**	**2,096**	**2,060**	**491**	**566**	**497**	**506**	**1,082,623**	**1,922,861**	**4,948,241**
MUNY Pennington										
R - Medium Density	114	14	51	13	30	8	0	0	0	0
Pennington	**114**	**14**	**51**	**13**	**30**	**8**	**0**	**0**	**0**	**0**
MUNY Trenton										
Business/Commercial	524	41	0	0	0	0	0	0	7,069,965	0
Industrial/Warehouse	722	127	0	0	0	0	0	5,776,056	0	0
R - High Density	605	97	690	138	414	138	0	0	0	0
R - Multi-family	1,873	69	771	0	115	371	285	0	0	0
Trenton	**3,724**	**334**	**1,461**	**138**	**529**	**509**	**285**	**5,776,056**	**7,069,965**	**0**
MUNY Washington										
Business/Commercial	617	290	0	0	0	0	0	0	4,523,989	0
Conservation	872	69	0	0	0	0	0	0	0	0
Industrial/Warehouse	151	59	0	0	0	0	0	1,028,713	0	0
Mixed Use	224	129	365	58	176	58	73	0	2,898,873	0
Office	447	135	0	0	0	0	0	0	0	1,172,636
R - High Density	54	14	81	16	49	16	0	0	0	0
R - Low Density	2,162	486	728	291	437	0	0	0	0	0
R - Medium Density	89	24	97	25	57	15	0	0	0	0
R - Multi-family	20	1	11	0	2	5	4	0	0	0
R - Very Low Density	5,401	1,686	874	699	175	0	0	0	0	0
Washington	**10,037**	**2,892**	**2,156**	**1,089**	**896**	**94**	**77**	**1,028,713**	**7,422,862**	**1,172,636**
MUNY West Windsor										
Government/Institution	264	107	0	0	0	0	0	0	0	700,549
Office	304	169	0	0	0	0	0	0	0	1,620,635
R - High Density	167	40	239	48	143	48	0	0	0	0
R - Low Density (Age-re	118	33	48	0	2	29	17	0	0	0
R - Very Low Density	5,455	765	401	320	81	0	0	0	0	0
West Windsor	**6,309**	**1,114**	**688**	**368**	**226**	**77**	**17**	**0**	**0**	**2,321,184**
Mercer	70,310	16,152	14,863	4,598	6,164	2,705	1,396	36,859,601	31,321,912	23,472,284
COUNTY Monmouth										
MUNY MILLSTONE TWP										
R - Very Low Density	3,088	557	193	155	38	0	0	0	0	0

Existing Zoning Impacts Appendix 2 - Other Impacts Associated With Build-Out in WMA 11 by Municipality

7/18/2003	TOTAL ACRES	LAND AVAIL	NUMBER OF UNITS FROM IMPACTS					SQUARE FEET FROM IMPACTS		
DISTRICT ZONE			UNITS	4 BD	3 BD	2 BD	1 BD	IND/WARE	COMM	OFFICE
MILLSTONE TWP	**3,088**	**557**	**193**	**155**	**38**	**0**	**0**	**0**	**0**	**0**
MUNY ROOSEVELT BORO										
Business/Commercial	5	0	0	0	0	0	0	0	0	0
Industrial/Warehouse	39	18	0	0	0	0	0	0	0	0
R - Low Density	180	60	66	26	40	0	0	0	0	0
R - Rural Density	438	26	3	2	1	0	0	0	0	0
R - Very Low Density	389	99	47	37	10	0	0	0	0	0
ROOSEVELT BORO	**1,051**	**203**	**116**	**65**	**51**	**0**	**0**	**0**	**0**	**0**
MUNY UPPER FREEHOLD TW										
Business/Commercial	1	0	0	0	0	0	0	0	4,112	0
Government/Institution	2,948	6	0	0	0	0	0	0	0	48,718
R - Very Low Density	3,088	775	385	308	77	0	0	0	0	0
UPPER FREEHOLD TWP	**6,037**	**781**	**385**	**308**	**77**	**0**	**0**	**0**	**4,112**	**48,718**
Monmouth	10,176	1,541	694	528	166	0	0	0	4,112	48,718
Study Region	174,004	57,977	26,024	13,122	8,607	2,836	1,459	39,101,592	33,728,622	26,022,164

Existing Zoning Impacts Appendix 2 - Other Impacts Associated With Build-Out in WMA 11 by Municipality

