Watershed Management Area 20 GOZ® Build-out Analysis for Upper Freehold Township and Doctors Creek Sub-watershed

Prepared for: The Delaware Valley Regional Planning Commission
For the WMA 20 Watershed Planning Project
Prepared by: The Regional Planning Partnership
Date: January 2003

ACKNOWLEDGEMENTS

This report was prepared by the Regional Planning Partnership for the Delaware Valley Regional Planning Council as part of the New Jersey Department of Environmental Protection's Division of Watershed Management Statewide watershed planning process begun in 2000.

The Regional Planning Partnership would like to acknowledge the contributions made to this report by Land Use and Action Now Committee of the WMA 20.

The alternatives described in this report were prepared as examples of how alternatives to existing zoning could work in WMA20, as part of Phase One of the watershed planning process. Any future GOZ analysis of the watershed should involve decision makers and stakeholders working together to refine Smart Growth alternatives to build-out where the impacts of build-out threaten water resources.

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1.0 INTRODUCTION

The New Jersey Department of Environmental Protection initiated a watershed planning process for the State in 2000, dividing the State into 20 watershed management areas. The Delaware Regional Planning Commission (DVRPC) was contracted by the Department to manage the planning process for Watershed Management Area 20 (WMA 20). In turn, The Regional Planning Partnership (RPP) was contracted by DVRPC to manage the Land Use and Action Now (LUAN) Committee for the Doctors Creek sub-watershed.

One of the roles of the Land Use and Action Now Committee was to identify areas appropriate for preservation and for growth. The Committee expressed an interest in using RPP's Goal Oriented Zoning (GOZ®) build-out model to help evaluate the impacts of build-out on water resources to assist in identifying preservation and growth areas.

RPP conducted a demonstration analysis for Upper Freehold Township in Monmouth County and made a presentation to the Land Use and Action Now (LUAN) Committee in July of 2002. The Committee requested another presentation of the Upper Freehold analysis for a larger audience that included local officials. At the second presentation, the Committee recommended that RPP make a similar presentation the Public Advisory Committee (PAC) and that the model should be used by the Department as a tool for watershed planning. For the PAC presentation, RPP conducted a build-out analysis using the entire Doctors Creek sub-watershed (which consists of parts of two counties and several municipalities) as the study area. The results of this analysis were presented at the PAC meeting on January 23, 2003, and are documented below.

2.0 SIGNIFICANCE OF BUILD-OUT FOR MUNICIPALITIES AND REGIONS

To understand the future quality of life in any community it is essential to estimate the amount of new development allowed by a municipality's zoning ordinance. This estimation of theoretical zoning yield is called a build-out analysis.

A build-out analysis provides answers to capacity questions municipalities need to answer in order to plan for their future. These questions include but are not limited to:

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

To answer water resource questions, in particular, municipalities need to know:

- 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?

Answers to these questions rely on understanding build-out. Until recently such an analysis required laborious mapping and calculations. However, new GIS-based tools have been developed to answer some of the above questions more rapidly and allow alternatives to be explored before final decisions are made.

Although GOZ® calculates the impacts on a variety of natural resource, infrastructure and public costs, the focus of this report is on the water resources impacts associated with build-out for Upper Freehold Township and the Doctors Creek sub-watershed.

3.0 IMPERVIOUS SURFACE AND WATER RESOURCES

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).

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).

Streams in areas with 10% or less impervious cover are generally considered healthy as identified by Schueler (1994), EPA (1994), and Arnold (1996). Streams located in most parts of the United States, with the exception of the southwest, are generally found to be healthy where the sub-watersheds contain less than 10% impervious cover. (It must be remembered however, that each stream is unique and field checks are required when developing a specific plan for a particular stream.)

Schueler identifies three categories 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.

4.0 UPPER FREEHOLD TOWNSHIP BUILD-OUT ANALYSIS

Build-out impacts for Upper Freehold Township in Monmouth County were identified by RPP using its GOZ® model. For details on how the GOZ® model works, see Appendix 1. For information on the multipliers used to calculate impacts and the sources of the multipliers, see Appendix 2. The model uses composite zoning that is drawn from detailed zoning contained in municipal ordinances. These zones were aggregated into a composite Zoning framework. This allows similar types of zones to be grouped to allow comparisons across different municipalities and simplifies the model's calculations. For Upper Freehold Township, RPP used the composite zoning to calculate the impacts of build-out under existing zoning.

