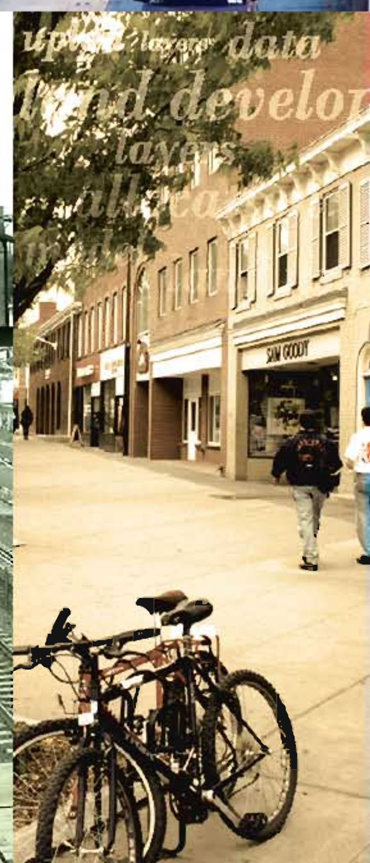
APPLICATION *of the* UPLAN LAND USE PLANNING MODEL

July 2009



DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

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DELAWARE VALLEY REGIONAL PLANNING COMMISSION

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The Delaware Valley Regional Planning Commission is dedicated to uniting the region's elected officials, planning professionals and the public with the common vision of making a great region even greater. Shaping the way we live, work and play, DVRPC builds consensus on improving transportation, promoting smart growth, protecting the environment, and enhancing the economy. We serve a diverse region of nine counties: Bucks, Chester, Delaware, Montgomery and Philadelphia in Pennsylvania; and Burlington, Camden, Gloucester and Mercer in New Jersey. DVRPC is the official Metropolitan Planning Organization for the Greater Philadelphia Region — leading the way to a better future.

Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

DVRPC is funded by a variety of funding sources including federal grants from the U.S. Department of Transportation's Federal Highway Administration (FHWA) and Federal Transit Administration (FTA), the Pennsylvania and New Jersey departments of transportation, as well as by DVRPC's state and local member governments. The authors, however, are solely responsible for its findings and conclusions, which may not represent the official views or policies of the funding agencies.

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Executive Summary

This report documents the completion of the UPlan calibration process and presents the development and application of a generalized forecasting methodology for applying UPlan in ongoing Delaware Valley Regional Planning Commission (DVRPC) studies. UPlan is a Geographical Information System (GIS) based land use planning and forecasting model with a sophisticated embedded transportation/land use interface. The implementation strategy involves emulating ongoing DVRPC land use and transportation planning activities within UPlan, as much as possible, while implementing the transportation/land use linkage recommended by federal guidelines. Ultimately, the goal is to integrate UPlan into ongoing regional, county, and local land use/transportation planning activities.

UPlan is a land use planning model developed at the University of California, Davis that spatially allocates new development for use in long-range land use planning and scenario testing. UPlan allocates new footprint development to areas that are currently undeveloped or designated developed but vacant. Land consumption is accounted for by explicit allocation to areas defined by a boundary in space. Land use categories included in UPlan are industrial, high density commercial, low density commercial, high density residential, medium density residential, low density residential, and very low density residential. Commercial land uses include office, retail, and most government services activities.

When UPlan was applied at DVRPC, new methods were developed to statistically allocate the various development types to specific geographical locations (see *Development and Calibration of the UPlan Land Use Planning Model*; Publication # 05017, DVRPC 2005). UPlan's GIS-based transportation/land use model was calibrated based on historical transportation and land use interactions. UPlan is intended to estimate the effect of existing and proposed transportation facilities on land use patterns, as recommended by federal guidelines. The calibrated model can be thought of as an approximate and synthetic land use market which emulates developer decisions, given the existing and proposed transportation systems, land use plans, and policies. This type of analysis promotes smart growth objectives and the economic viability of the DVRPC region through the efficient use of transportation infrastructure.

UPlan is generally consistent with the DVRPC planning process. This type of analysis allows the planner to visualize the hidden landscape effects of socio-economic forces under alternative environmental and policy constraints. UPlan is not intended to produce definitive development recommendations, particularly for individual land use parcels. Rather, UPlan is intended to assist in making land planning choices given the transportation infrastructure, environmental constraints, as well as local community and developer preferences.

A limited implementation of UPlan is deployed in two pilot studies in Gloucester County, NJ to validate the calibrated model. The first pilot study is a rule-based zoning build-out analysis. The US 322 corridor, between the Commodore Barry Bridge and the Mantua/Glassboro border, is

built-out under three rule-based development alternatives -- Sewer Constrained, Corridor Constrained, and Maximum Build-out. The 2030 scenarios are summarized by transportation analysis zone (TAZ) and input to the travel demand model (TDM). The second pilot study tests UPlan's transportation/land use feedback capability. The NJ 55 corridor is selected for this test because the freeway opened for traffic in 1989, one year before DVRPC's initial land use inventory was collected. By using UPlan to forecast 2030 land use from the1990 initial land use inventory, land use changes at each NJ 55 interchange can be compared with the actual changes recorded in the 2005 Land Use Inventory, thereby validating the UPlan output. As part of this UPlan pilot study, the effect of building the proposed NJ Transit River LINE light rail transit (LRT) extension into Gloucester County was also tested to determine the models sensitivity to transit improvements.

The fully implemented UPlan model is employed in a regional scenario analysis. Four land use scenarios are tested as part of this analysis: the Trend scenario is an unconstrained allocation of the DVRPC Board-adopted 2035 forecasts to developable land, the Sprawl scenario spreads low density development among the remaining open space in the suburban and rural portions of the region, the Recentralization scenario assigned projected growth at high density in central urban areas and inner ring suburbs, finally the Growth Area scenario allocates Board-adopted development to designated future growth areas (FGA) identified in the *Destination 2030: The Year 2030 Plan for the Delaware Valley*. Additionally, the DVRPC TDM is applied for each of the land use scenarios to estimate impacts on the transportation system and, by extension, environment. All four scenarios assume the same "existing plus committed" highway and transit networks which include existing (2005) highway facilities and public transit routes plus committed facility improvements that will be in service by 2009. The differences between scenarios are principally characterized at the TAZ level demographic and employment estimates prepared by the UPlan land use scenario methodology. These alternate socioeconomic data sets are input to the TDM, including the mobile source emissions postprocessor, and simulated separately for each land use scenario. The simulated travel patterns and resulting highway link and transit line volumes are then summarized to quantify the impacts of each land use scenario. A summary is configured as a simple goals achievement matrix, centered on the Trend scenario as the point of reference for this analysis because it represents the 2035 regional outcome, without additional planning interventions.

Introduction

This report completes the documentation of the UPlan calibration process and presents the development and application of a generalized forecasting methodology for applying UPlan in ongoing Delaware Valley Regional Planning Commission (DVRPC) studies. UPlan is a Geographic Information System (GIS) based land use planning and forecasting model with a sophisticated embedded transportation/land use interface. The implementation strategy involves emulating ongoing DVRPC land use and transportation planning activities in UPlan, as much as possible, while implementing the transportation/land use linkage recommended by federal guidelines. Ultimately, the goal is to integrate UPlan into ongoing regional, county, and local land use/transportation planning activities.

Chapter II presents an overview of the UPlan model and documents the final calibration of land consumption parameters for eight of DVRPC's nine member counties[1]. A short discussion of the parameter estimates and interpretation follows. **Chapter III** describes the results of a series of UPlan validation exercises which are intended to develop a forecasting methodology that replicates DVRPC socioeconomic forecasts, as much as possible, using the final Gloucester County, NJ UPlan implementation as a basis. The methodology incrementally incorporates additional elements of *Destination 2030: The Year 2030 Plan for the Delaware Valley* (Destination 2030); comparing the resulting UPlan minor civil division (MCD) population and employment forecasts with DVRPC Board-adopted forecasts (Board-forecast) at each stage in the process.

Chapter IV of the report documents the results of two UPlan pilot studies also conducted with the final Gloucester County, NJ calibration. First, US 322 Corridor Built-Out Analysis conducted for Swedesboro Borough and the surrounding townships of Harrison, Logan, and Woolwich. The second pilot is a land use/transportation impact study in the NJ 55 corridor. This study is conducted to validate the transportation/land use interface within UPlan by estimating the land use effects of opening the NJ 55 Freeway (in 1989) and proposed NJ TRANSIT River LINE light rail transit (LRT) Extension to Glassboro. **Chapter V** presents a comprehensive technical explanation of UPlan's deployment in a scenario analysis that will inform the 2035 regional plan to be published under the title *Connections: The Regional Plan for a Sustainable Future* (Connections).

Chapter VI presents the conclusions of these efforts, as well as a glossary of terms.

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[1] Philadelphia County is largely built-out and the new footprint development changes between 1990 and 2000 were not extensive enough to support calibration in UPlan.

Appendix A lists the final UPlan generalized calibration parameters while the final MCD policy coefficients are presented in **Appendix B**. **Appendix C** contains the detailed zoning and development density value units in US 322 Corridor Build-out study. The UPlan input parameters are given in **Appendix D**. An explanation of the travel demand model (TDM) is provided in **Appendix E**.

Finalization of Parameters

UPlan Primer

UPlan is a Geographic Information System (GIS) based[2] land development model used for long-range regional planning and scenario testing. UPlan uses population and employment parameters to forecast demand for new footprint development associated with long-term regional growth. New footprint development consumes previously undeveloped land to satisfy land development demand due to population and employment growth. The allocation area is given by assuming new footprint development can occur only in pre-specified locations; for instance, where land is vacant, wooded, or in agricultural use. The allocation area can be considered land available for development. UPlan then evaluates land development attractors and development discouragements tailored to each parcel available for development. Each attractor and discouragement is assigned a weight representing the magnitude of effect and a buffer width representing the area of effect; these scores are then summed to generate a single net attractiveness value. Parcels with high net attractiveness can be considered prime for development. Finally, certain areas that are unsuited to development can be excluded from the allocation area by using a mask. These masks prevent UPlan from allocating development of any kind to that location even if it is highly attractive. Masks represent policy decisions to reserve land from development or conditions that preclude development. Attractiveness and discouragement factors have unique values for each development type while masks prohibit all development (see Appendix A for all attraction and discouragement layers and parameters). After net attractiveness is calculated, UPlan allocates the most attractive land to each development type. This allocation order generally reflects bidding power in the land use market.

Calibrating UPlan

Before forecasts can be prepared with UPlan, the model calibration must be finalized and validated. Calibrating the model involves using survey data to test the quality and accuracy of the model output. During calibration, parameters are adjusted to reflect realities and the model as a whole is tuned to reproduce the observed changes in the land use survey.

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[2] UPlan uses raster data with 50 x 50 meter cell size.

UPlan Forecasting Masks[3]

- Water bodies
- Streams
- Flood plains
- Wetlands
- Existing development
- Preserved open space

Modeling the land market is a tall order. To overcome these challenges, the modeler must begin with the assumption that actual land development patterns are given over the calibration period. The modeler then works backward from the known data to derive a set of parameters that generates the correct type of development in each parcel as accurately as possible. For the UPlan calibration, the allocation area is limited to parcels that developed between 1990 and 2000; that is to say, the difference between the 2000 urbanized footprint and the 1990 urbanized footprint recorded in the DVRPC land use survey. For example, a parcel near a freeway interchange is known to have developed low density commercial in the land use survey. UPlan model should be calibrated to allocate low density commercial to this parcel rather than industrial or residential. Successive runs with modified attraction and discouragement parameter values will cause the model to allocate land uses differently. This process is repeated until a satisfactory allocation is obtained.

UPlan Allocation Hierarchy

1. Industrial
2. High Density Commercial
3. High Density Residential
4. Low Density Commercial
5. Medium Density Residential
6. Low Density Residential
7. Very Low Density Residential (not used in the DVRPC implementation)

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[3] These masks have been updated from the previous UPlan report (Development and Calibration of the UPlan Land Use Planning Model; Publication # 05017, DVRPC 2005) to include gains in open space and agricultural preservation. As stated in Destination 2030, these gains are not entirely due to additional preservation. Some are due to more accurate mapping techniques.

UPlan Land Use Allocation Factors

- Highway and public transportation networks
- Highway congestion
- Clustering of like land uses
- MCD land development policy[4]
- Existing and proposed sewer service areas[5]

The final step is to refine the population and employment density factors to reproduce land consumption as recorded in the DVRPC land use survey. This is a trial and error process that uses incremental changes to the inputs by category while comparing the simulation with the survey. For instance, in the Gloucester County calibration, the industrial floor area ratio had to be significantly decreased while the square foot allocation per employee had to be increased to match consumption levels measured in the 2000 land use inventory. When the allocation areas reach full build-out, the density parameters are finalized and recorded. Final calibration will include a set of attractiveness/discouragement factors and a set of development density parameters unique to each county. In the forecasting stage, the calibrated model is applied to project land use patterns into the future. A well calibrated model (i.e. a model that can replicate observed settlement patterns) will be able predict future outcomes with reasonable accuracy and reliability.

The final calibration parameters are presented in two tables that are discussed in detail in the next section. Table 1 presents the calibration parameters for each county. Table 2 reports the allocation for each county compared to census data. Finally, generalized region wide attraction and discouragement parameters have been refined from those in the 2005 UPlan report (see *Development and Calibration of the UPlan Land Use Planning Model;* Publication # 05017, DVRPC 2005) and in a few cases, disaggregated by county. The updated county parameters are listed in Appendix A, tables A-1 through A-3. As a result of imposing the build-out development density coefficients listed in Table 1, it is necessary to refine the MCD attractor/discouragement parameters from the initial values documented in the calibration report. These coefficients represent MCD land policy parameters and are given in Appendix B, tables B-1 through B-8.

Estimated Development Density

Actual 1990 to 2000 population and employment growth and the associated development density parameters are given in Table 1. The counties are categorized as growing or stable according to these parameter estimates. Stable counties developed in the pre-World War II period as a consequence of Philadelphia's powerful industrial economy with growth concentrated in and

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[4] Minor Civil Divisions weights are calibrated to produce the optimal land allocation configuration and not necessarily consistent with the MCD comprehensive plan or history of development.
[5] Perfect correlation between development and sewers preclude sewer data from being used in the calibration. This is added once the model is updated for forecasting (see Chapter II).

around Philadelphia proper, Camden City (Camden County), Chester City (Delaware County), and Trenton (Mercer County). Slow population growth rates, balanced residential densities, and significant industrial employment characterize stable counties.

Growing counties began to develop in the post-war period as a consequence of industrial decline and the rise of the automobile as the primary mode of transportation. High population growth rates, low residential densities, and significant employment in low density commercial characterize growing counties. Bucks County, Chester County, Montgomery County, Gloucester County, and Burlington County fall into this category.

Analysis of Residential Estimates

The overall rate of population growth in Pennsylvania counties during the 1990's is twice the amount that is seen in New Jersey counties (approximately 21,000 persons/year and 10,000 persons/year respectively).

- Growing versus stable counties in Pennsylvania (see Table 1):
    - Montgomery (7,087 persons/year), Bucks (6,280 persons/year), and Chester counties (5,810 persons/year) grew rapidly in the 1990's compared to stable Delaware County (1,960 persons/year).
    - The distribution of residential densities show stable Delaware County is more densely populated (60 percent in high/medium) than the growing counties: Bucks (42 percent in high/medium), Chester (38 percent in high/medium), or Montgomery counties (23 percent in high/medium).
- Stable versus growing counties in New Jersey (see Table 1):
    - Stable Camden County (2,190 persons/year) added population slowly compared to growing Burlington County (2,833 persons/year) while Mercer County (2,492 population/year) and Gloucester County (2,563 persons/year) make moderate gains.
    - The distribution of residential densities show the growing counties of Gloucester (40 percent) and Burlington (43 percent) both have a relatively low share of high and medium density residential while Camden (57 percent) and Mercer (61 percent) hosts a greater portion of these densities.
- Residential development density categories are calibrated for each county. In general, stable counties exhibit less land consumption per low density housing unit than growing counties in both states. Compare the stable counties of Delaware (0.7 acres/unit), Mercer (0.5 acres/unit), and Camden (0.3 acres/unit) to growing counties of Bucks (1.0 acres/unit), Chester (1.1 acres/unit), Gloucester (0.8 acres/unit), and Burlington (0.65 acres/unit). Montgomery County does not fit this pattern (0.5 acres/unit). This trend can be seen at other densities as well. These figures show that currently growing counties are consuming more acreage per housing unit, at all densities, than currently stable counties.

Table 1. UPlan Parameters by County [Calibration Interval 1990 – 2000][6]

UPlan Inputs	Pennsylvania Counties				New Jersey Counties			
	Growing			Stable	Growing		Stable	
	Bucks County	Chester County	Montgomery County	Delaware County	Burlington County	Gloucester County	Camden County	Mercer County
Base Year Population (1990 Census)	541,174	376,396	678,111	547,651	395,066	230,082	502,824	325,824
Calibration Year Population (2000 Census)	603,967	434,492	748,977	567,256	423,397	255,719	524,730	350,752
Persons per Household (2000 Census)	2.40	2.44	2.62	2.40	2.35	2.25	2.15	2.79
% Households in Residential: High Density	20.0%	15.2%	17.2%	28.7%	20.2%	17.2%	20.2%	24.5%
% Households in Residential: Medium Density	22.0%	22.6%	22.6%	30.8%	22.6%	22.6%	37.1%	37.5%
% Households in Residential: Low Density	56.0%	57.2%	55.2%	40.5%	52.2%	55.2%	40.2%	38.2%
% Households in Residential: Very Low Density	2.0%	5.0%	5.0%	0.0%	5.0%	5.0%	2.5%	0.0%
Avg. High Density Lot size (Acres)	0.15	0.12	0.10	0.10	0.14	0.11	0.09	0.09
Avg. Medium Density Lot size (Acres)	0.50	0.45	0.16	0.25	0.18	0.22	0.14	0.16
Avg. Low Density Lot size (Acres)	1.00	1.10	0.65	0.70	0.65	0.80	0.30	0.50
Avg. Very Low Density Lot size (Acres)	2.50	2.00	2.00	2.00	2.00	2.00	1.50	2.00
ΔEmployment per ΔHousehold	1.27	2.09	1.05	2.91	2.12	1.4	1.14	1.33
% Vacant	5%	5%	5%	5%	5%	5%	5%	5%
% Employment: Industrial	4.3%	0.1%	5.0%	8.2%	0.1%	5.0%	0.1%	11.7%
% Employment: High Density Commercial	12.0%	22.3%	7.4%	13.3%	22.3%	7.4%	22.3%	60.8%
% Employment: Low Density Commercial	83.7%	77.6%	87.6%	78.5%	77.6%	87.6%	77.6%	26.7%
Sq. Ft. Industrial	1,000	600	600	675	300	1,800	300	500
Sq. Ft. High Density Commercial	400	375	600	350	200	400	450	200
Sq. Ft. Low Density Commercial	450	450	600	450	300	500	525	300
Floor Area Ratio: Industrial	0.16	0.17	0.17	0.2	0.25	0.16	0.2	0.23
Floor Area Ratio: High Density Commercial	0.3	0.2	0.17	0.3	0.35	0.17	0.17	0.35
Floor Area Ratio: Low Density Commercial	0.1	0.14	0.1	0.2	0.25	0.1	0.12	0.15

Source: DVRPC July 2009

[6] Employment per Household is 1990 – 2000 Census change in employment per change in households (excluding existing development)- not overall employment per household