7/18/2003

DISTRICT/ZONE	PEOPLE	SCHOOL AGE CHILDREN	JOBS	VEH TRIPS	VMT	COSTS FROM IMPACTS ROADS	UTILITY	SCHOOLS
REGION Study Region								
COUNTY Hunterdon								
MUNY ALEXANDRIA TWP								
Business/Commercial	0	0	764	11,815	106,337	$0	$0	$0
Government/Institution	0	0	0	0	0	$0	$0	$0
Industrial/Warehouse	0	0	830	3,857	34,710	$0	$0	$0
R - Rural Density	2,830	749	0	8,719	78,472	$9,560,936	$17,020,146	$16,620,252
R - Very Low Density	239	64	0	736	6,618	$837,760	$1,491,360	$1,456,320
ALEXANDRIA TWP	3,069	813	1,594	25,127	226,137	$10,398,696	$18,511,506	$18,076,572
MUNY DELAWARE TWP								
	0	0	0	0	0	$0	$0	$0
Business/Commercial	0	0	76	1,169	10,522	$0	$0	$0
Industrial/Warehouse	0	0	0	0	0	$0	$0	$0
R - Rural Density	2,514	665	0	7,745	69,706	$8,492,792	$15,118,662	$14,763,444
R - Very Low Density	4,064	1,075	0	12,521	112,681	$13,728,792	$24,439,662	$23,865,444
DELAWARE TWP	6,578	1,740	76	21,435	192,909	$22,221,584	$39,558,324	$38,628,888
MUNY EAST AMWELL TWP								
R - Rural Density	112	30	0	344	3,094	$376,992	$671,112	$655,344
R - Very Low Density	0	0	0	0	0	$0	$0	$0
EAST AMWELL TWP	112	30	0	344	3,094	$376,992	$671,112	$655,344
MUNY FRANKLIN TWP								
Business/Commercial	0	0	473	7,311	65,797	$0	$0	$0
R - Rural Density	831	220	0	2,559	23,035	$2,806,496	$4,996,056	$4,878,672
R - Very Low Density	1,125	298	0	3,467	31,200	$3,801,336	$6,767,046	$6,608,052
FRANKLIN TWP	1,956	518	473	13,337	120,032	$6,607,832	$11,763,102	$11,486,724
MUNY FRENCHTOWN BORO								
Business/Commercial	0	0	0	0	0	$0	$0	$0
Government/Institution	0	0	0	0	0	$0	$0	$0
Industrial/Warehouse	0	0	264	1,228	11,051	$0	$0	$0
R - Low Density	6	2	0	19	172	$20,944	$37,284	$36,408
R - Very Low Density	434	115	0	1,337	12,033	$1,466,080	$2,609,880	$2,548,560
FRENCHTOWN BORO	440	117	264	2,584	23,256	$1,487,024	$2,647,164	$2,584,968
MUNY HOLLAND TWP								
Business/Commercial	0	0	222	3,430	30,871	$0	$0	$0
Industrial/Warehouse	0	0	193	896	8,064	$0	$0	$0
R - Multi-family	161	21	0	630	5,668	$423,130	$456,365	$1,311,465
R - Very Low Density	2,116	559	0	6,524	58,704	$7,152,376	$12,732,486	$12,433,332
HOLLAND TWP	2,277	580	415	11,480	103,307	$7,575,506	$13,188,851	$13,744,797
MUNY KINGWOOD TWP								
Business/Commercial	0	0	2,391	36,973	332,758	$0	$0	$0
Office	0	0	7,352	24,893	224,036	$0	$0	$0
R - Very Low Density	7,709	2,039	0	23,751	213,758	$26,043,864	$46,362,654	$45,273,348
KINGWOOD TWP	7,709	2,039	9,743	85,617	770,552	$26,043,864	$46,362,654	$45,273,348
MUNY LAMBERTVILLE CITY								
Business/Commercial	0	0	68	1,056	9,505	$0	$0	$0
Government/Institution	0	0	0	0	0	$0	$0	$0
R - Medium Density	227	57	0	729	6,562	$732,807	$1,004,967	$1,474,524

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DISTRICT/ZONE	PEOPLE	SCHOOL AGE CHILDREN	JOBS	VEH TRIPS	VMT	COSTS FROM IMPACTS ROADS	UTILITY	SCHOOLS
R - Multi-family	166	22	0	646	5,812	$428,108	$461,734	$1,326,894
R - Very Low Density	67	18	0	211	1,891	$230,384	$410,124	$400,488
LAMBERTVILLE CITY	460	97	68	2,642	23,770	$1,391,299	$1,876,825	$3,201,906
MUNY MILFORD BORO								
Business/Commercial	0	0	20	310	2,794	$0	$0	$0
Government/Institution	0	0	18	60	539	$0	$0	$0
Office	0	0	0	0	0	$0	$0	$0
R - High Density	459	112	0	1,489	13,403	$1,184,205	$1,329,075	$2,545,785
R - Medium Density	81	20	0	259	2,331	$253,316	$347,396	$509,712
R - Very Low Density	62	16	0	191	1,719	$209,440	$372,840	$364,080
MILFORD BORO	602	148	38	2,309	20,786	$1,646,961	$2,049,311	$3,419,577
MUNY RARITAN TWP								
R - Rural Density	660	174	0	2,035	18,308	$2,230,536	$3,970,746	$3,877,452
R - Very Low Density	12	3	0	38	344	$41,888	$74,568	$72,816
RARITAN TWP	672	177	0	2,073	18,652	$2,272,424	$4,045,314	$3,950,268
MUNY STOCKTON BORO								
	0	0	0	0	0	$0	$0	$0
Government/Institution	0	0	0	0	0	$0	$0	$0
R - Low Density	183	48	0	563	5,071	$617,848	$1,099,878	$1,074,036
R - Medium Density	23	6	0	75	669	$81,423	$111,663	$163,836
STOCKTON BORO	206	54	0	638	5,740	$699,271	$1,211,541	$1,237,872
MUNY WEST AMWELL TWP								
Business/Commercial	0	0	1,993	30,796	277,160	$0	$0	$0
Industrial/Warehouse	0	0	2,075	9,646	86,816	$0	$0	$0
Office	0	0	1,384	4,686	42,173	$0	$0	$0
R - Low Density	412	109	0	1,270	11,431	$1,392,776	$2,479,386	$2,421,132
R - Very Low Density	7,664	2,026	0	23,608	212,469	$25,886,784	$46,083,024	$45,000,288
WEST AMWELL TWP	8,076	2,135	5,452	70,006	630,049	$27,279,560	$48,562,410	$47,421,420
Hunterdon	32,157	8,448	18,123	237,592	2,138,284	$108,001,013	$190,448,114	$189,681,684
COUNTY Mercer								
MUNY East Windsor								
R - Very Low Density	59	15	0	181	1,633	$198,968	$354,198	$345,876
East Windsor	59	15	0	181	1,633	$198,968	$354,198	$345,876
MUNY Ewing								
Business/Commercial	0	0	4,733	73,172	658,544	$0	$0	$0
Conservation	0	0	0	0	0	$0	$0	$0
Industrial/Warehouse	0	0	35,266	163,873	1,474,857	$0	$0	$0
Office	0	0	8,818	29,861	268,745	$0	$0	$0
R - High Density	259	64	0	841	7,565	$660,284	$741,060	$1,419,468
R - Medium Density	8,039	1,997	0	25,794	232,153	$25,358,741	$34,776,821	$51,025,812
R - Multi-family	720	94	0	2,828	25,456	$1,911,552	$2,061,696	$5,924,736
Ewing	9,018	2,155	48,817	296,369	2,667,320	$27,930,577	$37,579,577	$58,370,016
MUNY Hamilton								
Business/Commercial	0	0	2,251	34,792	313,149	$0	$0	$0
Government/Institution	0	0	599	2,029	18,263	$0	$0	$0
Industrial/Warehouse	0	0	7,508	34,888	313,994	$0	$0	$0
Office	0	0	12,146	41,121	370,096	$0	$0	$0