For demonstration purposes, RPP created another zoning scenario as an alternative to the existing zoning. RPP altered the existing zoning to create an alternative smart growth scenario. 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), current land uses within Upper Freehold and its neighboring municipalities, existing zoning ordinances, transportation corridors, aerial photos showing where infrastructure exists, and State Plan Policy Map Planning Areas.

After reviewing these data sources, staff created a smart growth alternative by up-zoning 418 acres into seven medium density centers and down-zoning 9,040 acres. In addition, staff used the model's flexibility to revise the impervious cover multiplier from .1 to .05 to reflect clustered development and implementation of best management practices to reduce rain water runoff (narrow streets, porous pavement, vegetated swales etc.) in the down-zoned areas. The total number of projected new dwelling units remained constant between the existing zoning and the smart growth alternative.

Map 1 shows the two scenarios that were analyzed. Table 1 shows the impacts under the Alternative and Existing Zoning. The smart growth alternative resulted in a smaller increase in: impervious cover, polluted runoff, vehicle miles traveled, and air pollution. The increase of impervious cover was reduced by 25% in the smart growth alternative with centers and clustered growth. As noted previously, a reduction in the increase of impervious cover can keep a township below the 10% threshold established by Schueler and others.

The analysis for Upper Freehold Township was conducted as a demonstration of how the changes in land use plans can affect watershed planning. Township officials did not contribute to the development of the alternative scenario nor did they review the results of the analysis. The mayor of the Township was informed that the analysis was being conducted, but he did not review the results prior to the LUAN Committee meeting presentation. Because the alternative scenario was created without a public process and

Table 1

Comparison of Total Impacts by Subject Area for Upper Freehold Twp.

STUDY AREA : Upper Freehold Township

ELEMENT	Alternative Build-Out	Existing Build-Out	DIFFERENCE
Total Acres	30,132	30,132	0
Undeveloped Acres	11,034	11,034	0
Impervious & Water Impacts			
Impervious Cover (Acres)	1,377	1,829	-452
Phosphorus lbs/yr	1,442	1,558	-116
Nitrogen lbs/yr	11,133	12,019	-886
BOD lbs/yr	28,320	30,548	-2,228
Zinc lbs/yr	203	220	-17
Lead lbs/yr	95	103	-8
Potable Water Demand	2,089,320	2,118,062	-28,742
Wastewater Demand	2,089,320	2,118,062	-28,742
Summer HH Water Demand	1,927,736	2,540,211	-612,475
Residential & Non-Residential Impacts			
Total Units	4,857	4,857	0
Four Bedroom Units	2,982	3,884	-902
Three Bedroom Units	1,607	973	634
Two Bedroom Units	268	0	268
One Bedroom Units	0	0	0
People	14,673	15,056	-383
School Age Children	3,801	3,982	-181
Ind/Ware Sq ft	78,060	78,060	0
Comm/Retail Sq Ft	5,741,993	5,741,993	0
Office Sq Ft	4,116,804	4,116,804	0
Jobs	28,882	28,882	0
VMT & Air Impacts			
Vehicle Trips	317,076	317,641	-565
Vehicle Miles Traveled	2,853,677	2,858,767	-5,090
NMHC lbs/yr	4,622,957	4,631,201	-8,244
NOX lbs/yr	3,823,929	3,830,748	-6,819
CO lbs/yr	29,963,593	30,017,030	-53,437