Table 2. UPlan Land Area Allocations by County and Development Type

Pennsylvania												
Land Uses	Bucks County			Chester County			Delaware County			Montgomery County		
	Development Increment	UPlan Allocation	Percent Allocated	Development Increment	UPlan Allocation	Percent Allocated	Development Increment	UPlan Allocation	Percent Allocated	Development Increment	UPlan Allocation	Percent Allocated
Industrial	381	380	**99.7%**	-373	10	n/a	347	351	101.2%	293	304	103.8%
Commercial: High/Low	6,682	6,862	**102.7%**	7,741	7,713	99.6%	2,464	2,439	99.0%	9,347	9,500	101.6%
Residential: High	2,259	2,210	**97.8%**	750	764	101.9%	416	413	99.3%	944	932	98.7%
Residential: Med/Low	29,927	28,921	**96.6%**	34,424	34,587	100.5%	5,252	5,203	99.1%	26,042	26,526	101.9%
Total	**39,249**	**38,373**	**97.8%**	**42,542**	**43,074**	**101.3%**	**8,479**	**8,406**	**99.1%**	**36,626**	**37,262**	**101.7%**
Households Employment	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**
Households	28,550	28,413	99.5%	24,806	25,833	104.1%	8,748	8,901	**101.7%**	31,124	33,489	107.6%
Employment	36,272	36,120	99.6%	51,779	54,143	104.6%	25,599	25,891	**101.1%**	35,172	35,268	100.3%

New Jersey												
Land Uses	Mercer County			Burlington County			Gloucester County			Camden County		
	Development Increment	UPlan Allocation	Percent Allocated	Development Increment	UPlan Allocation	Percent Allocated	Development Increment	UPlan Allocation	Percent Allocated	Development Increment	UPlan Allocation	Percent Allocated
Industrial	71	112	157.7%	-164	2	**-1.2%**	490	479	**97.8%**	0	2	n/a
Commercial: High/Low	1,481	1,455	98.2%	1,546	1,439	**93.1%**	3,883	3,865	**99.5%**	2,463	2,462	100.0%
Residential: High	1,081	1,109	102.6%	633	601	**94.9%**	366	379	**103.6%**	310	325	104.8%
Residential: Med/Low	6,103	6,026	98.7%	10,039	10,218	**101.8%**	11,960	11,752	**98.3%**	3,684	3,771	102.4%
Total	**8,736**	**8,702**	**99.6%**	**12,054**	**12,260**	**101.7%**	**16,699**	**16,475**	**98.7%**	**6,457**	**6,560**	**101.6%**
Households Employment	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**	**1990-2000 Growth**	**UPlan Allocation**	**Percent Allocated**
Households	8,875	8,904	100.3%	12,380	13,141	106.1%	12,380	12,352	99.8%	10,837	11,098	102.4%
Employment	13,699	13,601	99.3%	27,822	27,770	99.8%	17,629	17,323	98.3%	12,378	12,661	102.3%

Source: DVRPC July 2009

Analysis of Commercial Estimates

Excluding job losses in Philadelphia, the absolute rate of growth in employment in Pennsylvania's suburban counties during the 1990's is much higher than seen in New Jersey -- approximately 10,500 jobs/year versus 1,500 jobs/year, respectively. In percentage terms, suburban Pennsylvania employment is growing much faster than New Jersey – 0.9 versus 0.2 percent per year (see Table 2). Looking at the change between 1990 and 2000:

- Delaware County (2.91) has a higher than average (1.70) ratio of jobs-to-households suggesting that many new residents commute to Delaware County from other counties.
- Bucks County has a relatively low jobs-to-households (1.27) ratio suggesting new residents commute away from Bucks County to work.
- Camden County diverges from expected results in two major indicators (during the calibration interval): low jobs-to-households ratio (1.14) and low industrial employment (0.1 percent). This suggests sustained economic decline such that the residents must look to other counties for work.
- Gloucester County has notably high industrial square footage per employee (1,800). This indicates a concentration of automated warehouses involving relatively few employees working in a large facility, particularly along I-295.

Surveyed Versus Simulated Land Development

Table 2 also presents land consumption statistics from the finalized calibrated model run for each county presented next to actual development as determined by the DVRPC land use inventory. The 1990 and 2000 inventories are 'rasterized' to 50-meter grids and then clipped of pre-1990 development to show the new footprint development. This is listed as the "Development Increment." The next two columns show the "UPlan Allocation" and the percent of actual development allocated. Overall, the calibration density parameters result in UPlan land area (as measured by 50-meter grids) allocation that closely match the surveyed increment of new footprint development between 1990 and 2000. All allocation errors are within five percent of actual, and the density parameters should give an accurate indication of the land area consumption associated with forecast county totals of population and employment.

Forecasting Methodology

The forecasting trials for Gloucester County, NJ include incrementally adding components of the DVRPC long-range plan, Destination 2030, and monitoring UPlan's ability to replicate Board-forecasts of population and employment associated with projected growth from 2000 to 2030.

Methodology to Include Sewers

The attractiveness factors associated with sewers could not be estimated during the model calibration because virtually all parcels that develop over the calibration period have sewer access. Running simulations (Sim #) with several variations of the sewer area allocation parameters allows selecting the variation most compatible with land use policies in Destination 2030. Adding a "non-sewer area" mask is not necessarily correct because sewer systems can be extended to serve new development over the study period. Introducing a sewer area attractor with an associated buffer area allows UPlan to consider proximity to existing sewer systems as well. For comparison purposes, a base case without sewers was made followed by several simulations with variations of sewer inclusion and the results analyzed. The forecast will be deemed acceptable if forecast 2030 population and employment is compatible with Board-forecasts at the minor civil division (MCD) level. Table 3 compares UPlan forecasts of MCD level population and employment estimates with the corresponding Board-forecasts to generate error statistics. A difference of one-third or greater is considered significant.

A series of five simulations were prepared for Gloucester County to determine the most appropriate way to incorporate sewer service into UPlan forecasts.

- Simulation 4: The base case. This simulation produced a population estimate 21.1 percent different from Board-forecast and an employment 35.0 percent different from Board-forecast.
- Simulation 5: Sewers are introduced with a buffer width of 3,000 feet and a weight of 15. Compared to the base case (Sim 4), this leads to a slightly greater difference from Board-forecast population (21.4 percent) and employment (33.5 percent) estimates leading to an overall worse fit compared to Sim 4.
- Simulation 6: The opposite approach is used in the next trial (Sim 6) where non-sewered areas are masked. This generates slightly greater population (21.4 percent) and slightly smaller employment (33.5 percent) differences from Board-forecast when compared to the base case; results are nearly identical to Sim 5.

- Simulation 7: Sewer attraction weight is doubled from 15 to 30. This produces population estimates (21.2 percent) and employment estimates (33.1 percent) that are the least different from Board-forecasts compared to Sim #4.

- Simulation 8: Increase sewer attraction weight to 50. In this iteration, population (21.1 percent) and employment (33.3 percent) differences improve slightly over Sim #4.

As seen by the comparison, Sim #7 is the most compatible variation with the Board-forecast because it improves employment while maintaining comparable population forecasts overall.

Table 3. 2030 Sewer Area Simulation Methodology

Sim #	Model Characteristics	Population Average Difference	Employment Average Difference
4	Base Case	21.1%	35.0%
5	Sewer Attractor (3,000 ft; 15 weight)	21.4%	33.5%
6	Non-Sewer Mask	21.4%	33.5%
7	Sewer Attractor (3,000 ft; 30 weight)	21.1%	33.1%
8	Sewer Attractor (3,000 ft; 50 weight)	21.1%	33.3%
9	Sim 7 + Proposed Open Space Mask	16.8%	35.8%
10	Sim 7 + Allocate to 2030 Growth Areas	18.5%	25.6%

Source: DVRPC July 2009

Simulations to Include Additional Plan Elements

Two additional simulations are included to test the remaining elements of Destination 2030. These elements are added to the configuration finalized in Sim #7. The results are also shown in Table 3 above:

- Sim #9: Includes Proposed Open Space mask. This scenario assumes policies are implemented to achieve the Open Space goals of Destination 2030. Adding this mask improves population forecasts versus Sim #7 (16.8 percent and 21.1 percent, respectively) while employment forecasts suffer slightly against Sim #7, 35.8 percent and 33.1 percent, respectively.

- Sim #10: Substitutes Destination 2030 FGAs for the allocation area. This scenario assumes MCD policies effectively direct growth into these areas that, if implemented, will cut land consumption in half over the simulation period. When allocation is limited to these areas, population forecasts (18.5 percent) are made slightly worse than Sim #9 but still better than Sim #7 (21.1 percent). However, employment forecasts improve significantly over all previous simulations (25.6 percent vs. 33.1 percent).

Outlier Analysis for Simulation: 4, 7, and 10

UPlan population and employment forecasts produce five significant population outliers (see tables 4 and 5) when compared to the Board-forecast. These include Greenwich, Harrison, Logan, Mantua, and Woolwich townships. However, Board-forecasts predict Greenwich Township will lose population over the study period. UPlan cannot take this decline into account and making this correction will bring the percent difference back into an acceptable range. On the other hand, Logan Township is notable because of the extremely high forecast. UPlan forecasts Logan Township will add ten times the number of additional residents as the Board-forecast. Employment forecasts show six significant outliers: Elk, Mantua, Monroe, South Harrison, and West Deptford townships, as well as National Park Borough. Here, the most extreme error is South Harrison Township. UPlan forecasts nearly 3,000 new jobs by the year 2030; while the Board-forecasts show only modest growth, less than 500 new jobs. Destination 2030 classifies South Harrison Township as a “rural area” and as such, is the target of agricultural preservation and smart growth initiatives to limit such rapid commercial expansion.

Sim #7 results are similar to Sim #4 but with some improvements. Population forecasts include the same five outliers (see Table 6): Greenwich, Harrison, Logan, Mantua, and Woolwich townships. Again, the same exception applies for Greenwich Township as in Sim #4. Employment forecasts show some improvement over Sim #4 (see Table 7). Outliers include following townships: Elk, Mantua, Monroe, South Harrison, and West Deptford. National Park Borough error falls to within acceptable range. Note the improvement in Harrison and Woolwich townships.

Sim #10 (see tables 8 and 9) showed across the board improvements in the benchmarks of acceptability in population and employment forecasts. With respect to the population forecast, Logan Township’s difference from the Board-forecast is vastly improved over Sim #7. Also note the changes in Clayton Borough and Mantua Township. At the same time, two previously unproblematic townships have joined the outliers: Deptford and East Greenwich townships. Employment results show improvements in the following MCDs: South Harrison Township, Wenonah Borough, and West Deptford Township along with National Park Borough. While West Deptford and South Harrison townships employment estimates remain significantly different from Board-forecasts, the increased compatibility cannot be overlooked. Woolwich Township also joins the outliers in this simulation.

Table 4. Gloucester County Population Allocation: UPlan Sim #4

Gloucester County	*Board Adopted 2000 Pop.*	*Board Adopted 2030 Pop.*	*Board Adopted Change 2000-2030*	*Percent Change 2000-2030*	*UPlan Forecast 2030 Pop.*	*Forecast Change Pop.*	*Difference (negative)*	*Percent Difference*
Clayton Borough	7,139	10,205	3,066	42.9%	7,391	252	(2,814)	-27.6%
Deptford Township	26,763	30,240	3,477	13.0%	30,404	3,641	164	0.5%
East Greenwich Township	5,430	7,290	1,860	34.3%	6,186	756	(1,104)	-15.1%
Elk Township	3,514	6,885	3,371	95.9%	4,803	1,289	(2,082)	-30.2%
Franklin Township	15,466	20,700	5,234	33.8%	20,772	5,306	72	0.3%
Glassboro Borough	19,068	25,455	6,387	33.5%	20,180	1,112	(5,276)	-20.7%
Greenwich Township	4,879	4,640	-239	-4.9%	6,207	1,328	1,567	33.8%
Harrison Township	8,788	17,485	8,697	99.0%	24,178	15,390	6,693	38.3%
Logan Township	6,032	7,320	1,288	21.4%	19,231	13,199	11,911	162.7%
Mantua Township	14,217	19,855	5,638	39.7%	27,845	13,628	7,990	40.2%
Monroe Township	28,967	43,735	14,768	51.0%	40,532	11,565	(3,203)	-7.3%
National Park Borough	3,205	3,130	-75	-2.3%	3,234	29	104	3.3%
Newfield Borough	1,616	1,650	34	2.1%	1,634	18	(16)	-1.0%
Paulsboro Borough	6,160	5,670	-490	-8.0%	6,192	32	522	9.2%
Pitman Borough	9,331	9,480	149	1.6%	9,367	36	(113)	-1.2%
South Harrison Township	2,417	3,945	1,528	63.2%	5,106	2,689	1,161	29.4%
Swedesboro Borough	2,055	2,240	185	9.0%	2,062	7	(178)	-8.0%
Washington Township	47,114	56,450	9,336	19.8%	55,729	8,615	(721)	-1.3%
Wenonah Borough	2,317	2,440	123	5.3%	2,328	11	(112)	-4.6%
West Deptford Township	19,368	24,610	5,242	27.1%	21,834	2,466	(2,776)	-11.3%
Westville Borough	4,500	4,685	185	4.1%	4,516	16	(169)	-3.6%
Woodbury City	10,307	9,600	-707	-6.9%	10,341	34	741	7.7%
Woodbury Heights Borough	2,988	2,870	-118	-3.9%	3,008	20	138	4.8%
Woolwich Township	3,032	16,510	13,478	444.5%	9,251	6,219	(7,259)	-44.0%
County Total	**254,673**	**337,090**	**82,417**	**32.4%**	**342,329**	**87,656**	**5,239**	**NA**

Source: DVRPC July 2009

Table 5. Gloucester County Employment Allocation: UPlan Sim #4

Gloucester County	*Board Adopted 2000 Emp.*	*Board Adopted 2030 Emp.*	*Board Adopted Change 2000-2030*	*Percent Change 2000-2030*	*UPlan Forecast 2030 Emp.*	*Forecast Change Emp.*	*Error (negative)*	*Percent Error*
Clayton Borough	1,863	2,705	842	45.2%	1,863	-	(842)	-31.1%
Deptford Township	12,508	14,605	2,097	16.8%	15,469	2,961	864	5.9%
East Greenwich Township	1,408	2,033	625	44.4%	1,408	-	(625)	-30.7%
Elk Township	676	1,622	946	140.0%	3,255	2,579	1,633	100.6%
Franklin Township	3,099	4,229	1,130	36.5%	3,099	-	(1,130)	-26.7%
Glassboro Borough	8,045	8,987	942	11.7%	8,045	-	(942)	-10.5%
Greenwich Township	3,263	3,554	291	8.9%	3,263	-	(291)	-8.2%
Harrison Township	2,285	5,167	2,882	126.1%	4,732	2,447	(435)	-8.4%
Logan Township	6,176	10,965	4,789	77.5%	9,531	3,355	(1,434)	-13.1%
Mantua Township	6,701	11,243	4,542	67.8%	6,701	-	(4,542)	-40.4%
Monroe Township	7,377	9,737	2,360	32.0%	16,609	9,232	6,872	70.6%
National Park Borough	327	324	-3	-1.0%	443	116	119	36.8%
Newfield Borough	730	737	7	0.9%	730	-	(7)	-0.9%
Paulsboro borough	2,408	2,599	191	7.9%	2,408	-	(191)	-7.4%
Pitman Borough	3,077	2,770	-307	-10.0%	3,077	-	307	11.1%
South Harrison Township	384	869	485	126.3%	3,294	2,910	2,425	279.1%
Swedesboro Borough	2,356	2,635	279	11.9%	2,571	215	(64)	-2.4%
Washington Township	11,875	18,374	6,499	54.7%	13,061	1,186	(5,313)	-28.9%
Wenonah Borough	675	861	186	27.6%	692	17	(169)	-19.6%
West Deptford Township	9,107	13,086	3,979	43.7%	22,203	13,096	9,117	69.7%
Westville Borough	2,547	2,323	-224	-8.8%	2,547	-	224	9.6%
Woodbury City	10,194	10,480	286	2.8%	10,216	22	(264)	-2.5%
Woodbury Heights Borough	1,479	1,266	-213	-14.4%	1,479	-	213	16.8%
Woolwich Township	907	4,457	3,550	391.4%	4,049	3,142	(408)	-9.2%
County Total	**99,467**	**135,627**	**36,160**	**36.4%**	**140,745**	**41,278**	**5,118**	**NA**

Source: DVRPC July 2009

Table 6. Gloucester County Population Allocation: UPlan Sim #7

Gloucester County	Board Adopted 2000 Pop.	Board Adopted 2030 Pop.	Board Adopted Change 2000-2030	Percent Change 2000-2030	UPlan Forecast 2030 Pop.	Forecast Change Pop.	Difference (negative)	Percent Difference
Clayton Borough	7,139	10,205	3,066	42.9%	7,391	252	(2,814)	-27.6%
Deptford Township	26,763	30,240	3,477	13.0%	30,622	3,859	382	1.3%
East Greenwich Township	5,430	7,290	1,860	34.3%	6,319	889	(971)	-13.3%
Elk Township	3,514	6,885	3,371	95.9%	4,851	1,337	(2,035)	-29.5%
Franklin Township	15,466	20,700	5,234	33.8%	18,798	3,332	(1,902)	-9.2%
Glassboro Borough	19,068	25,455	6,387	33.5%	20,303	1,235	(5,152)	-20.2%
Greenwich Township	4,879	4,640	-239	-4.9%	6,258	1,379	1,618	34.9%
Harrison Township	8,788	17,485	8,697	99.0%	25,510	16,722	8,025	45.9%
Logan Township	6,032	7,320	1,288	21.4%	19,242	13,210	11,922	162.9%
Mantua Township	14,217	19,855	5,638	39.7%	28,221	14,004	8,366	42.1%
Monroe Township	28,967	43,735	14,768	51.0%	40,645	11,678	(3,091)	-7.1%
National Park Borough	3,205	3,130	-75	-2.3%	3,234	29	104	3.3%
Newfield Borough	1,616	1,650	34	2.1%	1,666	50	16	0.9%
Paulsboro borough	6,160	5,670	-490	-8.0%	6,192	32	522	9.2%
Pitman Borough	9,331	9,480	149	1.6%	9,363	32	(118)	-1.2%
South Harrison Township	2,417	3,945	1,528	63.2%	3,279	862	(666)	-16.9%
Swedesboro Borough	2,055	2,240	185	9.0%	2,075	20	(165)	-7.4%
Washington Township	47,114	56,450	9,336	19.8%	56,769	9,655	319	0.6%
Wenonah Borough	2,317	2,440	123	5.3%	2,335	18	(105)	-4.3%
West Deptford Township	19,368	24,610	5,242	27.1%	21,980	2,612	(2,630)	-10.7%
Westville Borough	4,500	4,685	185	4.1%	4,525	25	(160)	-3.4%
Woodbury City	10,307	9,600	-707	-6.9%	10,370	63	770	8.0%
Woodbury Heights Borough	2,988	2,870	-118	-3.9%	3,004	16	134	4.7%
Woolwich Township	3,032	16,510	13,478	444.5%	9,420	6,388	(7,090)	-42.9%
County Total	**254,673**	**337,090**	**82,417**	**32.4%**	**342,369**	**88,470**	**5,279**	**NA**

Source: DVRPC July 2009

Table 7. Gloucester County Employment Allocation: UPlan Sim #7

Gloucester County	Board Adopted 2000 Emp.	Board Adopted 2030 Emp.	Board Adopted Change 2000-2030	Percent Change 2000-2030	UPlan Forecast 2030 Emp.	Forecast Change Emp.	Difference (negative)	Percent Difference
Clayton Borough	1,863	2,705	842	45.2%	1,863	-	(842)	-31.1%
Deptford Township	12,508	14,605	2,097	16.8%	15,441	2,933	836	5.7%
East Greenwich Township	1,408	2,033	625	44.4%	1,408	-	(625)	-30.7%
Elk Township	676	1,622	946	140.0%	3,200	2,524	1,578	97.2%
Franklin Township	3,099	4,229	1,130	36.5%	3,099	-	(1,130)	-26.7%
Glassboro Borough	8,045	8,987	942	11.7%	8,045	-	(942)	-10.5%
Greenwich Township	3,263	3,554	291	8.9%	3,263	-	(291)	-8.2%
Harrison Township	2,285	5,167	2,882	126.1%	4,887	2,602	(280)	-5.4%
Logan Township	6,176	10,965	4,789	77.5%	9,619	3,443	(1,346)	-12.3%
Mantua Township	6,701	11,243	4,542	67.8%	6,701	-	(4,542)	-40.4%
Monroe Township	7,377	9,737	2,360	32.0%	16,466	9,089	6,729	69.1%
National Park Borough	327	324	-3	-1.0%	426	99	102	31.6%
Newfield Borough	730	737	7	0.9%	730	-	(7)	-0.9%
Paulsboro borough	2,408	2,599	191	7.9%	2,408	-	(191)	-7.4%
Pitman Borough	3,077	2,770	-307	-10.0%	3,077	-	307	11.1%
South Harrison Township	384	869	485	126.3%	3,063	2,679	2,194	252.5%
Swedesboro Borough	2,356	2,635	279	11.9%	2,571	215	(64)	-2.4%
Washington Township	11,875	18,374	6,499	54.7%	13,029	1,154	(5,345)	-29.1%
Wenonah Borough	675	861	186	27.6%	692	17	(169)	-19.6%
West Deptford Township	9,107	13,086	3,979	43.7%	22,175	13,068	9,089	69.5%
Westville Borough	2,547	2,323	-224	-8.8%	2,547	-	224	9.6%
Woodbury City	10,194	10,480	286	2.8%	10,211	17	(269)	-2.6%
Woodbury Heights Borough	1,479	1,266	-213	-14.4%	1,479	-	213	16.8%
Woolwich Township	907	4,457	3,550	391.4%	4,330	3,423	(127)	-2.8%
County Total	**99,467**	**135,627**	**36,160**	**36.4%**	**140,730**	**41,246**	**5,103**	**NA**