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DISTRICT/ZONE	PEOPLE	SCHOOL AGE CHILDREN	JOBS	VEH TRIPS	VMT	COSTS FROM IMPACTS ROADS	UTILITY	SCHOOLS
R - High Density	379	92	0	1,233	11,091	$968,895	$1,087,425	$2,082,915
R - Low Density	285	75	0	879	7,907	$963,424	$1,715,064	$1,674,768
R - Medium Density	3,837	951	0	12,309	110,785	$12,132,027	$16,637,787	$24,411,564
R - Multi-family	1,876	248	0	7,371	66,332	$4,963,066	$5,352,893	$15,382,713
R - Rural Density	0	0	0	0	0	$0	$0	$0
R - Very Low Density	27	7	0	87	774	$94,248	$167,778	$163,836
Hamilton	6,404	1,373	22,504	134,709	1,212,391	$19,121,660	$24,960,947	$43,715,796
MUNY Hopewell Twp								
Business/Commercial	0	0	30,282	468,159	4,213,438	$0	$0	$0
Industrial/Warehouse	0	0	683	3,175	28,575	$0	$0	$0
Office	0	0	31,041	105,096	945,870	$0	$0	$0
R - Low Density	1,831	486	0	5,646	50,797	$6,188,952	$11,017,422	$10,758,564
R - Medium Density	2,725	676	0	8,743	78,680	$8,585,603	$11,774,243	$17,275,596
R - Very Low Density	3,239	857	0	9,981	89,818	$10,943,240	$19,480,890	$19,023,180
Hopewell Twp	7,795	2,019	62,006	600,800	5,407,178	$25,717,795	$42,272,555	$47,057,340
MUNY Lawrence								
Business/Commercial	0	0	4,068	62,902	566,104	$0	$0	$0
Conservation	0	0	0	0	0	$0	$0	$0
Government/Institution	0	0	7,890	26,718	240,470	$0	$0	$0
Industrial/Warehouse	0	0	1,624	7,545	67,911	$0	$0	$0
Mixed Use	295	66	739	12,398	111,582	$1,031,358	$1,414,398	$2,075,256
Office	0	0	9,428	31,917	287,262	$0	$0	$0
R - High Density	516	125	0	1,671	15,045	$1,320,568	$1,482,120	$2,838,936
R - Low Density	425	113	0	1,309	11,775	$1,434,664	$2,553,954	$2,493,948
R - Medium Density	1,026	257	0	3,294	29,621	$3,284,061	$4,503,741	$6,608,052
R - Multi-family	491	64	0	1,935	17,388	$1,304,236	$1,406,678	$4,042,398
R - Multi-family (Age-restricted)	1,083	97	0	4,444	40,003	$3,225,744	$3,479,112	$0
R - Very Low Density	1,116	296	0	3,439	30,942	$3,769,920	$6,711,120	$6,553,440
Lawrence	4,952	1,018	23,749	157,572	1,418,103	$15,370,551	$21,551,123	$24,612,030
MUNY Pennington								
R - Medium Density	147	36	0	470	4,232	$470,444	$645,164	$946,608
Pennington	147	36	0	470	4,232	$470,444	$645,164	$946,608
MUNY Trenton								
Business/Commercial	0	0	17,675	273,254	2,459,287	$0	$0	$0
Industrial/Warehouse	0	0	8,664	40,259	362,331	$0	$0	$0
R - High Density	1,942	473	0	6,299	56,685	$4,952,130	$5,557,950	$10,646,010
R - Multi-family	1,452	192	0	5,704	51,320	$3,843,016	$4,144,868	$11,911,188
Trenton	3,394	665	26,339	325,516	2,929,623	$8,795,146	$9,702,818	$22,557,198
MUNY Washington								
Business/Commercial	0	0	11,310	174,852	1,573,669	$0	$0	$0
Conservation	0	0	0	0	0	$0	$0	$0
Industrial/Warehouse	0	0	1,543	7,170	64,531	$0	$0	$0
Mixed Use	945	212	7,247	115,179	1,036,620	$3,311,202	$4,540,962	$6,662,664
Office	0	0	4,104	13,897	125,062	$0	$0	$0
R - High Density	228	56	0	740	6,658	$588,514	$660,510	$1,265,178
R - Low Density	2,257	596	0	6,953	62,571	$7,623,616	$13,571,376	$13,252,512
R - Medium Density	279	69	0	895	8,052	$895,653	$1,228,293	$1,802,196