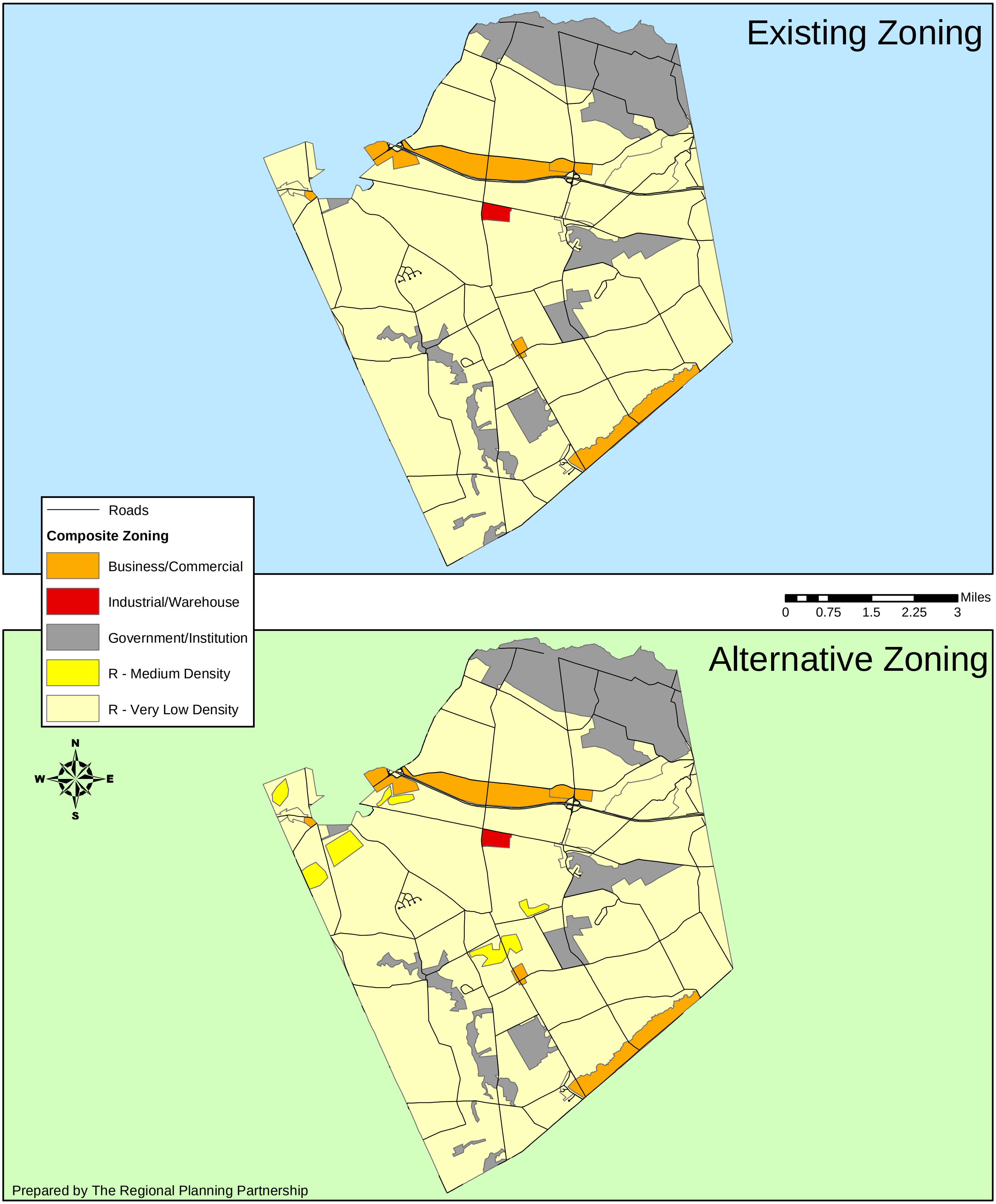
Note: Total Acres may not equal due to different sources for the base layers.

The impact factors in GOZ® were developed for use in a regional model, not for site specific analysis or for detailed analysis of a particular impact. Although the Crystal Reports produced by the model appear to provide specific factual data, the model's output is a theoretical product given the generalizations and assumptions used in the calculations.

Upper Freehold Township

GOZ® Scenarios

Map 1



has not been ground truthed, the RPP staff are presenting their analysis as a demonstration, not a recommendation.

5.0 DOCTORS CREEK SUB-WATERSHED ANALYSIS

5.1 Location

Doctors Creek sub-watershed consists of parts of Hamilton and Washington Townships in Mercer County and Upper Freehold and Millstone Townships and the Borough of Allentown in Monmouth County (See Map 2).

5.2 Alternative Scenario Development

As in the analysis of Upper Freehold Township, RPP used existing composite zoning to determine the impacts of build-out under existing zoning (See Map 3 Existing Zoning). The alternative scenario 1 was developed by up-zoning five areas as centers and creating a conservation easement primarily along the Negro Run and Doctors Creek stream corridors (See Map 3 Alternative 1). The centers were located by determining where infrastructure already exists (primarily in proximity of roads and existing developed areas). The down-zoned areas were determined by looking at where existing preserved land, proposed preservation areas, and environmentally sensitive land are located. A priority was given to protect land along stream corridors to achieve the goal of protecting water quality and to provide linkages to existing preserved open space (See Map 4).

Doctors Creek sub-watershed is predominantly zoned as “very low density” (.18 – 1 DU per Acre). There are 6,436 acres of developable land in the sub-watershed. For the purposes of this demonstration, RPP only altered the low-density residential zone to create Alternative 1. Five areas totaling 126 acres were selected to be up-zoned to medium density (2.1 – 5 DU per acre) to create new centers in the watershed. For demonstration purposes, RPP staff assumed 894 acres were placed in a conservation easement along the creeks. In summary, only 1,020 acres were altered.