Source: DVRPC July 2009

Table 8. Gloucester County Population Allocation: UPlan Sim #10

Gloucester County	*Board Adopted 2000 Pop.*	*Board Adopted 2030 Pop.*	*Board Adopted Change 2000-2030*	*Percent Change 2000-2030*	*UPlan Forecast 2030 Pop.*	*Forecast Change Pop.*	*Difference (negative)*	*Percent Difference*
Clayton Borough	7,139	10,205	3,066	42.9%	9,117	1,978	(1,088)	-10.7%
Deptford Township	26,763	30,240	3,477	13.0%	42,781	16,018	12,541	41.5%
East Greenwich Township	5,430	7,290	1,860	34.3%	11,701	6,271	4,411	60.5%
Elk Township	3,514	6,885	3,371	95.9%	5,258	1,744	(1,627)	-23.6%
Franklin Township	15,466	20,700	5,234	33.8%	21,892	6,426	1,192	5.8%
Glassboro Borough	19,068	25,455	6,387	33.5%	23,350	4,282	(2,105)	-8.3%
Greenwich Township	4,879	4,640	-239	-4.9%	7,026	2,147	2,386	51.4%
Harrison Township	8,788	17,485	8,697	99.0%	9,798	1,010	(7,687)	-44.0%
Logan Township	6,032	7,320	1,288	21.4%	8,023	1,991	703	9.6%
Mantua Township	14,217	19,855	5,638	39.7%	23,170	8,953	3,315	16.7%
Monroe Township	28,967	43,735	14,768	51.0%	34,781	5,814	(8,954)	-20.5%
National Park Borough	3,205	3,130	-75	-2.3%	3,250	45	120	3.8%
Newfield Borough	1,616	1,650	34	2.1%	1,670	54	20	1.2%
Paulsboro Borough	6,160	5,670	-490	-8.0%	6,441	281	771	13.6%
Pitman Borough	9,331	9,480	149	1.6%	9,763	432	283	3.0%
South Harrison Township	2,417	3,945	1,528	63.2%	2,667	250	(1,278)	-32.4%
Swedesboro Borough	2,055	2,240	185	9.0%	2,156	101	(84)	-3.7%
Washington Township	47,114	56,450	9,336	19.8%	57,678	10,564	1,228	2.2%
Wenonah Borough	2,317	2,440	123	5.3%	2,450	133	10	0.4%
West Deptford Township	19,368	24,610	5,242	27.1%	27,968	8,600	3,358	13.6%
Westville Borough	4,500	4,685	185	4.1%	4,637	137	(48)	-1.0%
Woodbury City	10,307	9,600	-707	-6.9%	10,442	135	842	8.8%
Woodbury Heights Borough	2,988	2,870	-118	-3.9%	3,312	324	442	15.4%
Woolwich Township	3,032	16,510	13,478	444.5%	7,926	4,894	(8,584)	-52.0%
County Total	**254,673**	**337,090**	**82,417**	**32.4%**	**337,255**	**82,582**	**165**	**NA**

Source: DVRPC July 2009

Table 9. Gloucester County Employment Allocation: UPlan Sim #10

Gloucester County	Board Adopted 2000 Emp.	Board Adopted 2030 Emp.	Board Adopted Change 2000-2030	Percent Change 2000-2030	UPlan Forecast 2030 Emp.	Forecast Change Emp.	Difference (negative)	Percent Difference
Clayton Borough	1,863	2,705	842	45.2%	1,865	2	(840)	-31.1%
Deptford Township	12,508	14,605	2,097	16.8%	15,589	3,081	984	6.7%
East Greenwich Township	1,408	2,033	625	44.4%	1,424	16	(609)	-29.9%
Elk township	676	1,622	946	140.0%	3,266	2,590	1,644	101.3%
Franklin Township	3,099	4,229	1,130	36.5%	3,125	26	(1,104)	-26.1%
Glassboro Borough	8,045	8,987	942	11.7%	8,054	9	(933)	-10.4%
Greenwich Township	3,263	3,554	291	8.9%	3,277	14	(277)	-7.8%
Harrison Township	2,285	5,167	2,882	126.1%	5,703	3,418	536	10.4%
Logan Township	6,176	10,965	4,789	77.5%	8,240	2,064	(2,725)	-24.9%
Mantua Township	6,701	11,243	4,542	67.8%	6,764	63	(4,479)	-39.8%
Monroe Township	7,377	9,737	2,360	32.0%	21,200	13,823	11,463	117.7%
National Park Borough	327	324	-3	-1.0%	349	22	25	7.8%
Newfield Borough	730	737	7	0.9%	730	-	(7)	-0.9%
Paulsboro Borough	2,408	2,599	191	7.9%	2,413	5	(186)	-7.2%
Pitman Borough	3,077	2,770	-307	-10.0%	3,086	9	316	11.4%
South Harrison Township	384	869	485	126.3%	384	-	(485)	-55.8%
Swedesboro Borough	2,356	2,635	279	11.9%	2,538	182	(97)	-3.7%
Washington Township	11,875	18,374	6,499	54.7%	16,640	4,765	(1,734)	-9.4%
Wenonah Borough	675	861	186	27.6%	851	176	(10)	-1.2%
West Deptford Township	9,107	13,086	3,979	43.7%	18,348	9,241	5,262	40.2%
Westville Borough	2,547	2,323	-224	-8.8%	2,552	5	229	9.8%
Woodbury City	10,194	10,480	286	2.8%	10,345	151	(135)	-1.3%
Woodbury Heights Borough	1,479	1,266	-213	-14.4%	1,479	-	213	16.8%
Woolwich Township	907	4,457	3,550	391.4%	2,513	1,606	(1,944)	-43.6%
County Total	**99,467**	**135,627**	**36,160**	**36.4%**	**140,735**	**41,268**	**5,108**	**NA**

Source: DVRPC July 2009

Transportation/Land Use Pilot Studies

The implementation of UPlan at Delaware Valley Regional Planning Commission (DVRPC) includes two pilot studies to test the applicability and determine reasonableness and usefulness of the results for ongoing planning work. Both studies utilized the implemented Gloucester County, NJ model described in the previous chapter.

The first pilot study is a rule-based zoning build-out analysis. The US 322 Corridor Build-out Analysis, covering a study area between the Commodore Barry Bridge and the Mantua/Glassboro township border, is built-out according to three rule-based development alternatives: Sewer Constrained, Corridor Constrained, and Maximum Build-out. The 2030 build-out allocations under each scenario were summarized by traffic analysis zone (TAZ) and input to the travel demand model (TDM). The travel simulation is run separately for each alternative. Forecast traffic volumes are then compared with future roadway capacity, including planned improvements, to identify highway deficiencies under each alternative.

The second pilot study, Land Use Impacts of NJ 55 and River LINE Extension, tests UPlan's transportation/land use feedback capability. The NJ 55 corridor is selected for this test because this freeway opened in 1989, one year before the base land use inventory in UPlan's calibration data base was collected. UPlan forecast land use changes at each NJ 55 interchange can be compared with actual changes recorded in the 2005 land use inventory, thereby validating the UPlan output. As part of this UPlan pilot study, the effect of building the proposed NJ Transit River LINE extension into Gloucester County was also tested to determine the models sensitivity to transit improvements.

Pilot Study #1: US 322 Corridor 2030 Build-out Analysis

Three build-out scenarios are developed for the US 322 corridor based on current zoning data for Harrison, Woolwich, and Logan townships, as well as the Borough of Swedesboro. UPlan generated household and employment increments are prepared for each scenario: Sewer Constrained, Corridor Constrained, and Maximum Build-out. All scenarios allocate development to appropriately zoned polygons based on allowed land use and density of development; masking out environmental constraints such as preserved agricultural areas, water bodies, streams, wetlands, and floodplains.

UPlan allocations are summarized by TAZ and input to the TDM. Board-forecasts outside of the US 322 corridor and 2030 travel simulation networks are based on the highway and transit facilities included in Destination 2030. These travel simulations, in addition to the Board-forecast TDM simulation from the 2030 air quality conformity demonstration, provide a basis for analyzing the transportation impact of current zoning in the corridor.

Comparison of UPlan Build-out with Parcel Land Use Analysis

Estimates of US 322 Build-out are made through UPlan and compared to a parcel analysis prepared independently of this study by DVRPC regional planners. The parcel analysis uses zoning polygons, land use characterizations, and zoning density parameters provided by the municipalities along the corridor (Map 1). Both studies are based on identical GIS data depicting water bodies, stream beds, wetlands, flood plains, sewer service areas, and preserved agricultural areas. The principal differences are methodological and involve the characterization of development densities for each zoning polygon. The parcel analysis also uses actual zoned density parameters for each polygon, excludes environmentally sensitive areas, and accounts for any approved deviations from zoning in planned developments. UPlan uses average densities for four categories of residential and three categories of commercial development based on cluster analysis. A comparison of UPlan with the land use analysis development densities by zoning polygon is given in the Appendix C. The residential units/acre inputs to UPlan are as follows:

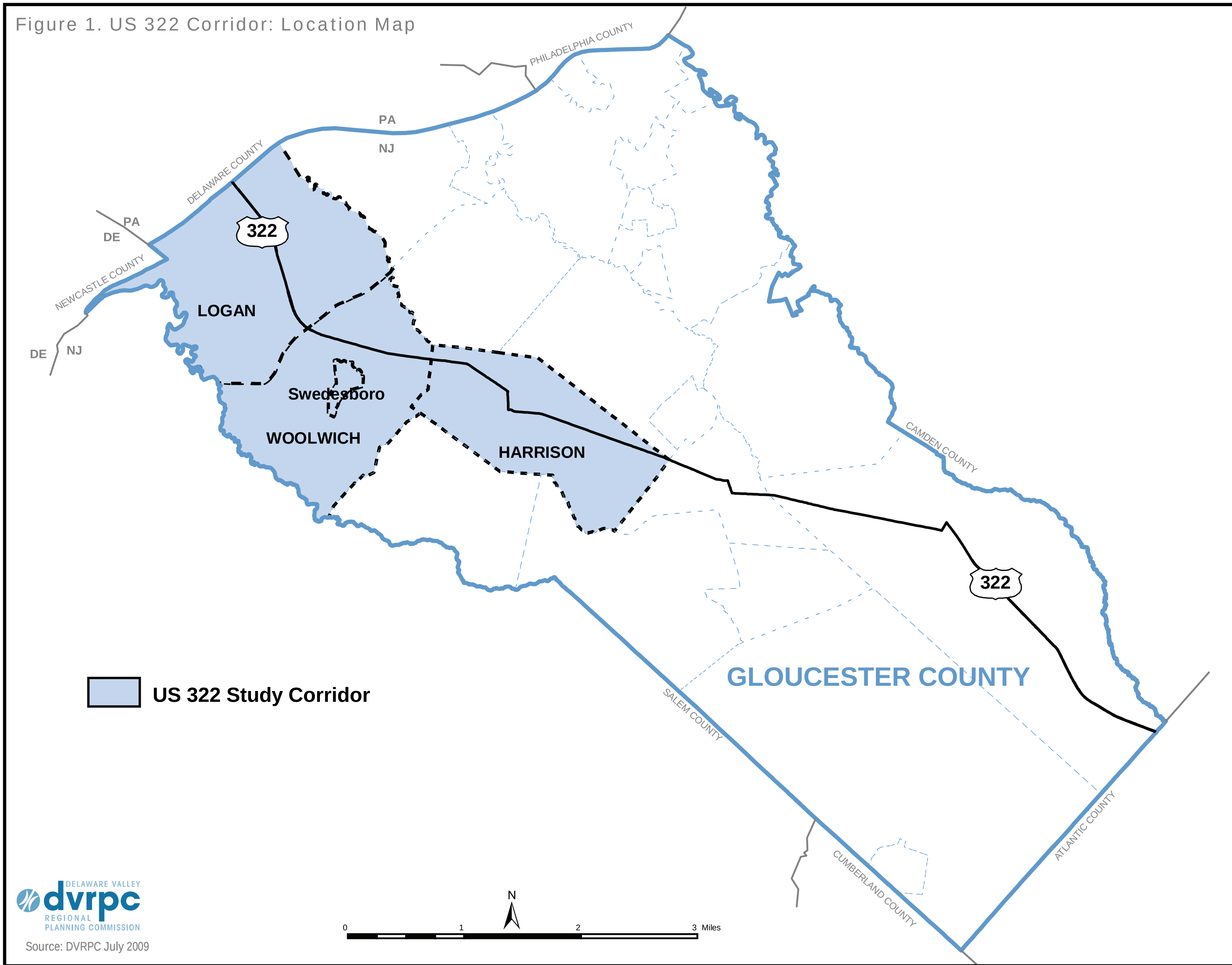
UPlan Density Parameters for Residential Build-out

Residential Category	Units/Acre
▶ High Density	12.5
▶ Medium Density	4.5
▶ Low Density	2.1
▶ Very Low Density	0.6

Table 10 compares UPlan (including a 10 percent reduction for streets) with parcel-level analysis allocations of households and commercial development acres by MCD for the entire US 322 corridor. In total for the corridor, UPlan allocates 1,489 (5 percent) additional households and 74 (2 percent) additional acres of commercial development. By municipality, the principle differences follow:

- In Harrison Township, household allocations are small, 623 (11 percent) fewer households. The commercial acreage differences, 365 (44 percent) acres, are more significant in percentage terms but are counterbalanced by a corresponding underestimate of 400 (20 percent) acres in Logan Township. UPlan was able to find more commercial acres in Harrison Township and correspondingly fewer commercial acres in Logan Township.
- Swedesboro Borough has some large percentage differences in allocated households, -265 units (61 percent) and commercial acres, 44 acres (259 percent), but the absolute differences are small. This represents a small UPlan reallocation of growth from residential to commercial vis-à-vis the land use analysis. Swedesboro Borough is almost totally built out and it has very little land available for new development. UPlan allocations for Woolwich Township are comparable, differing by 6 percent.

Figure 1. US 322 Corridor: Location Map



Source: DVRPC July 2009

Table 10. US 322 Corridor: Uncorrected Maximum Build-out Scenario

Municipality	Maximum Township Wide Build-out						
	UPlan Total Households less 10%	LU Analysis Total Households	Difference	UPlan Commercial Acres 10%	LU Analysis Commercial Acres	Difference	UPlan Total Employment less 10%
Harrison Township	5,119	5,742	-623	1,189	824	365	65,639
Logan Township	2,762	1,656	1,106	1,589	1,988	-400	75,610
Swedesboro Borough	169	434	-265	61	17	44	832
Woolwich Township	23,971	22,700	1,271	1,070	1,005	65	39,926
Total	**32,021**	**30,532**	**1,489**	**3,909**	**3,835**	**74**	**182,006**

Source: DVRPC July 2009

Table 11. US 322 Corridor: Corrected Maximum Build-out Scenario

Municipality	Maximum Township Wide Build-out						
	UPlan Total Households less 10%	LU Analysis Total Households	Difference	UPlan Commercial Acres 10%	LU Analysis Commercial Acres	Difference	UPlan Total Employment less 10%
Harrison Township	5,119	5,742	-623	1,189	824	365	62,852
Logan Township	1,657	1,656	1	1,966	1,988	-22	88,796
Swedesboro Borough	169	434	-265	61	17	44	1,741
Woolwich Township	23,971	22,700	1,271	1,070	1,005	65	29,559
Total	**32,021**	**30,532**	**1,489**	**4,286**	**3,835**	**452**	**182,948**

Source: DVRPC July 2009

These UPlan allocations are acceptable for travel simulation purposes, except for Logan Township, where UPlan has a significant bias towards residential development. UPlan output for Logan Township is corrected prior to the simulation by reducing household allocation by 60 percent and increasing the industrial and high-density commercial acreage allocation by 17 percent. The corrected results, shown in Table 11, virtually eliminate the differences.

UPlan 2000 Employment Density Estimates

Estimates of employment by place-of-work increases for each scenario are required for the trip generation component of the TDM. The land use analysis did not include employment estimates. UPlan calibrated floor-area ratios and parameters are as follows:

UPlan Employment Land Consumption Parameters

Development Category	Floor Area Ratio	Square-foot / Employee
▶ Industrial	0.38	500
▶ Commercial High Density	0.26	200
▶ Commercial Low Density	0.15	300

The Corrected Maximum Build-out scenario (see Table 11) results in almost 183,000 new employees in the corridor, with especially large increases in Harrison Township (62,852 new employees) and Logan Township (88,796 new employees).

As described in Chapter II, calibrating UPlan in Gloucester County as a whole requires substantial decreases in floor area ratio (FAR) and significant increases in the square footage per employee to fill out the commercial land area consumption measured in the 2000 land use inventory. Rather than reduce net development density, the US 322 Corridor Study utilizes several 2030 development scenarios to make the household and employment allocation more accurate. These scenarios are Corridor Constrained, Sewer Constrained, Maximum Build-out, and Board-forecast (conformity demonstration). The Corridor Constrained allocation restricts new development to areas immediately adjacent to US 322 (see Map 2). The Sewer Constrained scenario prevents new development in areas not currently served by waste treatment infrastructure (see Map 3). Finally, the Board-forecast is used as a benchmark to assess the validity of the other scenarios. Outside of the US 322 Corridor, the Board-forecast is used to estimate trip generation for the scenario travel simulations.

Household and Employment 2030 Forecast by Scenario

Table 12 compares UPlan household forecasts for each scenario with Board-forecasts. The scenario forecasts are not tremendously different from Board-forecasts, with the exception of Woolwich Township, which has large amounts of available land zoned for residential development. The Maximum Build-out scenario increases the number of households in Harrison Township and Logan Township; however, Woolwich Township is increased by almost 20,000 households over Board-forecast.

Table 12. US 322 Corridor: 2030 Household Forecast

Municipality	Board Forecast	Maximum Build-out	Corridor Constrained	Sewer Area Constrained
Harrison Township	5,839	7,967	5,355	4,180
Logan Township	2,501	3,658	2,178	2,843
Swedesboro Borough	864	939	937	939
Woolwich Township	5,392	7,156	7,156	14,735
Total	**14,596**	**37,495**	**15,626**	**22,697**

Source: DVRPC July 2009

Table 13. US 322 Corridor: 2030 Employment Forecast

Municipality	Board Forecast	Maximum Build-out	Corridor Constrained	Sewer Area Constrained
Harrison Township	5,167	65,137	27,839	31,042
Logan Township	10,965	94,972	36,353	39,086
Swedesboro Borough	2,635	4,097	4,046	4,026
Woolwich Township	4,457	30,466	27,134	2,550

Source: DVRPC July 2009

The Corridor Constrained scenario largely mitigates these increases over the Board-forecast. With the exception of Woolwich Township, MCD household differences from the official forecasts are less than 500 households. Woolwich Township increases are reduced to about 1,800 households over Board-adopted forecasts by the Corridor Constraint scenario.