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DISTRICT/ZONE	PEOPLE	SCHOOL AGE CHILDREN	JOBS	VEH TRIPS	VMT	COSTS FROM IMPACTS ROADS	UTILITY	SCHOOLS
R - Multi-family	21	3	0	82	740	$49,780	$53,690	$154,290
R - Very Low Density	2,709	716	0	8,347	75,121	$9,152,528	$16,293,108	$15,910,296
Washington	6,439	1,652	24,204	328,115	2,953,024	$21,621,293	$36,347,939	$39,047,136
MUNY West Windsor								
Government/Institution	0	0	2,452	8,302	74,714	$0	$0	$0
Office	0	0	5,671	19,204	172,840	$0	$0	$0
R - High Density	672	164	0	2,181	19,631	$1,715,303	$1,925,145	$3,687,531
R - Low Density (Age-restricted)	83	9	0	345	3,104	$502,656	$894,816	$0
R - Very Low Density	1,243	328	0	3,829	34,466	$4,199,272	$7,475,442	$7,299,804
West Windsor	1,998	501	8,123	33,861	304,755	$6,417,231	$10,295,403	$10,987,335
Mercer	40,206	9,434	215,742	1,877,593	16,898,259	$125,643,665	$83,709,724	$247,639,335
COUNTY Monmouth								
MUNY MILLSTONE TWP								
R - Very Low Density	598	158	0	1,844	16,589	$2,021,096	$3,597,906	$3,513,372
MILLSTONE TWP	598	158	0	1,844	16,589	$2,021,096	$3,597,906	$3,513,372
MUNY ROOSEVELT BORO								
Business/Commercial	0	0	0	0	0	$0	$0	$0
Industrial/Warehouse	0	0	0	0	0	$0	$0	$0
R - Low Density	205	54	0	630	5,673	$691,152	$1,230,372	$1,201,464
R - Rural Density	9	2	0	29	258	$31,416	$55,926	$54,612
R - Very Low Density	146	38	0	449	4,040	$492,184	$876,174	$855,588
ROOSEVELT BORO	360	94	0	1,108	9,971	$1,214,752	$2,162,472	$2,111,664
MUNY UPPER FREEHOLD TWP								
Business/Commercial	0	0	10	159	1,431	$0	$0	$0
Government/Institution	0	0	171	577	5,196	$0	$0	$0
R - Very Low Density	1,193	316	0	3,677	33,091	$4,031,720	$7,177,170	$7,008,540
UPPER FREEHOLD TWP	1,193	316	181	4,413	39,718	$4,031,720	$7,177,170	$7,008,540
Monmouth	2,151	568	181	7,365	66,278	$7,267,568	$12,937,548	$12,633,576
Study Region	74,514	18,450	234,046	2,122,550	19,102,821	$240,912,246	387,095,386	$449,954,595

APPENDIX 3: GOZ® MODEL DESCRIPTION

What is GOZ®?

GOZ® is a computer model that calculates how much development – housing and non-residential development – could be built if the developable land in a town or region were built as zoned. The model estimates a number of impacts from that development, including impacts on natural resources, infrastructure and public costs. GOZ® calculations can be used in other models or as material for more detailed studies, analyses or plans.

GOZ® allows the user to create zoning scenarios that can be designed and compared using either a traditional zoning framework or a framework based on Smart Growth principles, called Goal-Oriented Zoning, for which GOZ® was named.

GOZ® is an application developed by The Regional Planning Partnership (RPP) using the Geographic Information System (GIS) software ArcView®. RPP offers this tool to planners in New Jersey in order to inform planning decisions by providing an affordable, accessible, and easy-to-use method for developing capacity-based plans and zoning ordinances.

Why was GOZ® created?

Municipal master plans typically include many good goals. They state that the municipality intends to manage infrastructure efficiently, protect natural resources and preserve community character. The actual outcomes of the land development process, however, often fall short of these goals. RPP's experience in land development and conservation issues over the last 35 years, demonstrated to us that the problem is usually with the community's zoning ordinance, not its master plan.

Although polls show that most people do not like the problems associated with dispersed low-density, single-use development patterns, or "sprawl," most zoning ordinances require this pattern of development. Because most municipalities have never calculated the build-out of their zoning ordinances, most local officials do not know how many housing units or square footage of non-residential development would result if their developable land were built-out as zoned. Without that information, they cannot know the impacts that would be expected from that amount of development. They cannot, therefore, avoid or minimize these impacts by making different decisions.

THE MODEL

To solve this problem, RPP designed GOZ® to calculate the theoretical zoning yield, and compare the impacts from that yield, with other zoning scenarios. Besides being able to create their own scenarios based on altering existing zoning, users can apply a completely different zoning framework based on Smart Growth principles. This zoning framework is called Goal-Oriented Zoning, which is what GOZ® stands for. Goal-Oriented Zoning is based on the

centers, environs and planning areas in New Jersey's State Development and Redevelopment Plan.

Once the zoning information is put into GOZ®, the model is ready to make its calculations. GOZ® comes packaged with information available for New Jersey on land cover, preserved and environmentally sensitive land, as well as with commonly used impact formulae. The data can be updated and the assumptions about the zoning yield or the impacts can be changed to reflect the user's experience and any unique characteristics of the locality. RPP made GOZ® to be as transparent to the user as possible.

Step 1: Data inputs and mapping

GOZ® begins with land use / land cover mapping. The model classifies land into the following categories:

- Developed land — land with structures on it
- Undeveloped land — all land that is not developed
- Constrained land — land that cannot be developed due to environmental factors. The model considers permanently preserved land (farmland, parks, and open space), wetlands, water bodies and land with slopes of 12% or more as constrained land. The model is packaged with a Data Store of these data layers available statewide. The user can choose to use these and/or other constrained layers.

The model also requires a layer of the existing zoning for the study area, along with a database containing the density of housing units allowed in residential districts and the Floor Area Ratio (FAR) of building space allowed in each non-residential district.