5.3 Comparison of Scenarios

Table 2 is a report comparing the impacts of the existing zoning and Alternative 1. The report indicates that the number of dwelling units for both the existing zoning and the alternative 1 remains relatively the same. The existing zoning generates 3,031 dwelling units while the alternative generates 3,035. The number of four-bedroom housing units decreases in the alternative, while the number of two and three bedroom units increases. Vehicle trips and vehicle miles traveled are also reduced, which in turn reduces the amount of air pollution under the alternative scenario. The alternative scenario generates 74 acres less impervious cover than the existing zoning. With the reduced impervious cover there is a reduction in water pollutants as well.

Table 3 shows the amount of existing impervious cover and the total impervious cover at build-out under existing zoning and Alternatives 1 and 2. Currently there is about 8% impervious cover for the Doctors Creek sub-watershed. At build-out under existing zoning and Alternative 1, the impervious cover increases to 17% and 16%, respectively.

Table 2

Comparison of Total Impacts by Subject Area for Doctors Creek

STUDY AREA: Doctors Creek

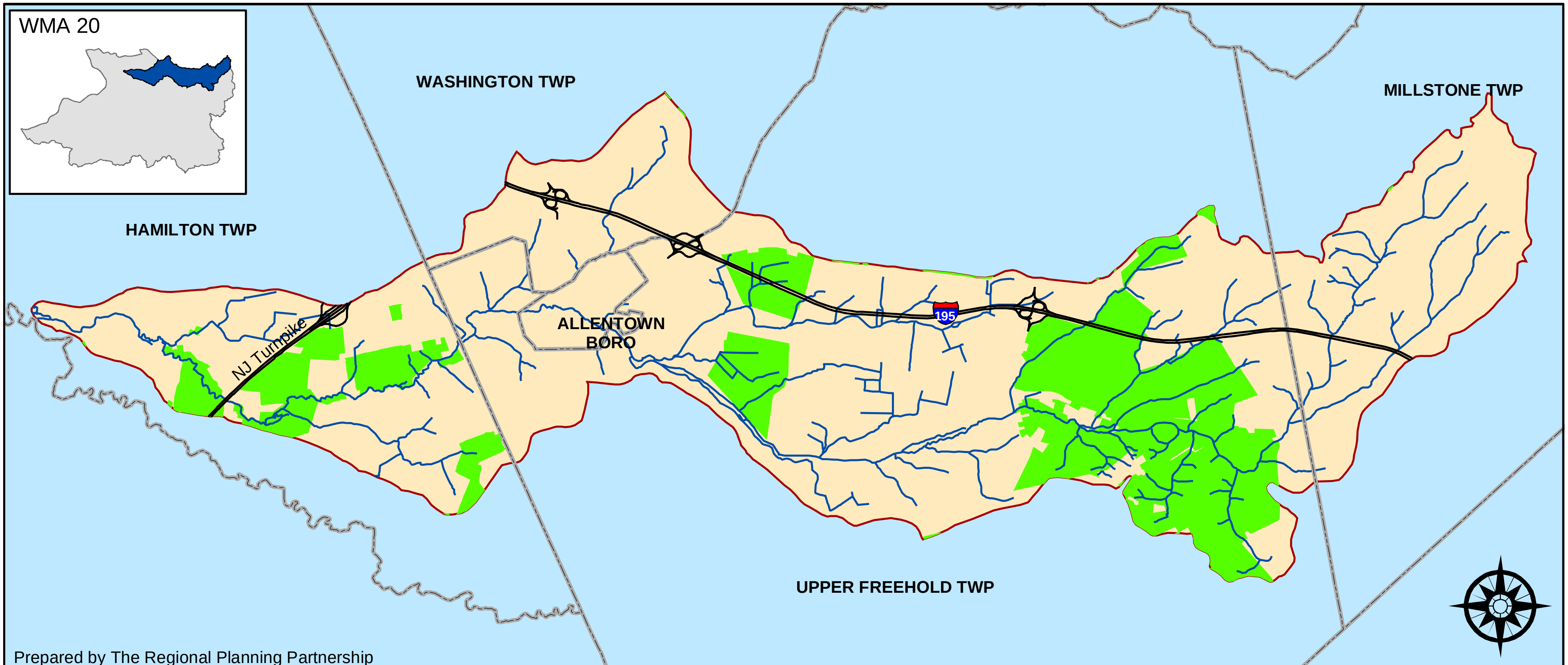
ELEMENT	Alternative #1 Build-Out	Existing Build-Out	DIFFERENCE
Total Acres	16,602	16,602	0
Undeveloped Acres	6,436	6,436	0
Impervious & Water Impacts			
Impervious Cover (Acres)	1,349	1,423	-74
Phosphrous lbs/yr	1,540	1,566	-26
Nitrogen lbs/yr	11,896	12,079	-183
BOD lbs/yr	30,207	30,664	-457
Zinc lbs/yr	212	217	-5
Lead lbs/yr	99	100	-1
Potable Water Demand	2,015,168	2,059,278	-44,110
Wastewater Demand	2,015,168	2,059,278	-44,110
Summer HH Water Demand	1,192,086	1,375,922	-183,836
Residential & Non-Residential Impacts			
Total Units	3,035	3,031	4
Four Bedroom Units	1,844	2,118	-274
Three Bedroom Units	999	805	194
Two Bedroom Units	181	97	84
One Bedroom Units	11	11	0
People	9,134	9,241	-107
School Age Children	2,357	2,412	-55
Ind/Ware Sq ft	106,635	106,635	0
Comm/Retail Sq Ft	12,563,418	12,923,746	-360,328
Office Sq Ft	697,726	697,726	0
Jobs	34,010	34,911	-901
VMT & Air Impacts			
Vehicle Trips	523,160	537,227	-14,067
Vehicle Miles Traveled	4,708,408	4,834,996	-126,588
NMHC lbs/yr	7,627,615	7,832,692	-205,077
NOX lbs/yr	6,309,262	6,478,896	-169,634
CO lbs/yr	49,438,227	50,767,439	-1,329,212