The Sewer Constrained scenario also mitigates Maximum Build-out household increases over Board-forecast, but to a lesser degree in Woolwich Township, where residential zones already have sewer service. Elsewhere, the differences between Corridor Constrained and Sewer Constrained scenarios are largely insignificant for travel simulation purposes.

Overall, the pattern of increases with respect to Board-adopted employment forecasts is similar to households, except that the magnitude is much greater (8.4 times the percentage increase) for households at Maximum Build-out (see Table 14). This relative increase is significant from a traffic point of view. It resulted from larger amounts of land zoned for commercial and the relatively high employee density assumed for this analysis. Woolwich Township, under the sewer area constraint, has a different pattern of change from the corridor-constrained allocation. Most areas with sewer service are south of the corridor, adjacent to Center Square and Swedesboro boroughs. This makes the sewer constraint more effective in Woolwich Township than the corridor constraint in reducing the employment forecasts. Elsewhere in the study area, the Corridor Constrained and Sewer Constrained forecasts are comparable to Board-forecasts for travel simulation purposes.

Figure 2. US 322 Corridor: Growth Areas

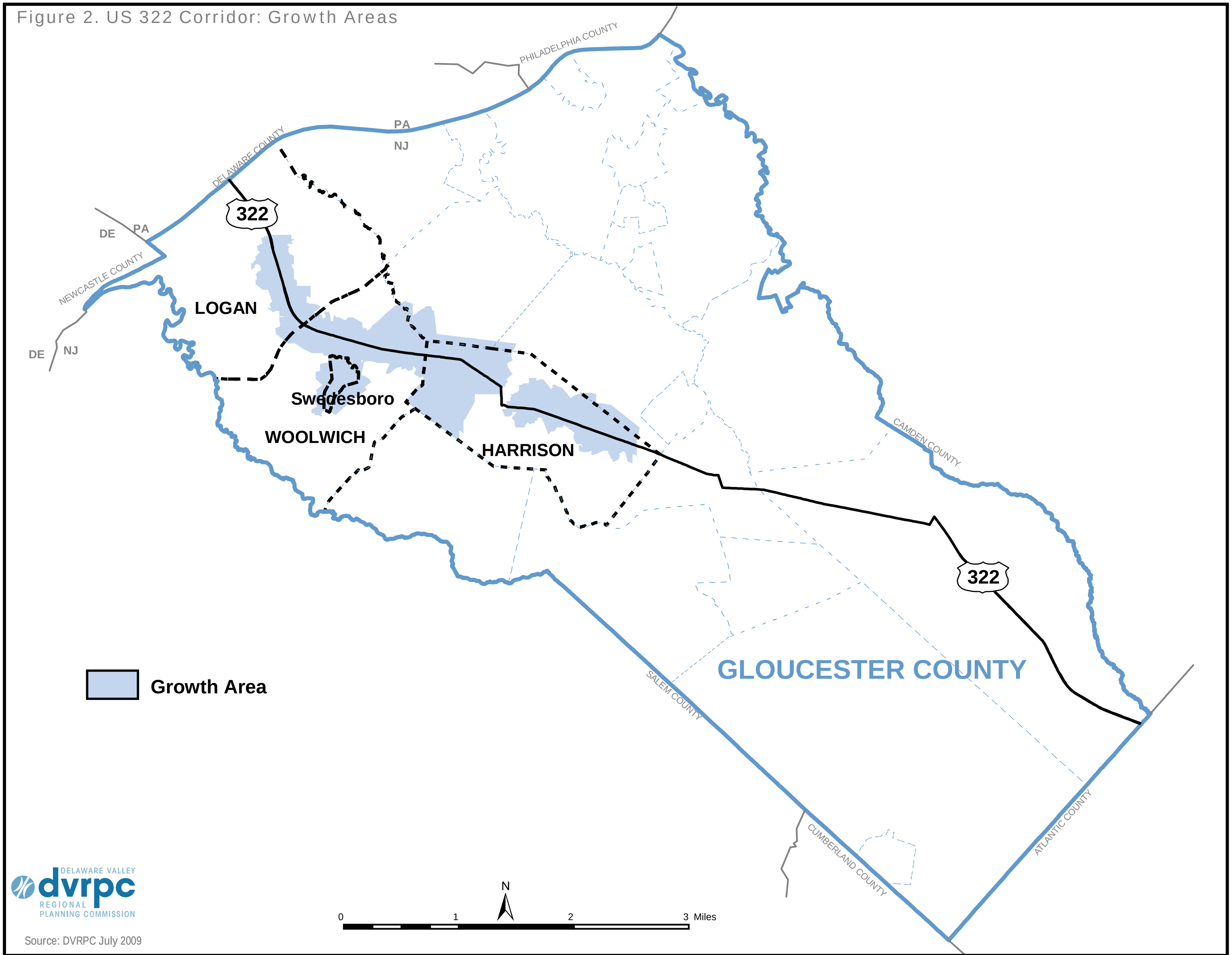
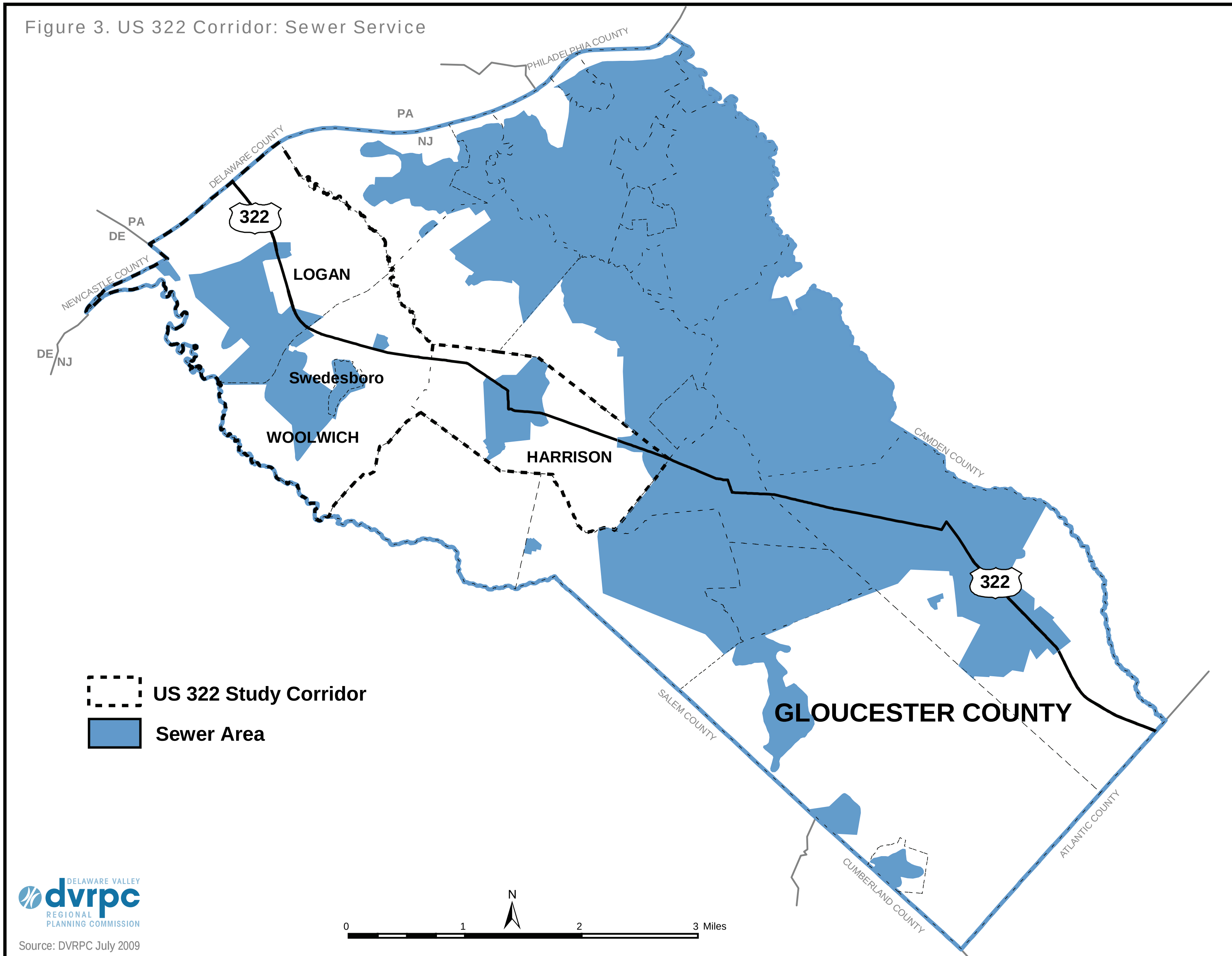


Figure 3. US 322 Corridor: Sewer Service



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Source: DVRPC July 2009

The traffic zone allocations of household and employment increments under the Maximum Build-out, Corridor Constrained, and Sewer Constrained scenarios are presented in Tables 14 through 16 respectively. TAZ allocation is tabulated by UPlan from the developable land by use-type implicit in US 322 zoning polygons and converted to equivalent household and employment increments. These increments are added to 2000 Census data to predict 2030 TAZ level household and employment increases for input to the TDM. Generally, the TAZ allocation follows MCD trends noted above; although, specific traffic analysis zones may have smaller or larger growth increments than average depending on the distribution of available land within each MCD.

Preparation of 2030 Trip Generation Inputs

The TDM requires a number of additional variables relating households to employment. These include: population, household by auto ownership, employed residents, and employment stratified by Standard Industrial Code (SIC) category. TAZ level 2030 forecasts of these additional trip generation inputs are prepared as part of the Board-adopted forecasts. In order to input the results of scenario allocations into travel simulations, separate adjustment factors for household and employment are calculated for each TAZ and scenario. A household adjustment factor is applied to population, households by auto ownership, and employed residents to prepare trip generation demographic inputs for each scenario. Similarly the employment adjustment factor is applied to each SIC category in the Board-forecast. Outside of the US 322 corridor, Board-forecasts are used without modification.

2030 Build-out Scenario Travel Simulation

The trip generation component is run separately for each scenario and resulting highway link volumes are stored in a database for further analysis. In all cases, the TDM assumes the transportation component of Destination 2030 except for widening on US 322 from two to four lanes only between I-295 and the New Jersey Turnpike. All other segments of US 322 are assumed to remain in their current roadway configuration.

Pilot Study #2: NJ 55 Corridor Land Use Impacts

In this pilot study, DVRPC employs UPlan to test the impact of transportation alternatives in Gloucester County. The purpose of this analysis is to determine what effect adding a new highway facility has on surrounding land use and then extend the analysis to include a proposed light rail transit (LRT) facility in place of the highway.

Two Gloucester County transportation projects are included in this analysis:

- NJ 55 freeway and its interchanges at Deptford, Elk, Franklin, Glassboro, Harrison, and Mantua townships (see Map 4).
- A southern extension of the proposed NJ TRANSIT River LINE, with stations located in Glassboro Borough, Mantua Township, Pitman and Wenonah boroughs, West Deptford Township, Woodbury City, and Woodbury Heights Borough (see Map 5).

Table 14. US 322 Corridor: Maximum Build-out Scenario

	Households				Employees			
MCD	2000 Census	2030 Board Forecast	UPlan 2030	Adjustment Factor	2000 Census	2030 Board Forecast	UPlan 2030	Adjustment Factor
Harrison Township	2,848	5,839	7,967	1.364	2,285	5,167	65,137	12.61
Woolwich Township	960	5,392	24,931	4.624	907	4,457	30,466	6.84
Swedesboro Borough	770	864	939	1.087	2,356	2,635	4,097	1.55
Logan Township	2,001	2,501	3,658	1.463	6,176	10,965	94,972	8.66
Grand Total	**6,579**	**14,596**	**37,495**	**2.569**	**11,724**	**23,224**	**194,671**	**8.38**

Source: DVRPC July 2009

Table 15. US 322 Corridor: Corridor Build-out Scenario

	Households				Employees			
MCD	2000 Census	2030 Board Forecast	UPlan 2030	Adjustment Factor	2000 Census	2030 Board Forecast	UPlan 2030	Adjustment Factor
Harrison Township	2,848	5,839	5,355	0.917	2,285	5,167	27,839	5.39
Woolwich Township	960	5,392	7,156	1.327	907	4,457	27,134	6.09
Swedesboro Borough	770	864	937	1.084	2,356	2,635	2,635	1.00
Logan Township	2,001	2,501	2,178	0.871	6,176	10,965	36,353	3.32
Grand Total	**6,579**	**14,596**	**15,627**	**1.071**	**11,724**	**23,224**	**95,372**	**4.11**

Source: DVRPC July 2009

Table 16. US 322 Corridor: Sewer Constrained Scenario

	Households				Employees			
MCD	2000 Census	2030 Board Forecast	UPlan 2030	Adjustment Factor	2000 Census	2030 Board Forecast	UPlan 2030	Adjustment Factor
Harrison Township	2,848	5,839	4,180	0.716	2,285	5,167	31,042	6.01
Woolwich Township	960	5,392	14,735	2.733	907	4,457	2,550	0.57
Swedesboro Borough	770	864	939	1.087	2,356	2,635	4,026	1.53
Logan Township	2,001	2,501	2,843	1.137	6,176	10,965	39,086	3.56
Grand Total	**6,579**	**14,596**	**22,697**	**1.555**	**11,724**	**23,224**	**76,703**	**3.30**

Source: DVRPC July 2009

To determine what land use changes occur as a result of a transportation project, each is modeled and compared with a No-build scenario. Although it is presently operational, in the No-build alternative NJ 55 and its interchanges are removed from the transportation network to simulate the effect of land use changes without this facility then compared with a build scenario, where the highway and its interchanges are in place to determine the difference between them. A base year of 1990 was selected from which to evaluate future land use changes because it is close to the 1989 opening year of NJ 55. Any land use changes occurring from 1989 to 1990 and new development previously constructed in anticipation of the new expressway are assumed to be negligible. All alternatives use the Simulation 7 final forecast parameters, detailed in Chapter III.

Existing Board-forecast population and employment are used and, as a result, total population and employment for the county remain constant, with an increase in any one MCD counterbalanced by corresponding decreases in other municipalities – a zero-sum net change.

Build Alternative 1: NJ 55 Expressway, without LRT

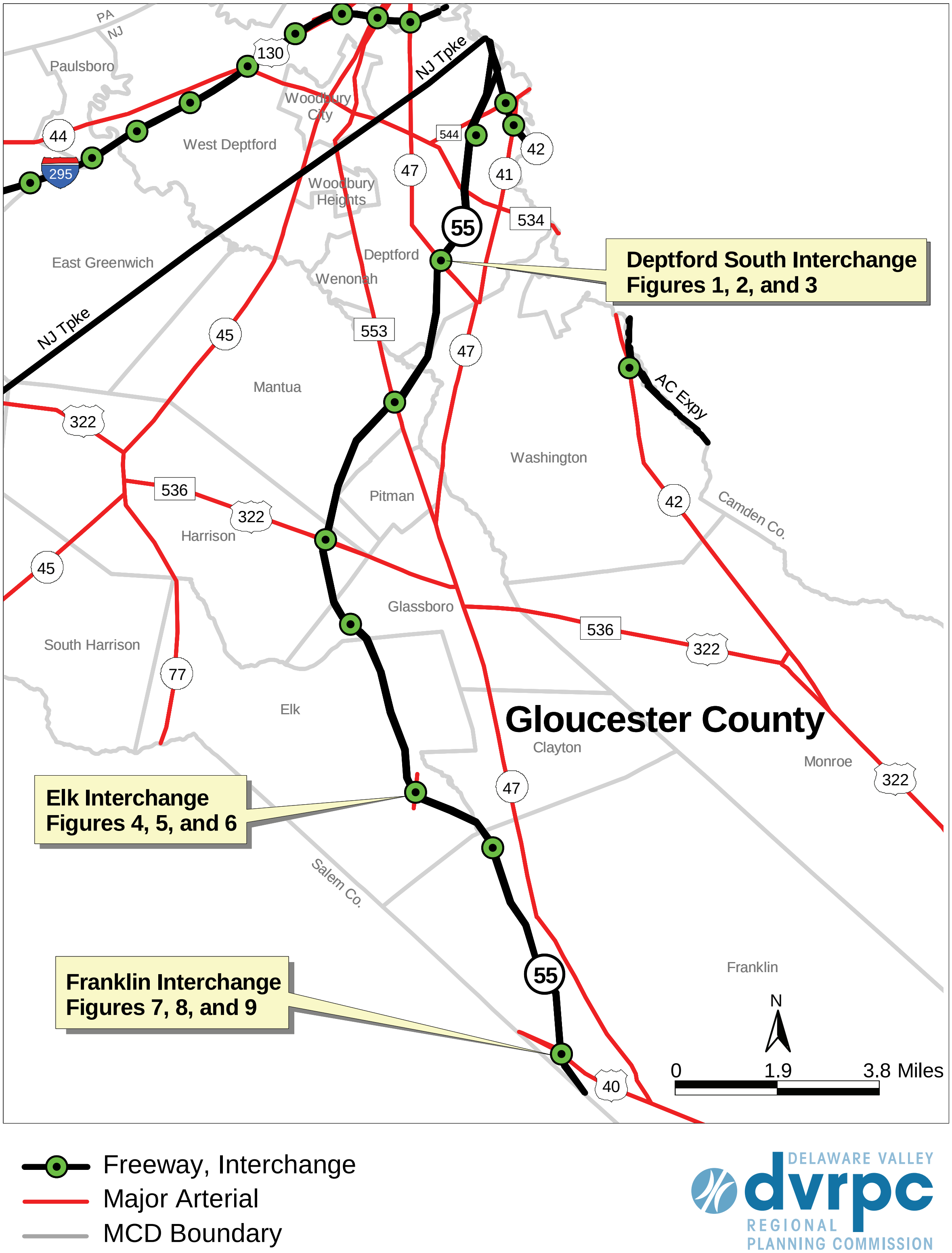
Including NJ 55 in this scenario results in a significant MCD population changes, compared with the No-build forecast. Along the NJ 55 corridor, the population of Deptford Township increases by nearly 1,500 persons a 39 percent increase compared with the No-build forecast (Table 17). Other corridor municipalities either gain population or remain steady, with the exception of Harrison Township, which experiences a population loss of 1,600 persons.

Outside the corridor, MCD population fluctuates in this alternative compared with the No-build. The largest of these changes occurs in West Deptford Township, whose population decreased by 1,000 persons, a 27 percent reduction from the No-build. Given its proximity to Deptford Township it is possible that some population shifted from West Deptford Township closer to NJ 55.

The total population of corridor and non-corridor MCD groups remains constant between this alternative and the No-build alternative. However, it appears that population is shifting between neighboring corridor and non-corridor municipalities, depending upon their proximity to a NJ 55 interchange. In the case of Harrison Township which lost population despite the location of an interchange within its boundaries, residential development was displaced by employment land uses, making other municipalities located near the interchange more attractive for residential development.

Accessibility to NJ 55 accounts for large overall gains along the corridor and corresponding losses in non-corridor municipalities (Table 18). These results support the notion that highways induce the development of new employment sites. As a result, this new footprint development reduces land available for residential use and displaces some population. This land constraint, where population gains in any particular MCD generally result in employment losses and vice-versa, is observed in Elk and Harrison Townships, which experienced the largest employment growth. There, largely undeveloped land around highway interchanges is ideal for employment sites. In contrast, corridor municipalities where less land is available, such as in Deptford Township, experience significant growth. However, while these areas may be constrained with limited land for new development, no MCD in the corridor lost employment.