Step 2: Calculating developable land and the amount of additional development

GOZ® uses the data from Step 1 to figure the amount of "developable" land in each zoning polygon. Unless a redevelopment factor is applied at the user's discretion, only land that is neither developed nor constrained is considered developable.

Based upon the amount of developable land and the applicable zoning provisions, GOZ® then calculates the total number of housing units or the square footage of non-residential space that could theoretically be built on the developable land. In this manner, GOZ® calculates the theoretical build-out for each zone.

Step 3: Calculating impacts from the additional development

Based on the amount and type of new development calculated in Step 2, GOZ® then calculates impacts upon infrastructure, natural resources, and public costs. The model performs these calculations using multipliers derived from published research and industry standards. The impact indicators include the following:

- Vehicle trips and vehicle miles traveled

- Public water and sewer demand
- Water and air pollution
- Capital costs of schools, water/sewer facilities, and roads

Users can modify the various assumptions and factors used by the model in its impact calculations.

Step 4: Reporting the results

GOZ® produces reports on the new development projected under build-out from Step 2 and on the impacts from Step 3. Users can generate these reports by municipality, county, watershed, or for the selected study area. The user can display the reports on-screen and print them, and export the data to a spreadsheet program. Users can also print maps showing the borders of zoning districts.

Step 5: Evaluating different scenarios

GOZ® allows the user to create zoning scenarios that can be designed and compared using either a traditional zoning framework or a framework based on Smart Growth principles, called Goal-Oriented Zoning.

Using the traditional zoning framework, users can modify their existing zoning to test different scenarios. Using the Goal-Oriented Zoning framework, users can design their own Smart Growth centers on a backdrop of zoning polygons based on the policies governing the State Plan Planning Areas, Centers and Environs. Users can see impacts from build-out under either framework or make comparisons between them.

The information provided by GOZ® can be used in other studies, models, plans or analyses.

The model provides the ability to quickly modify, calculate, and compare the impacts of alternative zoning scenarios. The user can change zoning classifications, impact multipliers, or zoning district boundaries with relative ease, and the model will calculate the impacts of the new scenario. The user can also assign a redevelopment factor to consider more of the developed land as developable.

The Regional Planning Partnership views GOZ® as an informational / educational tool particularly useful for local planners and stakeholders engaged in master planning, watershed planning, and the State Plan endorsement process.

APPENDIX 4: SUMMARY OF GOZ® MODEL IMPACT CALCULATION METHODOLOGY

GOZ® is a computer program that utilizes geographic information system (GIS) technology to calculate the impacts of build-out under various zoning scenarios. The Regional Planning Partnership staff designed GOZ® to inform planning decisions and improve planning practice by providing an affordable, accessible, and easy-to-use tool.

The GOZ® model organizes land use, infrastructure, and environmental maps and data. The program uses the amount of developable land within each zoning classification to calculate the type and amount of residential and non-residential development that would occur under build-out. Based upon the type and amount of new development, the model calculates various impacts on infrastructure, the environment, and public costs.

GOZ® allows the user to create various zoning scenarios that can be designed and compared using either a traditional zoning framework or a framework based on Smart Growth principles, called Goal-Oriented Zoning, for which GOZ® was named.

The model performs its impact calculations using generally-accepted impact assessment indicators, formulae, and multipliers. The calculation factors are included in three database tables. This paper describes the methodology and factors that the model uses to calculate build-out and development impacts.

I. Developable Land

The calculation methodology starts with land use/land cover (lu/lc) mapping, which classifies all land into numerous categories. RPP grouped the classifications as either “developed” or “undeveloped.”

The model uses additional mapping to define environmentally "constrained" land, which includes permanently preserved land (open space, farmland, etc), slopes of 12% or greater, wetlands and water bodies. The model is packaged with a Data Store of these data layers available statewide. The user can choose to use these and/or other constrained layers. The model subtracts this constrained land from the undeveloped land to provide the amount of "developable" land.

The developable land is the basis for the model's impact calculations, as described in the following sections.

II. Zoning Yield: Type and Amount of New Development

The next essential component of the model is the zoning layer and database, provided by the user. The layer of the zoning map shows all individual zoning districts (polygons), and the database includes the zoning classification and density (in dwelling units per acre, for residential zones) or floor area ratio (amount of development per square foot of ground space, for non-residential zones).

Based upon the amount of developable land in each zoning polygon and the permitted density or FAR of each zone, the model calculates the theoretical zoning yield, or build-out. This calculation provides the total number of dwelling units and the amount of three types of non-residential development (commercial / retail, office, and industrial / warehouse) that could theoretically occur under build-out.

The model applies a platting coefficient of 0.8 to this calculation. This factor means that for all types of development, 20% of developable land will be used for roads, parking, lawns, etc., and subtracted from the zoning yield calculation.

A. Traditional Zoning Framework

For existing zoning build-out, to calculate the total amount of development the model applies factors (% residential, density, % non-residential, and FAR) taken directly from the individual municipal zoning ordinances. These factors are contained in the "Zoning Yield Analysis" database table, which contains a separate record for each zoning district polygon. For one 32-town region, this table contained about 1900 records.

Given the large number of municipal zoning classifications (nearly 600 in 32 towns), in order to simplify the model's programming, the calculation of the breakdown of dwelling unit types is based upon "composite zones" for existing municipal zoning. The following tables show the classification of existing residential zones by density. To these composite zones, the model applies factors for the breakdown of residential development types.