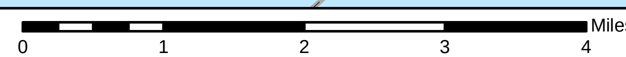
Note: Total Acres may not equal due to different sources for the base layers

The impact factors in GOZ® were developed for use in a regional model, not for site specific analysis or for detailed analysis of a particular impact. Although the Crystal Reports produced by the model appear to provide specific factual data, the model's output is a theoretical product given the generalizations and assumptions used in the calculations.

Doctors Creek

Map 2





- Streams
- Major Roads
- Municipalities
- Open Space
- Doctors Creek

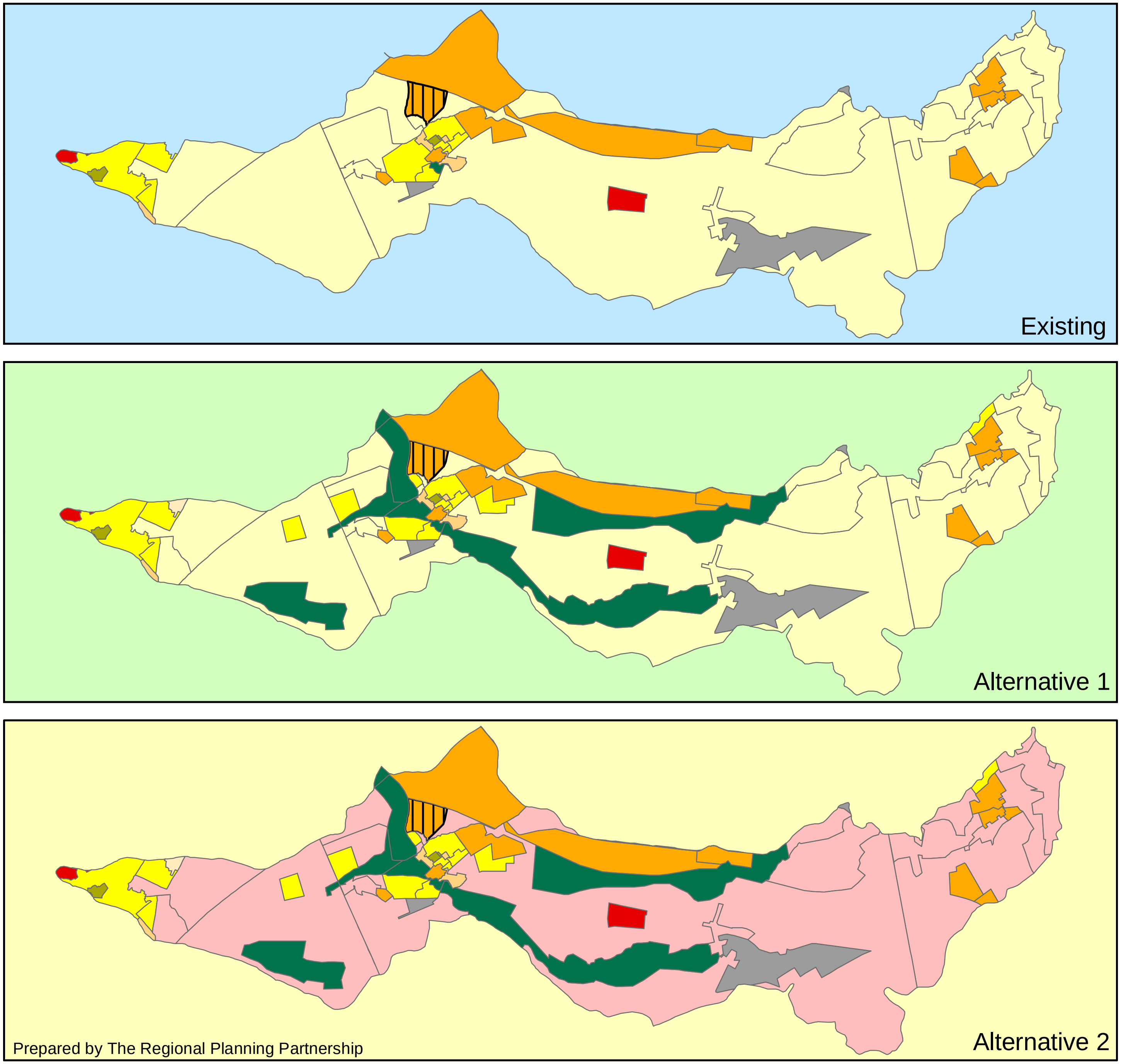
Data Sources:
NJDEP
NJDOT

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

GOZ Model Build-Out Scenarios - Composite Zoning

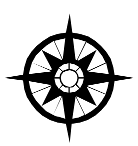
Map 3

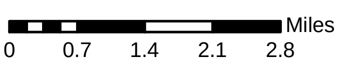
Doctors Creek



Composite Zoning

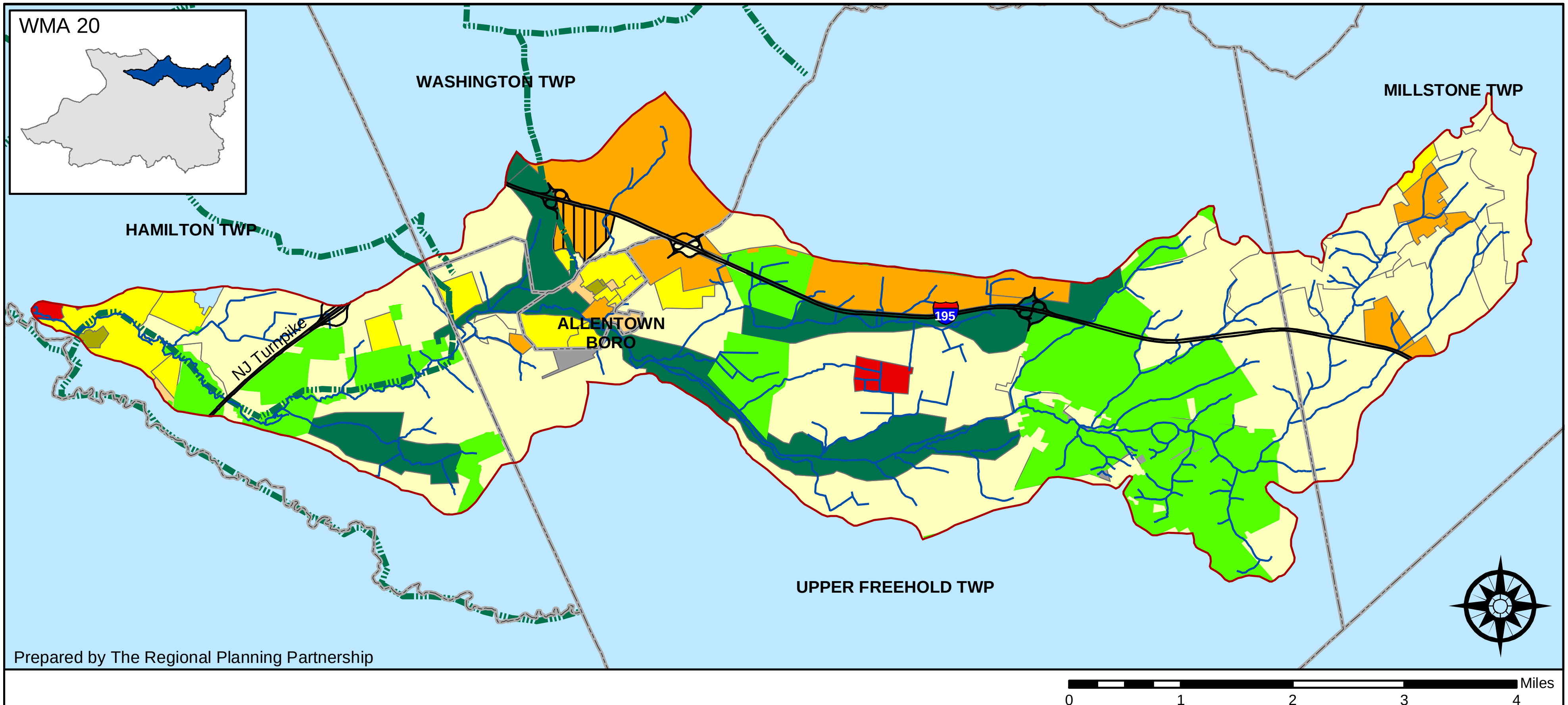
- Business/Commercial
- Office
- Industrial/Warehouse
- Government/Institution
- R - Multi-family
- R - High Density
- R - Medium Density
- R - Very Low Density
- R - Rural Density
- Conservation