Figure 4. NJ 55 Corridor: Gloucester County Highway Facilities



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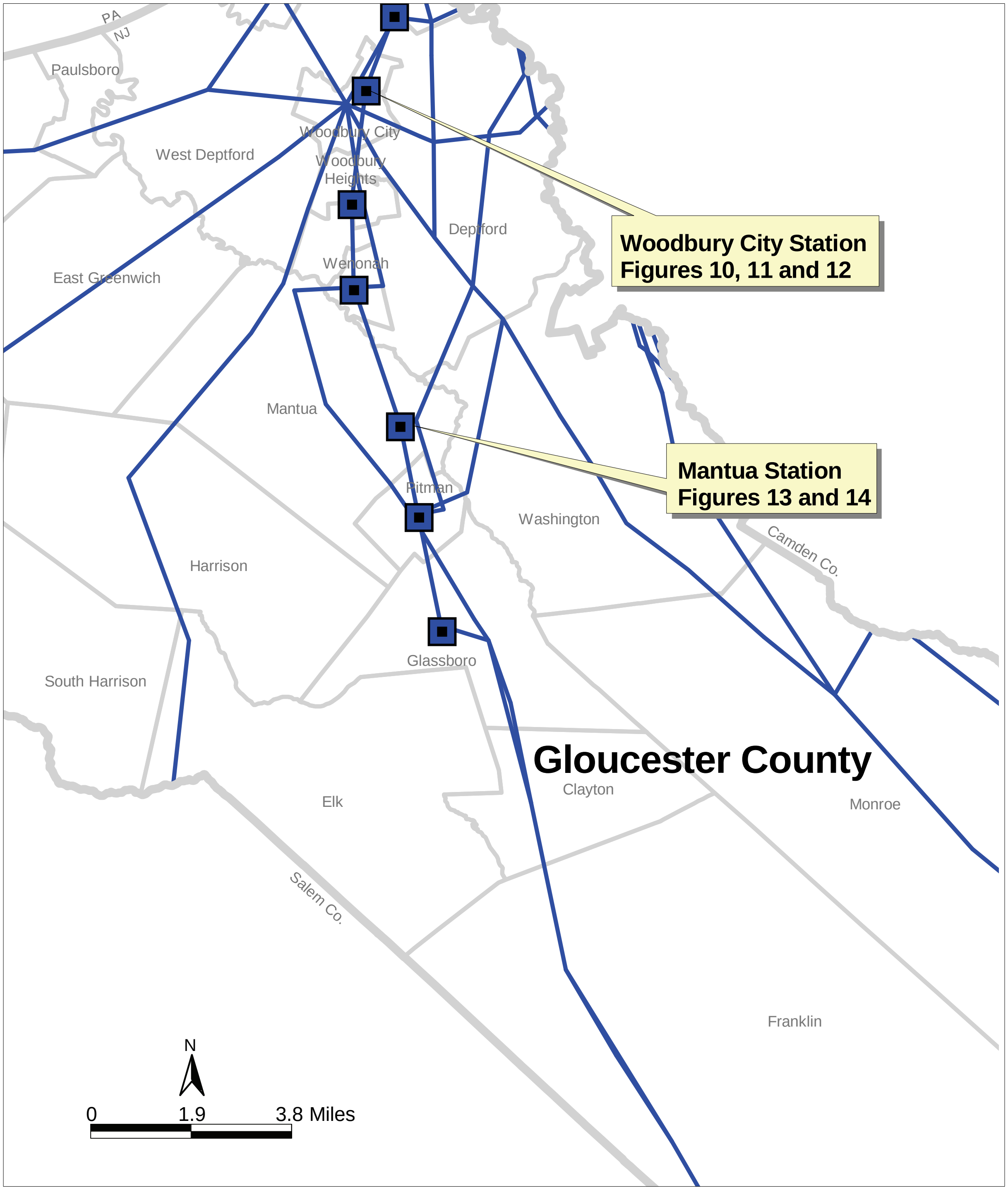
Source: DVRPC July 2009

Figure 5. NJ 55 Corridor: Gloucester County Transit Facilities (including LRT extension)



Proposed Rail Station
Bus Route
MCD Boundary

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Source: DVRPC July 2009

Mantua Township, with available land surrounding the NJ 55 interchange within its borders, does not experience an increase in employment as a result of its relatively low employment growth between 1990 and 2000, which discourages additional development through the forecast period.

Shifts in Gloucester County employment do occur in this scenario from non-corridor municipalities to those near the corridor. Few municipalities outside the corridor gain employment, among them Washington and West Deptford Townships, which both experienced employment increases. However, since parts of both municipalities are near NJ 55 interchanges in adjacent municipalities they benefit from similar employment-attracting characteristics as those municipalities in the corridor. The most significant employment decreases occur in municipalities outside the corridor along the edges of the county: South Harrison Township employment decreases by 1,100 jobs (25 percent) while in Woolwich Township it decreases by 1,600 jobs (27 percent). In Monroe Township the decrease is the largest in Alternative 1, dropping 26 percent, nearly 4,300 jobs.

Generally, employment land uses cluster around NJ 55 interchanges. At several interchanges near existing developed areas, residential development is displaced (compared to the No-build) by employment land uses. At the southern Deptford interchange, for example, development patterns change significantly around the interchange, from a scattered mix of commercial and low-density residential in the No-build alternative to a cluster of commercial development (Figures 1 and 2).

This development appears to shift some new employment from near the northern Deptford interchange, where the primary retail shopping area is located, leaving land available for additional residential development in this area. When compared with the actual land use change between 1990 and 2005, the land use development pattern resembles that forecast by UPlan, with clusters of commercial development near NJ 55 and new residential development nearby (Figure 3).

In areas without existing development, new development allocated near NJ 55 interchanges is primarily industrial or commercial. In Elk Township, for example, a sizable area of commercial development is forecast near the interchange in the township, which is largely undeveloped at present (Figures 4 and 5). However, when comparing this allocation with actual development between 1990 and 2005, it is apparent that this development has not yet occurred, indicating a longer horizon for the build-out of this area (Figure 6).

At the Franklin interchange of NJ 55, the southern edge of Gloucester County, no change in development was apparent between Alternative 1 and the No-build (Figures 7, and 8), showing that less development occurs outside existing urban areas. Though some residential and commercial development occurs between 1990 and 2005 (Figure 9), the build-out horizon for this area is beyond the 2030 forecast year selected for this analysis.

Table 17. NJ 55 Corridor: Build Alt #1 Population Impacts

NJ 55 Corridor Municipality	1990 Census Population	2030 No-Build Pop Change (from 1990)	NJ 55 Build Pop Change (from No-Bld)	Build / No-Build % Change
Deptford Township	24,137	+3,755	+1,458	39%
Elk Township	3,806	+1,530	-133	-9%
Franklin Township	14,482	+4,972	+34	1%
Glassboro Borough	15,614	+1,080	+407	38%
Harrison Township	4,715	+21,220	-1,627	-8%
Mantua Township	10,074	+18,200	-56	0%
Subtotal	**72,828**	**+50,757**	**+83**	**NA**
NJ 55 Non-Corridor Municipality	**1990 Census Population**	**2030 No-Build Pop Change (from 1990)**	**NJ 55 Build Pop Change (from No-Bld)**	**Build / No-Build % Change**
Clayton Borough	6,155	+142	+369	260%
East Greenwich Township	5,258	+1,321	+81	6%
Greenwich Township	5,102	+1,852	-59	-3%
Logan Township	5,147	+17,939	+277	2%
Monroe Township	26,703	+12,902	+735	6%
National Park Borough	3,413	+32	0	0%
Newfield Borough	1,592	+94	-4	-4%
Paulsboro Borough	6,577	+58	+5	9%
Pitman Borough	9,365	+43	+7	16%
South Harrison Township	1,919	+1,480	+118	8%
Swedesboro Borough	2,024	+20	+7	35%
Washington Township	41,960	+16,204	-936	-6%
Wenonah Borough	2,331	+65	-11	-17%
West Deptford Township	19,380	+3,708	-1,004	-27%
Westville Borough	4,573	+32	-7	-22%
Woodbury City	10,904	+81	-16	-20%
Woodbury Heights Borough	3,392	+27	+5	19%
Woolwich Township	1,459	+8,212	+363	4%
Subtotal	**157,254**	**+64,212**	**-70**	**NA**
Gloucester County Total	**230,082**	**+114,969**	**NA**	**NA**

Source: DVRPC July 2009

Table 18. NJ 55 Corridor: Build Alt #1 Employment Impacts

NJ 55 Corridor Municipality	1990 Census Employment	2030 No-Build Emp Change (from 1990)	NJ 55 Build Emp Change (from No-Bld)	Build / No-Build % Change
Deptford Township	10,740	+3,242	+534	16%
Elk Township	523	0	+3,373	–
Franklin Township	2,651	0	0	–
Glassboro Borough	7,924	0	0	–
Harrison Township	1,247	+672	+2,971	442%
Mantua Township	6,181	0	0	–
Subtotal	**29,266**	**+3,914**	**+6,878**	**NA**
NJ 55 Non-Corridor Municipality	**1990 Census Employment**	**2030 No-Build Emp Change (from 1990)**	**NJ 55 Build Emp Change (from No-Bld)**	**Build / No-Build % Change**
Clayton Borough	1,864	0	0	–
East Greenwich Township	1,427	0	0	–
Greenwich Township	3,283	0	0	–
Logan Township	2,980	+5,018	-615	-12%
Monroe Township	5,888	+16,293	-4,289	-26%
National Park Borough	374	+187	-77	-41%
Newfield Borough	941	0	0	–
Paulsboro Borough	3,728	0	0	–
Pitman Borough	3,535	0	0	–
South Harrison Township	181	+4,365	-1,102	-25%
Swedesboro Borough	1,893	+314	0	0%
Washington Township	8,138	+1,858	+651	35%
Wenonah Borough	751	0	+77	–
West Deptford Township	6,333	+16,100	+248	2%
Westville Borough	2,906	0	0	–
Woodbury City	10,103	+176	-104	-59%
Woodbury Heights Borough	2,115	0	0	–
Woolwich Township	373	+6,057	-1,648	-27%
Subtotal	**56,813**	**+50,368**	**-6,859**	**NA**
Gloucester County Total	**86,079**	**+54,282**	**NA**	**NA**

Source: DVRPC July 2009

Land Use Effects at the NJ 55 Deptford South Interchange

Figure 6. NJ 55 Corridor: No-Build Alt UPlan Allocation

Figure 7. NJ 55 Corridor: Build Alt #1 UPlan Allocation

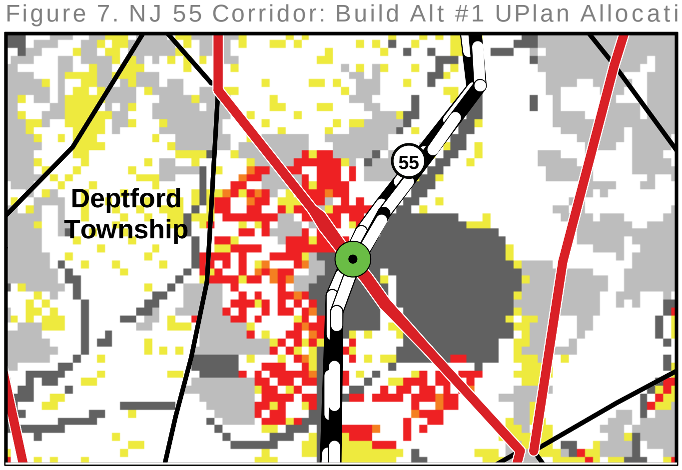
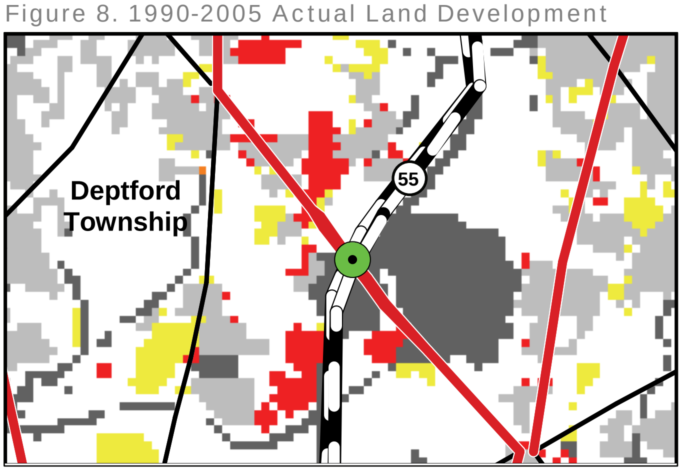
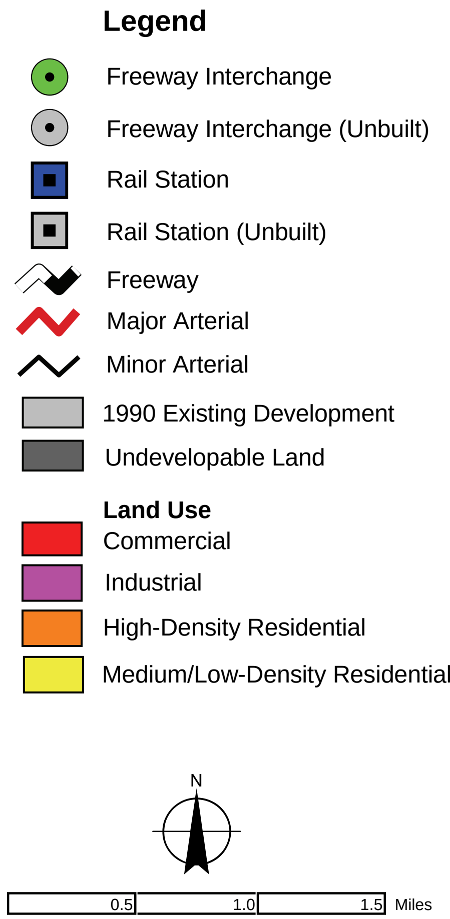


Figure 8. 1990-2005 Actual Land Development

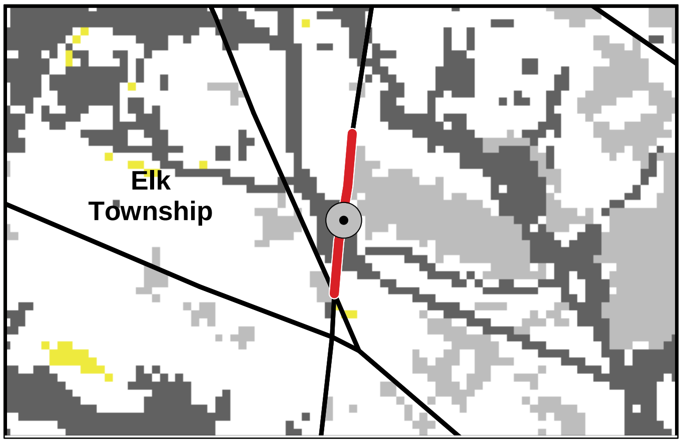




Source: DVRPC July 2009

Land Use Effects at the NJ 55 Elk Interchange

Figure 9. NJ 55 Corridor: No-Build Alt UPlan Allocation



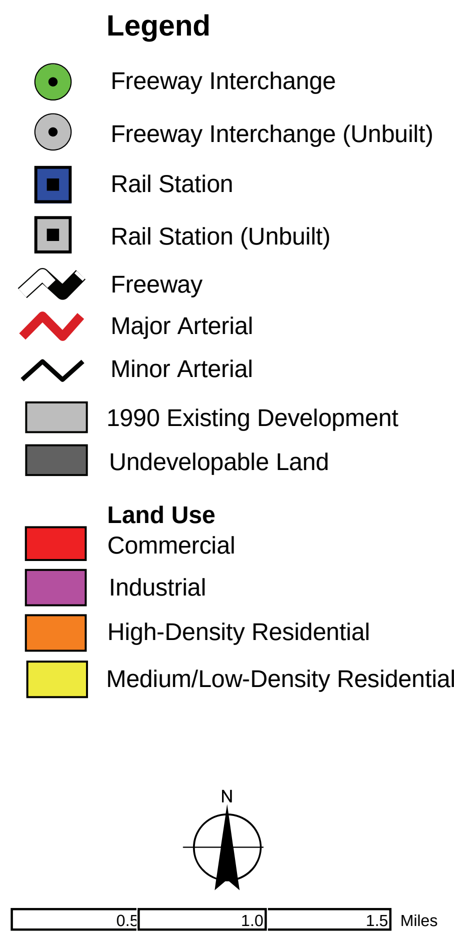


Figure 10. NJ 55 Corridor: Build Alt #1 UPlan Allocation

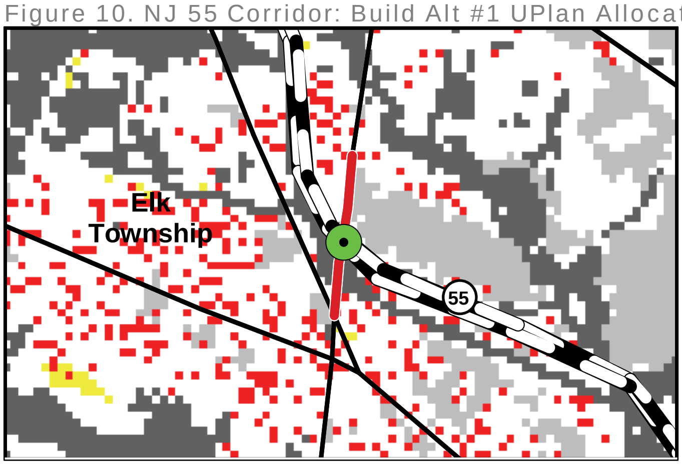
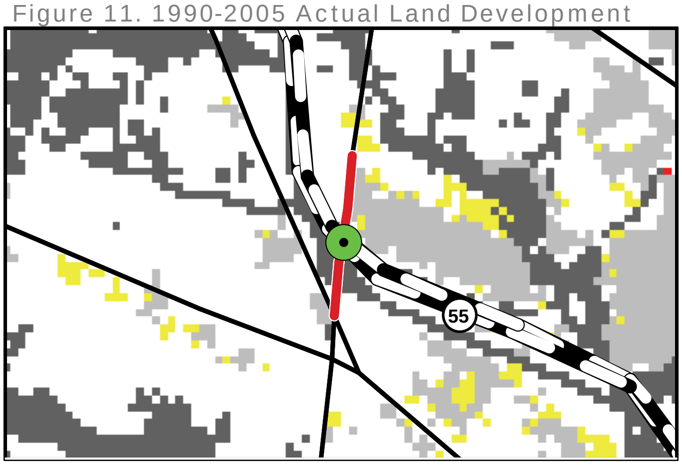


Figure 11. 1990-2005 Actual Land Development



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Source: DVRPC July 2009

Alternative 2: LRT Extension, without NJ 55 Expressway

This alternative assumes operation of an LRT line to Glassboro Borough along an existing right-of-way generally parallel to NJ 55. Overall, less absolute change occurs with this alternative than with the inclusion of NJ 55.

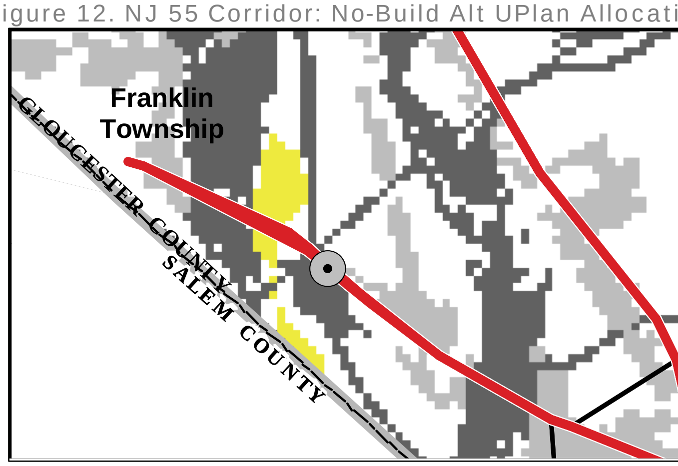
Population slightly increases in some municipalities along the rail corridor, such as in Mantua Township, but decreases in others (Table 19). These results suggest that new residential development may locate near public transit, but not immediately adjacent to it. One reason for this is that the proposed rail stations in this alternative are located in existing urban areas where little or no land is available for further development. Municipalities within commuting distance of rail stations are most likely to experience population gains. The inclusion of rail stations in these municipalities provides greater accessibility to transit and increases the relative attractiveness of the surrounding land, some of which may be available for residential development. However, population changes in this alternative are not significant, differing by one percent or less from the No-build forecast. Mantua Township, with available land near the proposed rail station, experiences the largest population increase. Other changes in population are minimal compared with the No-build scenario. These results suggest that the proposed LRT line will largely serve residents in already developed areas, rather than cause significant population growth.