Table 1 Classification of Traditional Zoning Framework (Composite Categories)

	du/acre	% SF 4+BR	% SF 3BR	% TH 4BR	% TH 3BR	% TH/ Apt 2BR	% Condo/ Apt 1BR
R - Rural Density	<0.18	80%	20%	0%	0%	0%	0%
R - Very Low Density	0.18 - 1.0	80%	20%	0%	0%	0%	0%
R - Low Density	1.1 - 2.0	40%	60%	0%	0%	0%	0%
R - Low Density*	1.1 - 2.0	0%	5%	0%	0%	60%	35%
R - Medium Density	2.1 - 5.9	10%	10%	16%	48%	16%	0%
Mixed Use	2.0 - 8.7	0%	5%	0%	0%	60%	35%
R - High Density	6.0 - 7.9	0%	0%	20%	60%	20%	0%
R - High Density*	6.0 - 7.9	0%	0%	0%	0%	40%	60%
R - Multi-Family	>8.0	0%	0%	0%	15%	48%	37%
R - Multi-Family*	>8.0	0%	0%	0%	0%	40%	60%

* Age-restricted

Sources: Densities -- RPP, based upon review of existing zoning in the region (compiled in 1998). Breakdown of unit types -- based upon literature review of TND/TOD design guidelines, interviews with New Jersey development practitioners, and *Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report I: Research Strategies,* Rutgers University, 1992.

B. Goal-Oriented Zoning Framework

The zoning yield calculation process is slightly different for existing zoning build-out than for build-out under the Goal-Oriented Zoning framework, as explained below.

For Goal-Oriented Zoning, RPP has developed a zoning classification scheme containing 13 zoning classifications. The model uses the density and FAR factors in the following table to calculate the total amount of residential development and the three types of non-residential development that would occur under build-out, and the table also contains factors used to calculate the breakdown of residential development types.

Table 2 Goal-Oriented Zoning Framework (SDRP Categories)

Zone	% Resid	density DU/acre	% SF 4+BR	% SF 3BR	% TH 4BR	% TH 3BR	% TH/ Apt 2BR	% Condo/ Apt 1BR		% Comm/ Retail	FAR	% Office	FAR	% Ind/ Wareh.	FAR
Urban CBD	30%	50	0%	0%	0%	15%	48%	37%		20%	6	50%	6	0%	0
Transit Core	40%	20	0%	0%	0%	15%	48%	37%		20%	3	40%	3	0%	0
Main Street Core	50%	15	0%	0%	0%	15%	48%	37%		20%	1	30%	1	0%	0
Neighborhood Core	70%	10	0%	0%	0%	15%	48%	37%		20%	0.2	10%	0.2	0%	0
Center Neighborhood I	95%	8	15%	40%	5%	30%	5%	5%		5%	0.2	0%	0	0%	0
Center Neighborhood II	100%	6	25%	35%	5%	20%	10%	5%		0%	0	0%	0	0%	0
Center Neighborhood III	100%	4	30%	40%	5%	25%	0%	0%		0%	0	0%	0	0%	0
Special Use District I	0%	0	0%	0%	0%	0%	0%	0%		0%	0	0%	0	100%	2
Metropolitan Environs	100%	3	60%	40%	0%	0%	0%	0%		0%	0	0%	0	0%	0
Suburban Environs	100%	1.5	80%	20%	0%	0%	0%	0%		0%	0	0%	0	0%	0
Fringe Environs	100%	0.125	100%	0%	0%	0%	0%	0%		0%	0	0%	0	0%	0
Rural Environs	100%	0.1	100%	0%	0%	0%	0%	0%		0%	0	0%	0	0%	0
Environmentally Sensitive Environs	100%	0.067	100%	0%	0%	0%	0%	0%		0%	0	0%	0	0%	0

Source: The Regional Planning Partnership, based upon literature review of TND/TOD design guidelines, interviews with New Jersey development practitioners, and *Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report I: Research Strategies,* prepared for the New Jersey Office of State Planning by the Center for Urban Policy Research, Rutgers University, 1992

For Goal-Oriented Zoning, the model also allows the user to apply a "redevelopment factor," in order to generate more development in selected zones. This factor is not site-specific, however, nor do the impact factors differ. Subsequent versions of the model will modify and enhance the redevelopment functions.

Population and Employment

Based upon the amount and type of residential and non-residential development, the GOZ® model calculates the total population, school age population, and number of new employees generated by build-out. The model uses factors contained in the "Multipliers by Land Use" database table, and the following table lists these factors:

Table 3 Multipliers for Population, School Age Population, and Employees

	Pop. / unit	School Pop. / unit	Emp. / 1000 sf
4+ BR	3.10	.82	
3 BR	3.10	.82	
2 BR	1.67	.15	
1 BR	1.67	.15	
Bus / Comm			2.5
Office			3.5
Industrial			1.5

Source: Adapted from *Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report I: Research Strategies,* p. 127, prepared for the New Jersey Office of State Planning by the Center for Urban Policy Research, Rutgers University, 1992.

Impacts on Infrastructure, the Environment, and Public Costs

1. Transportation and Air Pollution

Vehicle Trips

Based upon the types of dwelling units and non-residential development, the GOZ® model calculates daily vehicle trips using factors based upon trip generation rates published by the Institute of Transportation Engineers (ITE). These factors are also contained in the Multipliers by Land Use database table, and the following table lists these factors:

Table 4 Multipliers for Vehicle Trips

	Trips / unit	Trips / 1000 sf
4+ BR	9.55	
3 BR	9.55	
2 BR	7.44	
1 BR	6.47	
Bus / Comm		38.65
Office		11.85
Industrial		6.97

Source: *Trip Generation, 5th Edition.* Institute of Transportation Engineers, 1995.