Doctors Creek

Map 4



- Streams
- Major Roads
- Municipalities
- Open Space
- Proposed Green Links

Composite Zoning

- Industrial/Warehouse
- Business/Commercial
- Office
- Government/Institution
- R - High Density (6 - 7.9)
- R - Multi-family (>8)
- R - Medium Density (2.1 - 5.9)
- R - Very Low Density (0.18 - 1)
- Conservation

Data Sources:
NJDEP
NJDOT
RPP

This map was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

Table 3

	Watershed Area	95/97 % Impervious Surface	Existing* % Impervious Surface	Alternative 1** % Impervious Surface	Alternative 2*** % Impervious Surface
Doctors Creek	16603.115	8.265993279	16.83065118	16.30665312	15.13

* 1995 Impervious Surface (IS) plus IS from Build-Out under existing Zoning.

** 1995 IS plus IS from Build-Out under alternative 1 zoning.

*** 1995 IS plus IS from Build-Out under alternative 2 zoning.

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It was hoped that the percent impervious cover in the alternative scenario would be significantly lower than the existing zoning scenario. Although the alternative shows reductions in all the key areas, the results are not dramatic. This is partially due to the relatively small number of acres (1,020 acres or 16% of the developable land) that were rezoned for the alternative. In addition, the land that was placed in a conservation easement was already zoned at a relatively low density.

After reviewing the results, staff decided to run a second alternative (See Map 3 Alternative 2 and Table 4). For this analysis, staff decided to set a target – try to keep the alternative build-out impervious cover under the 10% threshold. Keeping the same centers and conservation areas, staff rezoned the remaining low-density residential zone to a rural zone. This second alternative resulted in an overall impervious cover of 15%. Staff determined that since the existing impervious cover (95/97 land cover) is already at 8%, without assuming clustering in the down-zoned areas and reducing the impervious cover multiplier and/or modifying the density of other composite zones it would be nearly impossible to achieve the 10% target. With 15% impervious cover it is likely that the creeks in the sub-watershed would exhibit signs of impairment, but would not yet fall into the impacted category.

As with the Upper Freehold Township analysis, the Doctors Creek analysis was conducted to demonstrate how changes in land use patterns can affect water resources and as a demonstration of how the GOZ® model can be used for watershed based planning and analysis. The results of the analysis were presented at the January 23, 2003 Public Advisory Committee meeting. The results of the analysis were not previously reviewed with local decision makers. The alternatives were not presented as preferred alternatives, but rather as alternatives that could be taken under consideration by the townships in the sub-watershed. Without more public involvement, neither RPP nor the PAC are recommending the alternatives at this time.