Compared with the Highway-build alternative, LRT employment changes are less significant. This minimal change suggests that a rail facility is not as great an employment attractor as a highway facility. Employment differs by one percent or less from the No-build forecasts; only small changes occur in the numbers of employees gained or lost (Table 20). These forecasts show only minimal impact on MCD employment, both in the municipalities served by the proposed LRT line and in other parts of the county.

The addition of rail stations has little noticeable effect on surrounding land uses. This lack of influence on new development is attributable in part to the relatively small UPlan attraction weight assigned to rail stations compared to freeway interchange values. It is also significant that many rail stations are located in developed areas. This can be seen in Woodbury City, where the proposed rail station is located in an area already developed to serve existing residents. Therefore, little new development occurs in the vicinity as a result of the rail station, compared with the No-build alternative (Figures 10 and 11). Although some new development may be possible within the municipality, no significant new footprint construction appears to have occurred between 1990 and 2005, based on an examination of DVRPC land use inventories for both years (Figure 12). A similar effect occurs in Mantua Township, where more land is available for development. Development is almost entirely residential in the No-build scenario, which is almost indistinguishable from the LRT alternative (Figures 13 and 14).

Land Use Effects at the NJ 55 Franklin Interchange

Figure 12. NJ 55 Corridor: No-Build Alt UPlan Allocation



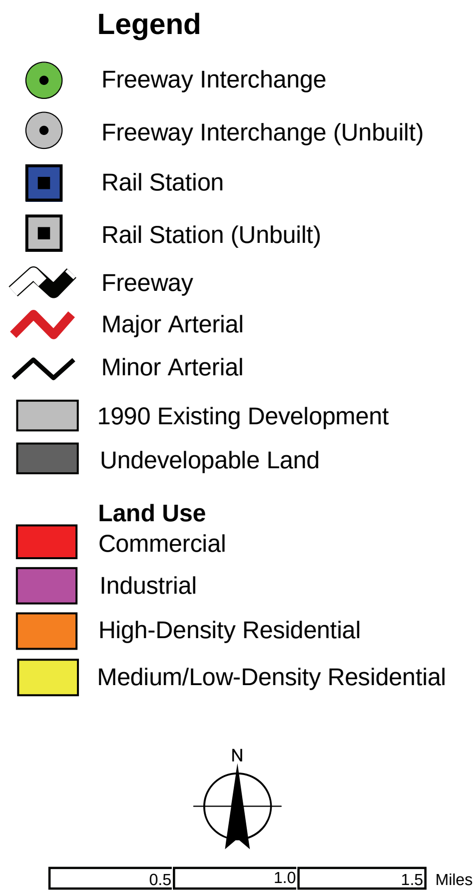


Figure 13. NJ 55 Corridor: Build Alt #1 UPlan Allocation

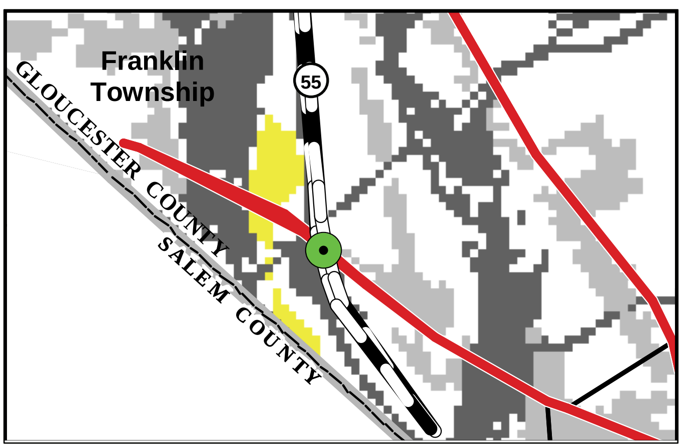
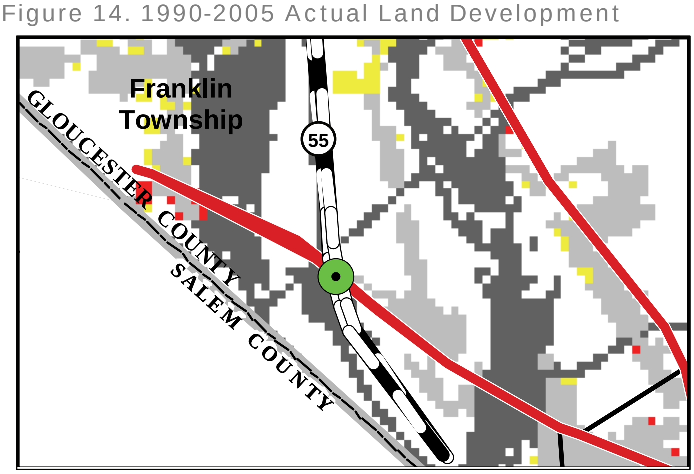


Figure 14. 1990-2005 Actual Land Development



DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Source: DVRPC July 2009

Table 19. NJ 55 Corridor: Build Alt #2 Population Impacts

Proposed NJ Transit Riverline Light Rail Extension Corridor Municipality	1990 Census Population	2030 No-Build Pop Change (from 1990)	Rail Build Pop Change (from No-Build)	Build / No-Build % Change
Glassboro Borough	15,614	+1,080	+16	1%
Mantua Township	10,074	+18,200	+97	1%
Pitman Borough	9,365	+43	-5	-12%
Wenonah Borough	2,331	+65	+9	14%
West Deptford Township	19,380	+3,708	+7	0%
Woodbury City	10,904	+81	-20	-25%
Woodbury Heights Borough	3,392	+27	0	0%
Subtotal	**71,060**	**+23,204**	**+104**	**NA**
Proposed NJ Transit Riverline Light Rail Extension Non-Corridor Municipality	**1990 Census Population**	**2030 No-Build Pop Change (from 1990)**	**Rail Build Pop Change (from No-Build)**	**Build / No-Build % Change**
Clayton Borough	6,155	+142	-25	-18%
Deptford Township	24,137	+3,755	-51	-1%
East Greenwich Township	5,258	+1,321	+31	2%
Elk Township	3,806	+1,530	+11	1%
Greenwich Township	5,102	+1,852	+22	1%
Franklin Township	14,482	+4,972	-6	0%
Harrison Township	4,715	+21,220	-27	0%
Logan Township	5,147	+17,939	+32	0%
Monroe Township	26,703	+12,902	-39	0%
National Park Borough	3,413	+32	-5	-16%
Newfield Borough	1,592	+94	-2	-2%
Paulsboro Borough	6,577	+58	-8	-14%
South Harrison Township	1,919	+1,480	+39	3%
Swedesboro Borough	2,024	+20	+2	10%
Washington Township	41,960	+16,204	-94	-1%
Westville Borough	4,573	+32	+2	6%
Woolwich Township	1,459	+8,212	+12	0%
Subtotal	**159,022**	**+91,765**	**-106**	**NA**
Gloucester County Total	**230,082**	**+114,969**	**NA**	**NA**

Source: DVRPC July 2009

Table 20. NJ 55 Corridor: Build Alt #2 Employment Impacts

Proposed NJ Transit Riverline Light Rail Extension Corridor Municipality	1990 Census Employment	2030 No-Build Emp Change (from 1990)	Rail Build Emp Change (from No-Build)	Build / No-Build % Change
Glassboro Borough	7,924	0	0	–
Mantua Township	6,181	0	0	–
Pitman Borough	3,535	0	0	–
Wenonah Borough	751	0	0	–
West Deptford Township	6,333	+16,100	+11	0%
Woodbury City	10,103	+176	-27	-15%
Woodbury Heights Borough	2,115	0	0	–
Subtotal	**36,942**	**+16,276**	**-16**	**NA**
Proposed NJ Transit Riverline Light Rail Extension Non-Corridor Municipality	**1990 Census Employment**	**2030 No-Build Emp Change (from 1990)**	**Rail Build Emp Change (from No-Build)**	**Build / No-Build % Change**
Clayton Borough	1,864	0	0	–
Deptford Township	10,740	+3,242	-28	-1%
East Greenwich Township	1,427	0	0	–
Elk Township	523	0	0	–
Greenwich Township	2,651	0	0	–
Franklin Township	1,247	+672	+56	8%
Harrison Township	3,283	0	0	–
Logan Township	2,980	+5,018	+33	1%
Monroe Township	5,888	+16,293	+49	0%
National Park Borough	374	+187	-22	-12%
Newfield Borough	941	0	0	–
Paulsboro Borough	3,728	0	0	–
South Harrison Township	181	+4,365	-16	0%
Swedesboro Borough	1,893	+314	0	0%
Washington Township	8,138	+1,858	+67	4%
Westville Borough	2,906	0	0	–
Woolwich Township	373	+6,057	-104	-2%
Subtotal	**49,137**	**+38,006**	**+35**	**NA**
Gloucester County Total	**86,079**	**+54,282**	**NA**	**NA**

Source: DVRPC July 2009

Land Use Effects for the Proposed Woodbury City Station

Figure 15. NJ 55 Corridor: No-Build Alt UPlan Allocation

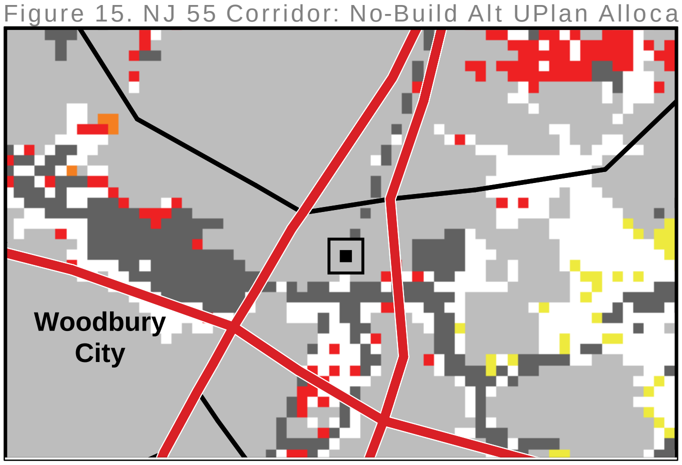


Figure 16. NJ 55 Corridor: Build Alt #2 UPlan Allocation

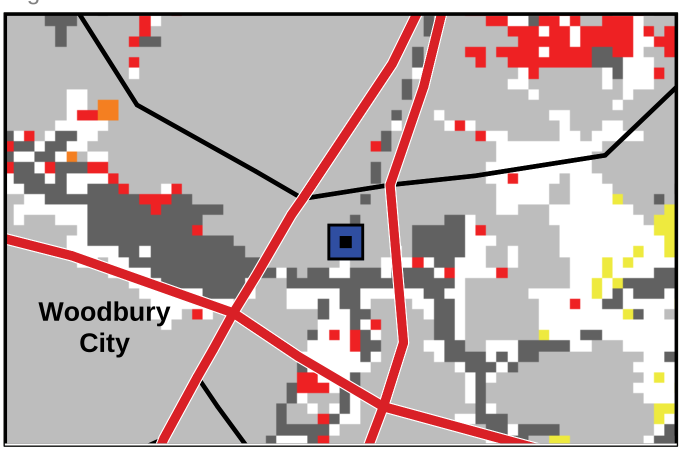
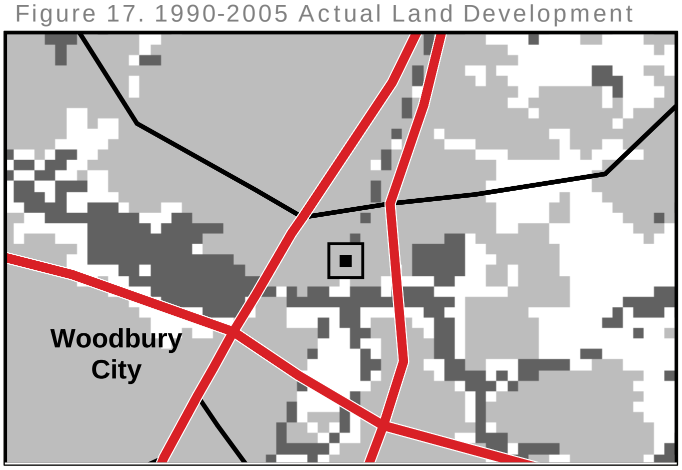


Figure 17. 1990-2005 Actual Land Development

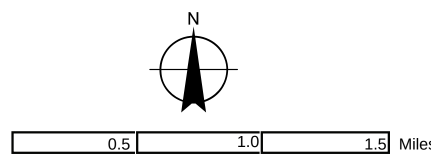


Legend

- Freeway Interchange
- Freeway Interchange (Unbuilt)
- Rail Station
- Rail Station (Unbuilt)
- Freeway
- Major Arterial
- Minor Arterial
- 1990 Existing Development
- Undevelopable Land

Land Use

- Commercial
- Industrial
- High-Density Residential
- Medium/Low-Density Residential



DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Source: DVRPC July 2009

Land Use Effects at the Proposed Mantua Station

Figure 18. NJ 55 Corridor: No-Build Alt UPlan Allocation

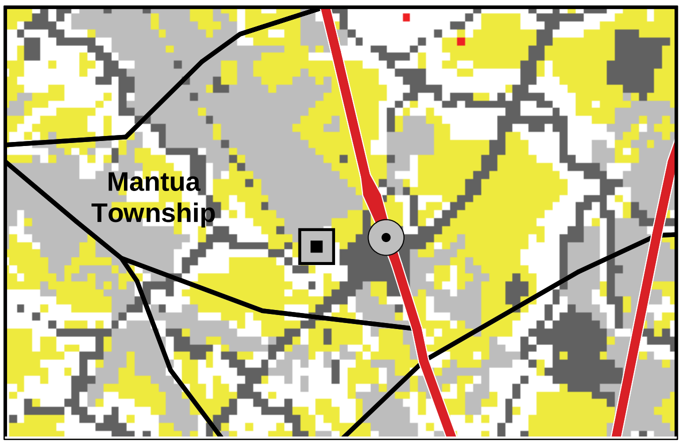
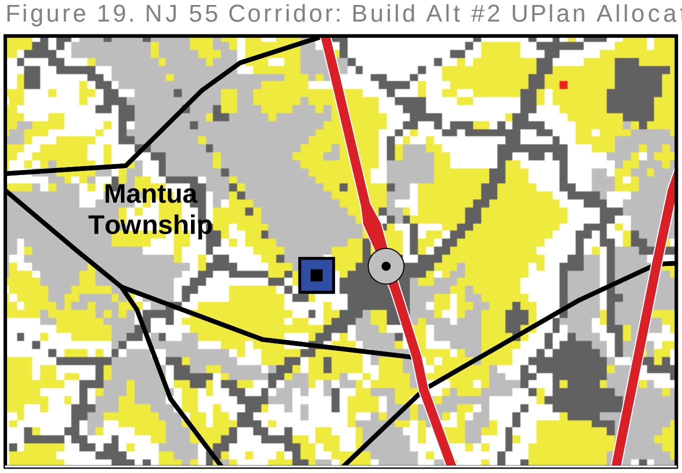


Figure 19. NJ 55 Corridor: Build Alt #2 UPlan Allocation

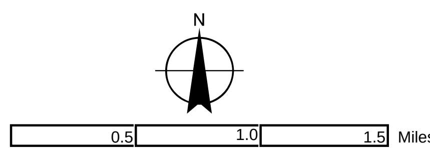


Legend

- Freeway Interchange
- Freeway Interchange (Unbuilt)
- Rail Station
- Rail Station (Unbuilt)
- Freeway
- Major Arterial
- Minor Arterial
- 1990 Existing Development
- Undevelopable Land

Land Use

- Commercial
- Industrial
- High-Density Residential
- Medium/Low-Density Residential



DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

Source: DVRPC July 2009

CHAPTER V

"What if" 2035 Scenario Application with UPlan

This chapter describes the land use and transportation modeling efforts in support of *Making the Land Use Connection: Regional What-If Scenario Analysis* (Publication # 08059, DVRPC 2008). This scenario analysis will be included as a component in the development of *Connections: The Regional Plan for a Sustainable Future* to quantify possible outcomes given a range of transportation and land use policy priorities. Four land use scenarios are tested as part of this analysis: the **Trend** scenario is an unconstrained allocation of the Board-forecasts to developable land, the **Sprawl** scenario allocates low density development among the remaining open space in the suburban and rural portions of the region, the **Recentralization** scenario assigned projected growth at high density in central urban areas and inner ring suburbs, finally the **Growth Area** scenario allocates Board-forecast demographics to designated future growth areas (FGA) identified in *Destination 2030: The Year 2030 Plan for the Delaware Valley*.

The rule-based functionality of UPlan makes it very useful in preparing precisely located new footprint development patterns associated with each of the four scenarios; however, supplemental methods are needed to address the aspects of scenario development not covered by UPlan:

- County level population and employment control totals;
- Infill development in presently built up areas; and
- Abandonment of existing housing and commercial buildings in existing urban areas.

In the current implementation, UPlan models each county separately using exogenously specified new footprint population and employment development control totals. This scenario planning activity requires supplemental methods, described below, to calculate the county control totals, estimate infill into presently developed areas and the proportion of growth allocated to new footprint development under each scenario. The Trend, Growth Area, and Recentralization scenarios make use of density enhancing infill in existing developed areas.

UPlan allocates new footprint development to parcels in urban and suburban portions of the region that are categorized as vacant or wooded or agricultural land in Delaware Valley Regional Planning Commission's (DVRPC) 2005 land use inventory. Many vacant parcels in the inventory are cleared industrial sites; although, small areas of open space in developed areas are also considered vacant. It is difficult and costly to identify parcels with abandoned buildings and/or infrastructure using aerial photographs and developed areas are typically categorized by apparent land use in the inventory regardless of the occupancy status. Although abandoned parcels constitute a significant percentage of development in certain older urban portions of the region, the large amount of infill in several scenarios will require some redevelopment at higher densities.

Infill Assumptions in the 2035 Board-forecast

Board-forecast population and employment have significant infill assumptions incorporated into the county, municipal, and zonal forecasts. For this study, these infill assumptions are quantified by comparing minor civil division (MCD) Board-forecasts to the corresponding UPlan output constrained by the availability of land for development within the 2005 land use inventory. The allocation assumes that all projected county population and employment growth is accommodated by new footprint development. The difference between Board-forecasts and UPlan output provides an approximate estimate of county and municipal infill. This step quantifies the infill assumptions included in the Board-forecasts used in the Trend and Growth Area scenarios.

UPlan requires separation the of new footprint population from infill population to allocate only new footprint development. Exogenous infill estimates will be added to UPlan's new footprint allocation to produce total socioeconomic growth forecasts for input to the travel demand model (TDM). All counties will be included in the analysis, except Philadelphia County, which has limited open space available for UPlan to allocate new footprint development.

As a quality check, DVRPC requested that each county provide their insights into likely and/or desirable infill percentages and development patterns. County provided infill estimates are compared with the estimated Board-forecast infill below.

Estimation of 2035 Infill

UPlan is used to allocate Board-forecast county total population to new footprint development. After tabulating the UPlan population allocation by MCD, the results are compared to Board-forecasts and the following criteria applied:

- If UPlan > Forecast; Then Infill = 0 (all growth is new footprint development)
- If UPlan ≈ Forecast; Then Infill = 0 (same as above)
- If UPlan < Forecast; Then Infill = Forecast – UPlan

These conditions assume any population growth that is not accommodated by new footprint development (the left-over, unallocated population) must be accommodated as infill. Population and employment estimates are then normalized to be consistent with county totals.

Implicit Board-forecast Infill by State

County population and employment infill estimates resulting from the above process are summarized by county in Tables 21 and 22, respectively. The county infill percentages associated with Board-forecasts are substantial and generally consistent with DVRPC regional growth policies. The Pennsylvania counties (excluding Philadelphia) have an aggregate infill of 48 percent for population and 51 percent for employment. The corresponding infill estimates for the New Jersey counties are lower for population, but higher for employment – 44 percent and 57 percent, respectively.

2035 County Population Infill Estimates

The infill estimates for individual counties vary depending on the infill policies implicit in the Board-forecasts. Rapidly growing counties, especially Bucks, Burlington, and Gloucester, have population infill estimates around 40 percent, while the relatively stable counties of Delaware, Mercer, and Camden have higher population infill percentages: 79 percent, 56 percent, and 49 percent, respectively. Chester County has a relatively high population infill percentage (60 percent), perhaps reflecting a reliance on infill in municipal land use plans. Montgomery has the lowest population infill percentage of the eight counties modeled with 34 percent infill.