In addition, the model applies a "trip reduction" factor for several Goal-Oriented Zoning zones, reducing the number of vehicle trips generated by new development in those zones. These factors are adapted from a 1991 Regional

Planning Partnership study, and they assume implementation of several other supporting measures including public transit service, travel demand management programs, improved site design, and changes in personal travel behavior. The following is a summary of the trip reduction factors:

Table 5 Trip Reduction Factors

Alternative zone	factor
Urban CBD	.72
Transit Core	.72
Main St	.76
Neighborhood core	.81
Center Neighborhood I	.81

Source: *The Impact of Various Land Use Strategies on Suburban Mobility*, The Regional Planning Partnership (formerly MSM Regional Council), 1991.

Vehicle Miles Traveled

The GOZ® model calculates the daily vehicle miles traveled (VMT) by multiplying the daily vehicle trips by an average vehicle trip length factor. The model assumes an average trip length of 9 miles for all vehicle trips. The source of this factor is *Travel Behavior Issues in the 90s*, a report based upon the 1990 National Personal Transportation Survey, published in 1992.

Air Pollution

The model calculates the level of air pollution (pounds per year) for three types of pollutants from motor vehicle emissions (non-methane hydrocarbons, carbon monoxide, and nitrogen oxides) based upon vehicle miles traveled. The model applies mobile source emission factors (grams / VMT), shown in the following table:

Table 6 Air Pollutant Factors

Pollutant	factor
NMHC	1.62
CO	10.50
NO_x	1.34

Source: *Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report I: Research Strategies*, p. 191, prepared for the New Jersey Office of State Planning by the Center for Urban Policy Research, Rutgers University, 1992.

2. Water Supply and Quality

Household Water Demand and Wastewater Demand

Based upon the types of dwelling units and non-residential development, the model calculates demand (gallons per day) for potable water and wastewater. The model assumes that the demand for water and wastewater are the same. For residential uses, the factors were derived by multiplying the number of persons per unit (see Table 3) by a water use factor of 75 gallons per

day, which is an industry standard. For non-residential uses, we used factors derived from the NJDEP regulations for projected wastewater flow criteria. The following table shows the factors.

Table 7 Water / Wastewater Demand Multipliers

	gal / day / unit	Gal /day / sf
4+ BR	232.5	
3 BR	232.5	
2 BR	125.25	
1 BR	125.25	
Bus / Comm		.1
Office		.1
Industrial		.0375

Sources: Residential: Adapted from *Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan, Report I: Research Strategies*, p. 127, prepared for the New Jersey Office of State Planning by the Center for Urban Policy Research, Rutgers University, 1992, and *Water Use Database*, prepared by the Delaware River Basin Commission, 1999.

Non-residential: NJAC 7:14A-23.3, *Projected flow criteria*, effective June 6, 1994. For industrial uses, a factor of 25 gallons per day per employee (for facilities without showers) was multiplied by a factor of 1.5 employees per 1000 square feet.

Summer Water Demand

Based upon the number of dwelling units by zone, the model also calculates summer residential outdoor water usage. This usage is in addition to the water usage calculated above. The following table shows the assignment of summer water demand factors (adapted from published research) to the model's residential zones.

Table 8 Summer Residential Outdoor Water Usage Multipliers

Existing Composite Zones	gal/day
R - Rural Density	523
R - Very Low Density	523
R - Low Density	157
R - Low Density*	157
R - Medium Density	157
R - Medium Density*	157
R - High Density	64
R - High Density*	64
R - Multi-family	64
R - Multi-family*	64

Smart Growth Zones	gal/day
Fringe Environs	523
Rural Environs	523
Environmentally Sensitive Environs	523
Center Neighborhood III	157
Metropolitan Environs	157
Suburban Environs	157
Center Neighborhood II	64

*Age restricted
Source: adapted from research by Rodney Sakrison, University of Washington, cited in *New Urban News*, April 1997.

Water Pollution

The model calculates water pollution based upon the amount of impervious surface projected for each zone under build-out. Based upon the amount of impervious surface, the model calculates the level of non-point water pollution (pounds per year) for five types of pollutants: phosphorus, nitrogen, biological oxygen demand (BOD), zinc, and lead. The model applies factors derived from a NJDEP manual to calculate the amount of impervious surface and the pollutant levels for different residential zones and non-residential uses. These factors are summarized below:

Table 9 Impervious Surface and Water Pollution Factors

Zone	density	% Imperv.	In pounds / acre / year				
		Surface	Phosphorus	Nitrogen	BOD	Zinc	Lead
R – Rural Density	<0.18	0.05	0.2	1.6	4	0.03	0.01
R – Very Low Density	0.18 - 1.0	0.1	0.3	2.3	5.8	0.04	0.02
R – Low Density	1.1 - 2.0	0.2	0.49	3.8	9.6	0.07	0.04
R – Low Density (Age-restricted)	1.1 - 2.0	0.2	0.49	3.8	9.6	0.07	0.04
R – Medium Density	2.1 - 5.9	0.35	0.77	6	15.2	0.11	0.06
R – Medium Density (Age-restricted)	2.0 - 8.7	0.35	0.77	6	15.2	0.11	0.06
R – High Density	6.0 - 7.9	0.5	1.06	8.2	20.8	0.15	0.08
R – High Density (Age-restricted)	6.0 - 7.9	0.5	1.06	8.2	20.8	0.15	0.08
R – Multi-family	>8.0	0.6	1.25	9.6	24.6	0.18	0.09
R – Multi-family (Age-restricted)	>8.0	0.6	1.25	9.6	24.6	0.18	0.09
Business/Commercial		0.8	1.63	12.6	32	0.23	0.11
Office		0.6	1.25	9.6	24.6	0.18	0.09
Industrial/Warehouse		0.6	1.25	9.6	24.6	0.18	0.09
Mixed Use		0.6	1.25	9.6	24.6	0.18	0.09
Government/Institution		0.6	1.25	9.6	24.6	0.18	0.09
Environmentally Sensitive Environs	.067	0.025	0.11	0.8	2.1	0.02	0.01
Fringe Environs	.1	0.05	0.2	1.6	4	0.03	0.01
Rural Environs	.125	0.05	0.2	1.6	4	0.03	0.01
Suburban Environs	1.50	0.2	0.49	3.8	9.6	0.07	0.04
Center Neighborhood III	3	0.35	0.77	6	15.2	0.11	0.06
Metropolitan Environs	0	0.35	0.77	6	15.2	0.11	0.06
Center Neighborhood II	4	0.5	1.06	8.2	20.8	0.15	0.08
Center Neighborhood I	6	0.6	1.25	9.6	24.6	0.18	0.09
Special Use District I	8	0.6	1.25	9.6	24.6	0.18	0.09
Neighborhood Core	10	0.9	1.82	14	35.8	0.26	0.13
Main Street Core	15	0.9	1.82	14	35.8	0.26	0.13
Transit Core	20	0.9	1.82	14	35.8	0.26	0.13