6.0 GOZ® Model

The analysis of Upper Freehold Township and the Doctors Creek sub-watershed demonstrates how the model is not a mysterious "black box." The assumptions written into the model are visible to the user, and the user can modify the assumptions if the user has justification. For example, for the Upper Freehold analysis, the alternative was designed as a smart growth scenario. For the purposes of this analysis, staff defined smart growth as directing growth into the seven new centers, down-zoning the environs, and assuming that development in the environs would be clustered. Schueler states that clustering development can reduce impervious surface by 10 to 50%. Therefore, the impervious cover multiplier was changed from .1 to .05. For the purposes of this study, the impervious cover factor was reduced because it was assumed that all new development would be clustered and best management practices that reduce runoff would be implemented. Best management practices include such things as narrower roads, vegetated swales, and porous pavement.

The Doctors Creek alternative demonstrated how the model could be used by different jurisdictions (multiple counties and municipalities), and it only moderately modified the

Table 4

Comparison of Total Impacts by Subject Area for Doctors Creek

STUDY AREA : Doctors Creek

ELEMENT	Alternative #2 Build-Out	Existing Build-Out	DIFFERENCE
Total Acres	16,602	16,602	0
Undeveloped Acres	6,436	6,436	0
Impervious & Water Impacts			
Impervious Cover (Acres)	1,139	1,423	-284
Phosphorus lbs/yr	1,457	1,566	-109
Nitrogen lbs/yr	11,265	12,079	-814
BOD lbs/yr	28,608	30,664	-2,056
Zinc lbs/yr	203	217	-14
Lead lbs/yr	94	100	-6
Potable Water Demand	1,723,846	2,059,278	-335,432
Wastewater Demand	1,723,846	2,059,278	-335,432
Summer HH Water Demand	536,767	1,375,922	-839,155
Residential & Non-Residential Impacts			
Total Units	1,782	3,031	-1,249
Four Bedroom Units	845	2,118	-1,273
Three Bedroom Units	745	805	-60
Two Bedroom Units	181	97	84
One Bedroom Units	11	11	0
People	5,251	9,241	-3,990
School Age Children	1,333	2,412	-1,079
Ind/Ware Sq ft	106,635	106,635	0
Comm/Retail Sq Ft	12,563,418	12,923,746	-360,328
Office Sq Ft	697,726	697,726	0
Jobs	34,010	34,911	-901
VMT & Air Impacts			
Vehicle Trips	511,195	537,227	-26,032
Vehicle Miles Traveled	4,600,711	4,834,996	-234,285
NMHC lbs/yr	7,453,147	7,832,692	-379,545
NOX lbs/yr	6,164,949	6,478,896	-313,947
CO lbs/yr	48,307,424	50,767,439	-2,460,015

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

The impact factors in GOZ® were developed for use in a regional model, not for site specific analysis or for detailed analysis of a particular impact. Although the Crystal Reports produced by the model appear to provide specific factual data, the model's output is a theoretical product given the generalizations and assumptions used in the calculations.

existing composite zoning. The multipliers were not adjusted to reflect clustered development in the environs.

7.0 RECOMMENDATIONS FOR FURTHER ANALYSIS

The Upper Freehold and the Doctors Creek sub-watershed analyses were presented to the Land Use and Action Now Committee and the PAC to demonstrate how the GOZ® model could be used as a tool to advance watershed planning by identifying how different land use patterns could affect water resources. The Land Use and Action Now Committee recommended to the PAC that the GOZ® model be used by DEP in any future watershed planning analysis for WMA 20. The PAC accepted the recommendation and encouraged the Department to incorporate the GOZ® model in future watershed analysis.

Several members of the Land Use and Action Now Committee and the PAC expressed an interest in understanding the impacts of their existing zoning. The GOZ® model could be used to provide information on their zoning potential and about alternatives that they may be considering.

In order to have a comprehensive water resource risk assessment, RPP recommends using the GOZ® model with other studies, such as a riparian corridor, groundwater quantity, and existing impervious cover analysis. In WMA 11, the model was used along with other studies to develop an impervious cover vulnerability analysis based on build-out for all 24 municipalities in the watershed.

The members of the LUAN and the PAC believe that the watershed planning process increased awareness and understanding of watershed issues as well as building support for regional initiatives. Prior to the watershed planning process there were townships that did not communicate with one another. Many townships are now working together to develop a regional greenway plan and to seek joint funding for planning initiatives. It is recommended that the work and the partnerships that have evolved through this process be integrated into any water programs currently being reviewed by the Department. The PAC has agreed to move forward in continuing to work together to seek a Wild and Scenic River designation for the Doctors and Crosswicks Creek. It is expected that the data collected during the watershed process will be used to advance that effort.

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APPENDIX 1: 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 2: 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. <u>Goal-Oriented Zoning Framework</u>

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

	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

	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.