Table 21. 2035 Population Infill Estimates using Board-forecasts

Municipality	2005-2035 Forecast Change	2035 UPlan New Footprint	2035 Infill Percent	2035 Infill Value	2035 UPlan Total
Bucks County	129,433	70,903	45%	58,637	753,891
Chester County	148,618	59,397	60%	89,235	622,512
Delaware County	10,090	2,152	79%	7,948	246,641
Montgomery County	113,592	75,752	34%	38,353	894,649
Pennsylvania Total	**401,733**	**208,205**	**48%**	**194,172**	**2,517,693**
Burlington County	94,337	55,518	42%	39,495	541,879
Camden County	13,627	6,981	49%	6,729	273,344
Gloucester County	95,145	58,511	39%	37,433	370,173
Mercer County	38,879	17,118	56%	21,881	404,096
New Jersey Total	**241,988**	**138,128**	**44%**	**105,539**	**1,589,493**
Population Total	**643,721**	**346,333**	**47%**	**299,711**	**4,107,186**

Source: DVRPC July 2009

2035 County Employment Infill Percentages

Employment infill percentages are in general more consistent than population at the county level. Most counties (Bucks, Chester, Burlington, Gloucester, and Mercer) have employment infill percentages in the range of 53 percent to 60 percent. There are three significant exceptions: Delaware, Montgomery, and Camden counties; all contain large amounts of older, partially abandoned industrial and/or commercial areas. Delaware County has a high employment infill percentage (74 percent), reflecting reuse and redevelopment of industrial sites especially in the eastern part of the county. Camden County has the opposite policy (37 percent), with little or no redevelopment of brown fields in the City of Camden and neighboring communities. For this reason, employment growth is shifted to the eastern part the county, where more of the new job opportunities are accommodated with new footprint development. Montgomery County (43 percent) appears to follow the Camden County model with little redevelopment in the southeast portion and heavy development in the northwest portion of the county.

Table 22. 2035 Employment Infill Estimates using Board-forecasts

Municipality	2005-2035 Forecast Change	2035 UPlan New Footprint	2035 Infill Percent	2035 Infill Value	2035 UPlan Total
Bucks County	64,350	30,328	53%	34,341	342,555
Chester County	83,465	38,030	55%	45,508	337,166
Delaware County	7,680	2,036	74%	5,670	118,665
Montgomery County	79,478	45,588	43%	34,320	585,860
Pennsylvania Total	**234,973**	**115,981**	**51%**	**119,839**	**1,384,245**
Burlington County	45,908	19,667	58%	26,561	260,849
Camden County	3,555	2,247	37%	1,326	117,875
Gloucester County	37,666	17,160	55%	20,691	146,080
Mercer County	40,944	16,744	60%	24,455	269,701
New Jersey Total	**128,073**	**55,817**	**57%**	**73,033**	**794,504**
Employment Total	**363,046**	**171,799**	**53%**	**192,872**	**2,178,750**

Source: DVRPC July 2009

County Estimates of Current Infill

DVRPC requested estimates of population and employment infill rates from each of the nine member governments. Bucks and Montgomery counties responded with their infill land use policies. These county estimates are compared with the corresponding estimate from UPlan in Table 23.

Table 23. County Reported Infill vs. UPlan Estimated Infill (Trend)

County	Population Infill			Employment Infill		
	Uplan Esitmated	County Reported	Precent Difference	Uplan Esitmated	County Reported	Percent Difference
Bucks	45.0%	48.0%	3.0%	53.0%	77.0%	24.0%
Montgomery	34.0%	25.0%	-9.0%	43.0%	55.0%	12.0%
Average	39.5%	36.5%	-3.0%	48.0%	66.0%	18.0%

Source: DVRPC July 2009

UPlan estimated population infill percentages are very similar (three percent lower) to the Bucks County provided estimates, but the employment infill percentage supplied by Bucks County is significantly different (24 percent higher) from infill assumed in Board-forecasts. Montgomery County's reported population infill (25 percent) is significantly less than the Board-forecast for peer counties (40 percent) though the UPlan estimate falls somewhere between (34 percent). Employment infill (55 percent) is similar to peer counties (53 percent to 60 percent) but UPlan estimates a lower (44 percent) employment infill implicit in Board-forecasts. Overall, the infill percentage associated with Board-forecasts differs somewhat from county policy but form a reasonable basis for preparing 2035 land use scenarios.

UPlan 2035 Municipal Forecast Outliers

The UPlan trial simulations documented above produce some outliers in comparison to the Board-forecasts for some MCDs. Municipalities where Board-forecasts are at least 1,000 units lower than the UPlan allocation are considered outliers. By this definition, the Trend allocation is consistent with the vast majority of municipalities considered in the analyses. Some eight percent of MCDs have population outliers and five percent have employment outliers.

Population outliers are summarized in Table 24. In Bucks County, the principal population outliers are Buckingham and Plumstead townships where the UPlan population is projected to be about 5,000 persons more than the Board-forecast. Bensalem and East Rockhill townships are also outliers, but the magnitude of the difference is significantly less than the previous two. In Chester County, the most glaring outlier, in absolute terms, is New Garden Township along with three other lesser outliers with similar percentage overestimates. Montgomery County has four outliers, with three falling in the PA 73 corridor. Radnor Township and Upper Darby Township are the only Delaware County outliers. In New Jersey, Burlington County has three outliers; Burlington, Mount Laurel, and Southampton townships. Camden County has one outlier: Gloucester Township. Gloucester County has three population outliers, all near the greater US 322 Corridor: Mantua, Harrison, and Greenwich townships. Princeton Township is the only population outlier in Mercer County.

Employment outliers are summarized in Table 25. In Pennsylvania, Bucks County has five employment outliers in the UPlan output. The largest is Bedminster Township, followed by Plumstead Township, Hilltown Township, Lower Makefield Township, and West Rockhill Township. Chester County has one employment outlier; Delaware County has two outliers; and Montgomery County has four outliers.

In New Jersey, Burlington County has two outliers; Gloucester and Mercer counties have one outlier each. Camden County has no employment outliers.

Overall, the magnitude of the outliers is considered to be within acceptable limits for the estimation of land consumption under the Trend scenario. The next section covers the development of alternate county population forecasts for each of the scenarios not based on Board-forecasts. These estimates are necessary because UPlan does not forecast regional growth; rather, it allocates new development associated with projected future population.

Scenario Population and Employment 2035 Growth Targets

DVRPC tested a variety of approaches in the initial phase of scenario development. Early attempts included using variable powers to raise or lower forecast growth rates. Squaring or taking the square root of the municipal growth rate, depending on the scenario goal, in each planning area type (PAT), creates a set of hyperbolic equations to reverse Board-adopted population and employment forecasts. These forecasts are comparable to projected growth rates from similar scenarios in DVRPC’s 2003 scenario exercise that forecast population and employment levels for the year 2025, detailed in *Regional Analysis of What If Transportation Scenarios* (Publication # 03020, DVRPC

2003). Finally, DVRPC decided to use simple multiplier equations to calculate growth rate targets for population and employment.

The equations are generated by applying simple multipliers to each PAT to fit the goals of the scenario and forecast municipal growth rates from 2005 to 2035. These equations are used because they do not rely on complex mathematics and are widely comprehensible by the public with a minimum of technical expertise.

Table 24. Population 2035 Infill Estimate Outliers

County/Municipality	2035 Forecast	2005-2035 Forecast Change	2035 UPlan New Footprint	2035 UPlan Total	Forecast-UPlan Difference	Percent Difference
Bucks County						
Bensalem Township	60,440	1,554	3,909	62,795	2,355	4%
Buckingham Township	24,831	6,138	11,082	29,775	4,944	20%
East Rockhill Township	7,816	2,085	3,380	9,111	1,295	17%
Plumstead Township	17,674	5,728	11,223	23,169	5,495	31%
Chester County						
Honey Brook Township	8,883	2,059	4,623	11,447	2,564	29%
Kennett Township	9,761	2,532	3,601	10,830	1,069	11%
Lower Oxford Township	7,581	2,674	4,470	9,377	1,796	24%
New Garden Township	15,921	4,901	9,209	20,229	4,308	27%
West Sadsbury Township	3,360	861	1,940	4,439	1,079	32%
Delaware County						
Radnor Township	31,164	188	1,387	32,363	1,199	4%
Upper Darby Township	79,070	-1,187	58	80,315	1,245	2%
Montgomery County						
Douglass Township	14,000	3,722	6,706	16,984	2,984	21%
Hatfield Township	20,689	3,112	4,890	22,467	1,778	9%
Upper Frederick Township	4,983	1,285	3,012	6,710	1,727	35%
Worcester Township	12,171	3,322	7,394	16,243	4,072	33%
Burlington County						
Burlington Township	25,123	3,397	8,392	30,118	4,995	20%
Mount Laurel Township	44,636	4,349	7,670	47,957	3,321	7%
Southampton Township	12,945	2,108	3,120	13,957	1,012	8%
Camden County						
Gloucester Township	70,640	4,615	6,996	73,021	2,381	3%
Gloucester County						
Greenwich Township	5,295	363	1,529	6,461	1,166	22%
Harrison Township	20,433	9,142	11,024	22,315	1,882	9%
Mantua Township	22,806	7,777	9,993	25,022	2,216	10%
Mercer County						
Princeton Township	18,425	1,233	5,147	22,339	3,914	21%

Source: DVRPC July 2009

The Recentralization scenario utilizes a third multiplier, based on the DVRPC transit score tool. This tool tests transit-supportiveness based on land use conditions and has been developed and refined especially for use in the Delaware Valley region.

The first multiplier is applied by PAT as identified in Destination 2030. The values in Table 26 are assigned to fit the expected rates in the Recentralization and Sprawl scenarios; Growth Area and Trend scenarios do not require multipliers. In the Recentralization scenario a majority of new population and employment development is expected to locate in the region's core cities and developed communities. In the Sprawl scenario, existing population and jobs leave the core cities and relocate to growing suburbs and rural areas. New population and job growth will also occur primarily in areas.

Table 25. Employment 2035 Infill Estimate Outliers

County/Municipality	2035 Forecast	2005-2035 Forecast Change	2035 UPlan New Footprint	2035 UPlan Total	Forecast-UPlan Difference	Percent Difference
Bucks County						
Bedminster Township	1,864	605	2,425	3,684	1,820	98%
Hilltown Township	5,507	989	2,306	6,824	1,317	24%
Lower Makefield Township	6,429	955	2,245	7,719	1,290	20%
Plumstead Township	6,704	2,238	3,633	8,099	1,395	21%
West Rockhill Township	5,616	1,971	3,005	6,650	1,034	18%
Chester County						
North Coventry Township	3,406	1,006	3,810	6,210	2,804	82%
Delaware County						
Marcus Hook Borough	1,786	-115	1,287	3,188	1,402	78%
Upper Darby Township	19,905	-763	254	20,922	1,017	5%
Montgomery County						
New Hanover Township	2,695	1,200	3,436	4,931	2,236	83%
Skippack Township	5,965	1,195	2,469	7,239	1,274	21%
Upper Frederick Township	748	69	2,039	2,718	1,970	263%
Upper Hanover Township	5,880	1,438	2,741	7,183	1,303	22%
Burlington County						
Delanco Township	3,475	300	1,458	4,633	1,158	33%
Wrightstown Borough	3,857	635	4,572	7,794	3,937	102%
Camden County						
none	none	none	none	none	none	none
Gloucester County						
West Deptford Township	13,715	3,857	6,768	16,626	2,911	21%
Mercer County						
Hamilton Township	39,959	1,959	7,189	45,189	5,230	13%

Source: DVRPC July 2009

A second multiplier is simply the percent growth of the Board-forecasts for each municipality between 2005 and 2035. This multiplier captures elements such as taxation, location, availability of open space, and other factors that impact a community's attractiveness to developers, especially relative to other communities of the same PAT. The value for the multiplier is one plus (or minus) the forecast growth.

Table 26. Planning Area Type Population Multipliers

Planning Area Type	Multiplier	
	Recentralization	Sprawl
Core City	2.0	1.0
Developed Community	3.0	1.1
Growing Suburb	1.0	2.0
Rural Area	0.0	2.0

Source: DVRPC July 2009

For example, if a community is forecast to grow 20 percent over the time period, the multiplier is 1.2. Under the Board-forecast, most municipal growth is expected to occur in the growing suburbs and rural areas. The final equation used for the sprawl scenario is:

Municipal Sprawl Population 2035 = MP2005* PAT * (1 + MG)

Where,
MP = 2005 Municipal population (Board-adopted)
PAT = Planning Area Type Multiplier (see Table 26)
MG = Forecast Municipal Growth Rate

The calculation based on the Sprawl scenario equation yields population levels well-above the Board-forecast. The intent is to hold regional growth steady at 6.15 million in 2035, while varying where new population will locate. To preserve the forecast, each municipality's population and employment findings were reduced proportionally.

The Recentralization scenario also uses a third multiplication factor based on DVRPC transit score. This additional multiplier is used to reflect the desirability of transit access in a denser, more centralized, and transit-oriented future scenario. Board-forecasts assume most growth over the next 30 years will occur in the rural areas and growing suburbs. Since transit score tends to be higher in core cities and developed communities, this multiplier also helps to counter the Board-forecast municipal growth rate multiplier, which tends to push population migration outward to growing suburbs and rural areas. Transit score in 2005 ranges between zero and 11.2 for the 354 municipalities in the DVRPC region. This multiplier is computed by dividing the transit score by one hundred and adding one. Municipalities not forecast to grow in this scenario maintain the 2005 population level. The equation will calculate only new population growth, approximately 630,000 additional persons by the forecast year, locating in each of the PATs. The final equation used for population forecasts in the recentralization scenario is:

Municipal Recentralization Growth 2035 = MP2005 + PAT * (1 + MG) * (1 + TS/100))

Where,
MP = 2005 Municipal population (Board-adopted)
PAT = Planning Area Type Multiplier (see Table 26)
MG = Forecast Municipal Growth Rate
TS = Municipality's Transit Score

The Recentralization equation also yields regional population levels well-above Board-forecast regional growth. Since the intent is to keep these overall totals constant, each municipality's population and employment findings are reduced proportionally. Growth in rural areas is discouraged so the PAT multiplier is set to zero to prevent development in large rural townships without FGAs. However, in the next phase of the analysis, UPlan will allocate these county control totals. In this step, new population could be forecast in rural areas where a FGA is designated.

Initial Population and Employment 2035 Growth Targets

Table 27 presents the first iteration of population forecasts by PAT for both relevant scenarios. This is the first iteration, which will only be used to determine county control numbers for UPlan, which will locate new footprint development in each county in the next step. There is slight variation in regional totals is due to rounding.

Table 27. First Iteration Population Forecasts by Planning Area Type

Planning Area Type	Recentralization		Sprawl	
	Population	Percent	Population	Percent
Core Cities	1,881,434	31%	1,169,086	19%
Development Communities	2,181,413	35%	1,486,421	24%
Growing Suburbs	1,761,274	29%	2,864,061	47%
Rural Areas	325,512	5%	630,059	10%
Region	**6,149,628**	**100%**	**6,149,627**	**100%**

Source: DVRPC July 2009

Core cities and developed communities experience strong population growth in the Recentralization scenario. In the Sprawl scenario, core cities and developed communities experience dramatic population losses, while growing suburbs grow equally dramatically and rural areas experience a solid population increase. The difference between scenarios is clearly illustrated by comparing Philadelphia's population under each scenario. In the Recentralization scenario, Philadelphia has 170,000 additional residents totaling 1.65 million people. In the Sprawl scenario, Philadelphia loses considerable population, dropping to under 1 million people.

Validation of Population and Employment 2035 Growth Targets

Average population densities are computed and used to test the validity of the growth targets. DVRPC calculated residential density for each municipality in both the Sprawl and Recentralization scenarios, excluding Philadelphia. Peak residential density occurred in the Recentralization scenario in Millbourne Borough, Delaware County with 33.5 persons per acre. Using an average household size of 2.5, this is 13.0 households per acre in the borough. This is calculated as an average; some areas would be denser while others would be less dense. In the Recentralization scenario, core cities are projected to have an average of 18.0 persons per acre, developed communities are projected to have an average of 6.0 persons per acre, growing suburbs are projected to have an average of 2.0 persons per acre, and rural areas are projected to have an average 0.3 persons per acre. In the Sprawl scenario, population density ranges from 11.0 persons per acre in core cities to 4.0 persons per acre in the developed communities to 3.0 persons per acre in the growing suburbs and 0.7 persons per acre in the rural areas.

County Population and Employment Growth by Development Type

Table 28 presents the regional totals of new footprint population forecasts for each scenario. UPlan will proportionally estimate the number of jobs and households formed along with the population growth. Since UPlan is run separately for each county, the regional totals of new footprint population and the associated infill and/or migration estimates are allocated to each of the DVRPC counties.

Table 28. UPlan 2035 New Footprint Population Allocation

Scenario	New Footprint Population
Sprawl	1,684,610
Trend	353,695
Growth Area	353,602
Recentralization	80,759

Source: DVRPC July 2009

Tables 29 through 36 present the final county level population and employment forecasts, disaggregated into infill and new footprint as reflected in the UPlan outputs. There are small variations in the final total output by UPlan from the input values determined above. This is especially true for UPlan employment estimates which are derived through labor participation rates from the population allocations. Along with municipal and TAZ allocations of infill and net migration changes associated with the scenarios the UPlan new footprint forecasts determine the zonal population and employment forecasts for use with the TDM. The UPlan output summarized here, forms the bases of the TDM forecasts presented below.

Regionally, the Trend scenario, presented in Tables 29 and 30, results in about 354,000 persons and 177,000 jobs allocated to new footprint development and about 277,000 additional persons and 193,000 additional jobs allocated as infill to existing developed areas throughout in the region. However, Philadelphia continues to lose population and gain jobs in small amounts.

The Growth Area scenario, presented in Tables 31 and 32 below, takes the Board-adopted (Trend) growth and allocates the new population and employment to areas targeted for new development in Destination 2030. The MCD and TAZ level Trend infill estimates are used for the most part in the Growth Area scenario reallocation of the Board-adopted forecasts to FGAs. The principal difference between the Growth Area and Trend scenario estimates is employment infill which is derived by UPlan from the population allocation. Projected land requirements overwhelm FGAs at Trend scenario development densities. After a series of trials, the Growth Area scenario utilized higher development density assumptions similar to those of the Recentralization scenario.

Table 29. Trend: 2035 Population Growth, Infill, and New Footprint

County	2005 Population	Infill (persons)	New Footprint (persons)	2035 Population
Bucks	624,350	37,015	92,419	753,784
Chester	473,881	81,951	66,666	622,498
Delaware	555,204	2,106	2,646	559,956
Montgomery	780,541	45,679	67,916	894,136
Philadelphia	1,483,848	-3,825	NA	1,480,023
PA Sub-Total	**3,917,824**	**162,926**	**229,647**	**4,310,397**
Burlington	446,864	53,864	40,475	541,203
Camden	515,007	7,282	2,395	524,684
Gloucester	274,230	31,050	64,094	369,374
Mercer	365,093	21,799	17,084	403,976
NJ Sub-Total	**1,601,194**	**113,995**	**124,048**	**1,839,237**
Total	**5,519,018**	**276,921**	**353,695**	**6,149,634**

Source: DVRPC July 2009

Table 30. Trend: 2035 Employment Growth, Infill, and New Footprint

County	2005 Employment	Infill (jobs)	New Footprint (jobs)	2035 Employment
Bucks	277,886	34,341	30,009	342,236
Chester	253,628	33,376	50,089	337,093
Delaware	237,582	5,670	295	243,547
Montgomery	505,952	34,320	45,158	585,430
Philadelphia	728,054	8,214	NA	736,268
PA Sub-Total	**2,003,102**	**115,921**	**125,551**	**2,244,574**
Burlington	214,621	35,128	10,780	260,529
Camden	222,721	1,326	2,635	226,682
Gloucester	108,229	20,691	16,975	145,895
Mercer	228,502	19,641	21,303	269,446
NJ Sub-Total	**774,073**	**76,786**	**51,693**	**902,552**
Total	**2,777,175**	**192,707**	**177,244**	**3,147,126**

Source: DVRPC July 2009

In the Growth Area forecasts, Philadelphia continues to lose population but gains a small number of jobs through infill. Bucks, Chester, and Montgomery counties experience similar levels of population infill in Pennsylvania while Burlington County also experiences the most infill in New Jersey.