Urban CBD	50	0.9	1.82	14	35.8	0.26	0.13

Source: adapted from Metropolitan Washington Council of Governments, 1997, appearing in *Stormwater and Non-Point Source Pollution Control Best Management Practices Manual,* NJ Dept. of Environmental Protection, December 1994.

3. Public Capital Costs

Based upon the number of dwelling units per zoning classification, the model calculates the public capital costs for three types of facilities: schools, roads, and utilities (water and sewer). The model uses factors derived from a 1974 report by the Real Estate Research Corporation (RERC). RPP multiplied the RERC multipliers by the increase in the consumer price index (CPI) between 1974 - 1999 in order to convert them to current dollar figures, as shown in the following table:

Table 10 Public Capital Cost Factors

Existing Zoning	Public Capital Costs / unit		
	Schools	Roads	Utilities
R - Rural Density	18,204	10,472	18,642
R - Very Low Density	18,204	10,472	18,642
R - Low Density	18,204	10,472	18,642
R - Low Density (age)	-	10,472	18,642
R - Medium Density	18,204	9,047	12,407
Mixed Use	18,204	9,047	12,407
R - High Density	15,429	7,177	8,055
R - High Density (age)	-	7,177	8,055
R - Multi-Family	15,429	4,978	5,369
R - Multi-Family (age)	-	4,978	5,369

Smart Growth Alternative	Public Capital Costs / unit		
	Schools	Roads	Utilities
Env Sens Environs	18,204	10,472	18,642
Rural Environs	18,204	10,472	18,642
Fringe Environs	18,204	10,472	18,642
Suburban Environs	18,204	10,472	18,642
Metropolitan Environs	18,204	9,047	12,407
Center Neigh III	18,204	9,047	12,407
Center Neigh II	15,429	7,177	8,055
Center Neigh I	15,429	7,177	8,055
Neighborhood Core	15,429	4,978	5,369
Main Street Core	15,429	4,978	5,369
Transit Core	5,596	2,723	3,257
Urban CBD	5,596	2,723	3,257

Source: Regional Planning Partnership, adapted from *The Costs of Sprawl*, Real Estate Research Corporation, 1974, cited in *Costs of Sprawl Revisited-The Evidence of Sprawl's Negative and Positive Impacts*, March 1998.

Comparison of Current Zoning Build-Out Impacts for Mercer County With Vision 2050 Goal-Oriented Zoning Impacts

7/18/2003
STUDY AREA Mercer

ELEMENT	Vision 2050:	Existing Zoning	DIFFERENCE
Total Acres	69,602	70,310	-708
Undeveloped Acres	16,148	16,152	-3
Impervious Cover (Acres)	3,443	6,248	-2,804
Total Units	27,159	14,863	12,296
Four Bedroom Units	11,693	4,598	7,095
Three Bedroom Units	8,760	6,164	2,596
Two Bedroom Units	3,787	2,705	1,082
One Bedroom Units	2,919	1,396	1,523
People	74,602	40,206	34,396
School Age Children	17,775	9,434	8,341
Potable Water Demand	13,220,116	9,877,507	3,342,609
Wastewater Demand	13,220,116	9,877,507	3,342,609
Summer HH Water Demand	3,084,402	2,834,835	249,567
Ind/Ware Sq ft	17,074,125	36,859,601	-19,785,476
Comm/Retail Sq Ft	23,198,520	31,321,912	-8,123,392
Office Sq Ft	46,647,062	23,472,284	23,174,778
Jobs	246,875	215,742	31,133
Vehicle Trips	1,389,542	1,877,593	-488,051
Vehicle Miles Traveled	12,505,793	16,898,259	-4,392,466
Capital costs - Roads	204,244,081	125,643,665	78,600,416
Capital costs - Utilities	298,306,267	183,709,724	114,596,543
Capital costs - Schools	401,087,845	247,639,335	153,448,510
Phosphrous lbs/yr	3,247	7,560	-4,313
Nitrogen lbs/yr	25,109	58,334	-33,225
BOD lbs/yr	63,915	148,731	-84,816
Zinc lbs/yr	464	1,053	-589
Lead lbs/yr	236	511	-275
NMHC lbs/yr	20,259,354	27,375,164	-7,115,810
NOX lbs/yr	16,757,749	22,643,665	-5,885,916
CO lbs/yr	131,310,664	177,431,690	-46,121,026
Capital costs per Unit - Roads	7,520	8,453	-933
Capital costs per Unit - Utilities	10,984	12,360	-1,377
Capital costs per Unit - Schools	14,768	16,661	-1,893

Note: Total Acres may not equal due to different sources for the base layers