Delaware and Camden counties host the least population growth as new footprint development; and Montgomery County receives the most employment new footprint development, but somewhat less infill than Bucks and Chester counties. The New Jersey counties receive substantially less infill and new footprint growth than Pennsylvania.

Table 31. Growth Area: 2035 Population Growth, Infill, and New Footprint

County	2005 Population	Infill (persons)	New Footprint (persons)	2035 Population
Bucks	624,351	58,637	76,598	759,586
Chester	473,880	59,397	71,773	605,050
Delaware	555,206	7,948	4,309	567,463
Montgomery	780,541	38,353	64,310	883,204
Philadelphia	1,483,851	-3,825	0	1,480,026
PA Sub-Total	**3,917,829**	**160,510**	**216,990**	**4,295,329**
Burlington	446,866	54,177	49,185	550,228
Camden	515,027	6,729	2,635	524,391
Gloucester	274,229	37,433	64,008	375,670
Mercer	365,097	17,118	20,784	402,999
NJ Sub-Total	**1,601,219**	**115,457**	**136,612**	**1,853,288**
Total	**5,519,048**	**275,967**	**353,602**	**6,148,617**

Source: DVRPC March 2009

Table 32. Growth Area: 2035 Employment Growth, Infill, and New Footprint

County	2005 Employment	Infill (jobs)	New Footprint (jobs)	2035 Employment
Bucks	277,903	32,739	47,418	358,060
Chester	253,622	33,411	44,844	331,877
Delaware	237,587	10,995	5,299	253,881
Montgomery	505,950	26,789	52,617	585,356
Philadelphia	728,054	8,214	0	736,268
PA Sub-Total	**2,003,116**	**112,148**	**150,178**	**2,265,442**
Burlington	202,535	22,790	23,056	248,381
Camden	222,732	3,474	1,537	227,743
Gloucester	108,235	14,807	28,099	151,141
Mercer	220,915	17,977	24,148	263,040
NJ Sub-Total	**754,417**	**59,048**	**76,840**	**890,305**
Total	**2,757,533**	**171,196**	**227,018**	**3,155,747**

Source: DVRPC July 2009

The Sprawl scenario, summarized in Table 33 and Table 34, assumes depopulation and job loss in the region's older communities and urban core. Philadelphia, and all other regional urban centers lose both population and jobs in large amounts to out migration; however, new footprint development more than makes up for the loss of urban population and jobs. Chester County experiences the greatest new footprint in Pennsylvania while Burlington County holds the same honor in New Jersey due to the large tracts of developable open space, agriculture, or wooded areas.

Table 33. Sprawl: 2035 Population Growth, Intra-County Movement, and New Footprint

County	2005 Population	Intra-County Migration (persons)	New Footprint (persons)	2035 Population
Bucks	624,351	-81,725	299,225	841,851
Chester	473,880	-36,525	373,086	810,441
Delaware	555,206	-135,877	109,486	528,815
Montgomery	780,544	-83,403	269,192	966,333
Philadelphia	1,483,851	-507,839	0	976,012
PA Sub-Total	**3,917,824**	**-845,368**	**1,050,988**	**4,123,452**
Burlington	446,866	-17,523	225,551	654,894
Camden	515,027	-135,031	110,596	490,592
Gloucester	274,229	-7,572	217,670	484,327
Mercer	365,097	-48,538	79,805	396,364
NJ Sub-Total	**1,601,219**	**-208,663**	**633,621**	**2,026,177**
Total	**5,519,051**	**-1,054,032**	**1,684,610**	**6,149,629**

Source: DVRPC July 2009

Table 34. Sprawl: 2035 Employment Growth, Intra-County Movement, and New Footprint

County	2005 Employment	Intra-County Migration (jobs)	New Footprint (jobs)	2035 Employment
Bucks	277,886	-6,684	79,738	350,940
Chester	253,628	-6,613	185,308	432,323
Delaware	237,582	-62,525	50,978	226,035
Montgomery	505,952	-6,683	118,167	617,436
Philadelphia	728,054	-209,144	0	518,910
PA Sub-Total	**2,003,102**	**-291,558**	**434,100**	**2,145,644**
Burlington	214,621	-7,893	114,872	321,600
Camden	222,721	-53,516	54,521	223,726
Gloucester	108,229	13,031	74,485	195,745
Mercer	228,502	5,191	26,723	260,416
NJ Sub-Total	**774,073**	**-43,187**	**270,601**	**1,001,487**
Total	**2,777,175**	**-334,836**	**704,792**	**3,147,131**

Source: DVRPC July 2009

The Recentralization scenario, presented in tables 35 and 36 relies heavily on infill and assumes a region-wide policy shift to encourage infill and redevelopment in older communities. This scenario results in the least regional new footprint development of the four scenarios. Philadelphia absorbs the most infill of all nine regional counties followed by Montgomery (population) and Chester (employment) counties in Pennsylvania while Camden (population) and Burlington (employment) counties experience the most infill of the New Jersey portion of the region.

Table 35. Recentralization: 2035 Population Growth, Infill, and New Footprint

County	2005 Population	Infill (persons)	New Footprint (persons)	2035 Population
Bucks	624,351	56,917	14,268	695,536
Chester	473,880	30,129	7,578	511,587
Delaware	555,206	70,347	7,826	633,379
Montgomery	780,544	75,092	18,775	874,411
Philadelphia	1,483,851	172,822	0	1,656,673
PA Sub-Total	**3,917,832**	**405,307**	**48,447**	**4,371,586**
Burlington	446,866	31,042	9,325	487,233
Camden	515,027	55,455	13,902	584,384
Gloucester	274,229	18,460	4,649	297,337
Mercer	365,097	39,560	4,436	409,093
NJ Sub-Total	**1,601,219**	**144,516**	**32,312**	**1,778,047**
Total	**5,519,051**	**549,823**	**80,759**	**6,149,633**

Source: DVRPC July 2009

Table 36. Recentralization: 2035 Employment Growth, Infill, and New Footprint

County	2005 Employment	Infill (jobs)	New Footprint (jobs)	2035 Employment
Bucks	277,886	65,507	7,547	350,940
Chester	253,628	174,213	4,482	432,323
Delaware	237,582	-18,375	6,828	226,035
Montgomery	505,952	99,037	12,447	617,436
Philadelphia	728,054	102,380	0	830,434
PA Sub-Total	**2,003,102**	**422,762**	**31,304**	**2,457,218**
Burlington	214,621	104,214	2,765	321,600
Camden	222,721	-4,639	5,644	223,726
Gloucester	108,229	85,622	1,894	195,745
Mercer	228,502	27,572	4,342	260,416
NJ Sub-Total	**774,073**	**212,769**	**14,645**	**1,001,487**
Total	**2,777,175**	**635,531**	**45,949**	**3,458,655**

Source: DVRPC July 2009

UPlan 2035 Scenario Density Parameters

In order to complete the zonal forecasts for the Trend scenario, population and employment infill estimation is distributed from municipality to the component zones using the proportions calculated from the 2005 population or employment data sets as appropriate. In all scenarios, forecast MCD and TAZ population and employment is calculated as the sum of new footprint allocations and the net of infill and migration patterns. For each scenario, UPlan disaggregates development density into two components. First, the percentage distributions of county growth totals into land use types; and second, the net development density within each land use type. Net development densities are summarized from the model output which differs slightly from input values because of calculation rounding errors.

Trend 2035 Scenario

New footprint development is allocated to the combination of vacant, wooded, and agricultural land uses identified in the 2005 land use survey. UPlan new footprint socioeconomic estimates by MCD and TAZ are taken directly from UPlan's new footprint land area allocations. For the Trend scenario, calibrated development type allocation and density from recent development patterns recorded in the DVRPC 1990, 2000, and 2005 land use inventories. These calibrated densities are recorded in Table 1 of Chapter II and combine low and very low densities. Table 37 presents the density distributions. Table 38 presents development densities in units per acre.

Table 37. Trend: Land Use Type Distribution

	Growing				Stabilized			
Residential	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	20.0%	15.2%	20.2%	17.2%	17.2%	28.7%	20.2%	24.3%
Medium Density	22.0%	22.6%	22.6%	22.6%	22.6%	30.8%	37.1%	37.5%
Low Density	58.0%	62.2%	57.2%	60.2%	60.2%	40.5%	42.7%	38.2%
Very Low Density	na	na	na	na	na	na	na	na
	Growing				Stabilized			
Commercial	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	4.3%	0.1%	0.1%	5.0%	5.0%	8.2%	0.1%	11.7%
High Density Commercial	12.0%	22.3%	22.3%	7.4%	7.4%	13.3%	22.3%	60.8%
Low Density Commercial	83.7%	77.6%	77.6%	87.6%	87.6%	78.5%	77.6%	27.5%

Source: DVRPC July 2009

Table 38. Trend: Residential and Employment Development Density

Residential Units Per Acre	Growing				Stabilized			
	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	6.7	8.3	7.2	10.0	10.0	10.1	11.3	11.1
Medium Density	2.0	2.2	5.6	4.6	6.3	5.8	7.1	6.3
Low Density	1.0	0.9	1.5	1.3	1.5	1.4	3.3	2.0
	Growing				Stabilized			
Employees Per Acre	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	6.6	8.3	14.0	2.4	9.4	9.8	16.5	15.2
High Density Commercial	24.8	17.7	38.5	43.9	9.4	27.7	12.2	58.0
Low Density Commercial	7.4	10.3	17.6	5.5	5.5	14.7	7.6	16.5

Source: DVRPC July 2009

Growth Area 2035 Scenario

For the Growth Area allocation, the FGAs are reduced by the 2000 to 2005 new footprint development that was identified in DVRPC's 2005 land use inventory. This is accomplished by masking out newly developed lands. Although the percentage distribution of new footprint development by land use category is identical to the calibrated values in Table 39, the limited amount of developable space in the growth areas necessitated a significant increase in development density to accommodate forecasted new footprint development. These increased densities are presented in Table 40.

Table 39. Growth Area: Land Use Type Distribution

	Growing				Stabilized			
Residential	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	10.0%	15.2%	20.2%	17.2%	17.2%	28.7%	20.2%	24.3%
Medium Density	15.0%	22.6%	22.6%	22.6%	22.6%	30.8%	37.1%	37.5%
Low Density	75.0%	62.2%	57.2%	60.2%	60.2%	40.5%	42.7%	38.2%
Very Low Density	na	na	na	na	na	na	na	na
	Growing				Stabilized			
Commercial	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	4.3%	0.1%	0.1%	5.0%	5.0%	8.2%	0.1%	11.7%
High Density Commercial	12.0%	22.3%	22.3%	7.4%	7.4%	13.3%	22.3%	61.6%
Low Density Commercial	83.7%	77.6%	77.6%	87.6%	87.6%	78.5%	77.6%	26.7%

Source: DVRPC July 2009

Table 40. Growth Area: Residential and Employment Development Density

	Growing				Stabilized			
Residential Units Per Acre	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	12.5	12.5	12.5	12.5	12.5	12.6	12.5	12.5
Medium Density	6.7	6.7	6.7	6.7	6.4	6.7	6.7	6.7
Low Density	3.0	3.0	3.0	3.0	2.8	3.0	3.0	3.0
	Growing				Stabilized			
Employees Per Acre	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	15.2	15.3	15.0	15.2	15.2	15.2	15.0	15.2
High Density Commercial	24.8	24.8	24.8	24.8	24.8	24.9	24.9	24.8
Low Density Commercial	31.0	38.6	38.6	38.6	38.6	38.6	38.6	38.6

Source: DVRPC July 2009

The density parameters in Table 40 are largely taken from *Realizing Density; Strategies for Compact Suburban Development* (Publication # 05009, DVRPC 2004), several iterations of increasing development densities were needed to accommodate the 2035 socioeconomic growth targets into FGAs.

Sprawl 2035 Scenario

The Sprawl scenario does not employ infill development; it assumes migration within and between the DVRPC counties, the inverse of infill. It is necessary to assume this movement to achieve adequate differentiation from the Trend scenario. Since the UPlan model is not capable of relocating existing population or employment within or between counties and/or the region, new footprint county population and employment totals are enhanced by the amount of internal migrants. Core city and developed community populations are reduced by the same number. This creates vacancies and potential new open space within the existing developed communities, which do not appear in the UPlan generated new footprint maps.

These modifications are made by creating a revised baseline population for each municipality to which the UPlan new footprint population allocation is added to derive total population and employment. As in the Growth Area and Trend scenarios, the revised baseline municipal estimates are disaggregated to zones using 2005 proportions of employment and population. The Sprawl scenario zonal allocation consists of two components: UPlan new footprint development and relocated population and employment as a result of internal county migration.

In order to achieve observed land use patterns, the new footprint allocation for the Sprawl scenario prepared by UPlan utilizes specialized land use type distributions and development densities. In general, lower density land use types received larger proportions of residential and commercial development in Table 41, as compared with the Trend and Growth Area scenarios in Tables 38 and 40.

Table 41. Sprawl: Land Use Type Distribution

	Growing				Stabilized			
Residential	**Bucks**	**Chester**	**Burlington**	**Gloucester**	**Montgomery**	**Delaware**	**Camden**	**Mercer**
High Density	10.0%	10.0%	20.2%	15.0%	10.0%	30.0%	10.0%	10.0%
Medium Density	15.0%	15.0%	22.6%	40.0%	20.0%	45.0%	20.0%	15.0%
Low Density	75.0%	75.0%	57.2%	25.0%	70.0%	25.0%	70.0%	75.0%
Very Low Density	na	na	na	na	na	na	na	na
	Growing				**Stabilized**			
Commercial	**Bucks**	**Chester**	**Burlington**	**Gloucester**	**Montgomery**	**Delaware**	**Camden**	**Mercer**
Industrial	4.3%	0.1%	0.1%	5.0%	5.0%	8.2%	0.1%	11.7%
High Density Commercial	12.0%	22.3%	22.3%	7.4%	7.4%	13.3%	22.3%	61.6%
Low Density Commercial	83.7%	77.6%	77.6%	87.6%	87.6%	78.5%	77.6%	26.7%

Source: DVRPC July 2009

Prevailing densities within selected development categories and counties were also adjusted to produce the characteristic development patterns of sprawl (see Table 41). Comparisons with the detailed development densities given in Tables 38 and 39 indicate that the degree of reduction varies by development type and county, although small density differences between these tables are the result of UPlan rounding. Preliminary new footprint land use patterns were reviewed carefully, and the development pattern adjusted as needed to produce satisfactory simulations for each county.

Table 42. Sprawl: Residential and Employment Development Density

Residential Units Per Acre	Growing				Stabilized			
	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	6.7	8.3	8.0	10.0	10.0	10.0	11.1	11.1
Medium Density	2.0	2.2	5.6	4.6	6.3	4.0	7.1	6.3
Low Density	1.0	0.9	2.7	1.3	1.5	1.4	3.3	2.0
	Growing				Stabilized			
Employees Per Acre	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	3.2	9.4	18.0	2.4	9.4	9.8	22.0	15.2
High Density Commercial	11.8	17.6	37.9	9.4	9.4	28.9	12.5	57.9
Low Density Commercial	3.5	10.3	17.6	5.5	5.5	14.7	7.6	16.5

Source: DVRPC July 2009

Recentralization 2035 Scenario

The Recentralization scenario relies on a proportional infill mechanism to reduce new footprint development over the life of the analysis. In this scenario, new footprint is limited to 10 percent of population growth in Delaware and Mercer counties, and 20 percent in all other counties included in the study. Except for cleared brown fields and other vacant lots, UPlan cannot identify areas that are capable of supporting infill. Regardless, most population and employment growth is assumed to locate in core cities and existing developed areas, which are largely built-out. As in the Trend and Growth Area scenarios, infill into developed areas is allocated to TAZs by proportion to the 2005 population or employment estimates. And then, the infill is added to the UPlan new footprint TAZ allocations and the 2005 estimates to produce the forecasts.

In suburban areas, new footprint land consumption is minimized by significantly increasing the percentage of development that takes place at high densities. These increased densities are shown in Table 44. For instance, in Bucks County the percentage of residential high density is increased from 20 percent under the Trend and Growth Area scenarios to 50 percent under the Recentralization scenario, with similar large increases for high density commercial. For largely developed counties, the increase is even higher to 60 to 80 percent.

Table 43. Recentralization: Land Use Type Distribution

	Growing				Stabilized			
Residential	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	50.0%	45.0%	50.0%	45.0%	60.0%	70.0%	80.0%	60.0%
Medium Density	35.0%	40.0%	35.0%	40.0%	30.0%	20.0%	15.0%	30.0%
Low Density	15.0%	15.0%	15.0%	15.0%	10.0%	10.0%	5.0%	10.0%
Very Low Density	na	na	na	na	na	na	na	na
	Growing				Stabilized			
Commercial	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	4.3%	0.1%	0.1%	5.0%	1.0%	8.2%	0.1%	11.7%
High Density Commercial	70.7%	75.0%	77.6%	71.0%	80.0%	78.5%	77.6%	80.8%
Low Density Commercial	25.0%	24.9%	22.3%	24.0%	19.0%	13.3%	22.3%	7.5%

Source: DVRPC July 2009

For each land use type, the development densities are increased from the calibrated densities given in Table 38 utilized for the Trend scenario. DVRPC recommended densities from *Realizing Density; Strategies for Compact Suburban Development*, used in the Growth Area scenario, where for the most part, reused to allocate new footprint land consumption here. These values are repeated in Table 44.

Table 44. Recentralization: Residential and Employment Development Density

Residential (Units Per Acre)	Growing				Stabilized			
	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
High Density	12.51	12.51	12.51	12.51	12.52	12.54	12.5	12.53
Medium Density	6.67	6.67	6.67	6.67	6.67	6.68	6.66	6.67
Low Density	3.03	3.88	3.02	3.02	3.03	3.03	3.31	3.04
Commerical (Employees Per Acre)	Growing				Stabilized			
	Bucks	Chester	Burlington	Gloucester	Montgomery	Delaware	Camden	Mercer
Industrial	15.13	15	15	15.17	15	15.16	15	15.19
High Density Commercial	24.81	24.8	24.8	24.81	24.81	24.83	24.82	24.8
Low Density Commercial	38.57	38.59	38.56	38.58	38.61	38.56	38.63	38.63

Source: DVRPC July 2009

In the next step, the alternate county population totals will be input into UPlan to allocate the new footprint development within each county among competing municipalities, given the above density parameters. UPlan forecast TAZ population and employment is calculated as the sum of current 2005 plus the new footprint and infill/migration allocations. The zonal output of the scenario generation process was then input to the TDM to estimate the regional impacts of each scenario.

Allocation of Scenario New Footprint Development

UPlan allocates the county control population and employment projections, as described in the first two sections of this chapter, to new footprint development. The Trend and Sprawl scenarios utilize the calibrated attractor and detractor values given in Tables A-1 to A-3 and the development masks described in Chapter III. The Recentralization and Growth Area scenarios are simulated using the same masks, but with a set of attractor and detractor values that differ from the calibration parameters. The future development that occurs in these scenarios is denser and more transit-oriented. Table 45 shows the Recentralization attractors that change and the related policy implications.

Table 45. Recentralization: Policy Basis for UPlan Attraction Changes

Increased Parameter	Policy Basis
Residential New Footprint Density	Promote Transit-Oriented Development
Residential and Commercial Attraction to Transit	Promote Transit-Oriented Development
Residential Attraction to Commercial	Encourage Mixed-Use Development
Commercial Attraction to Residential	Encourage Mixed-Use Development

Source: DVRPC July 2009

Table 46 lists the parameters related to transportation and land use. The values in this table will supplement the ones found in Appendix A. Parameters not listed below remain the same as the calibrated value.

Table 46. Recentralization: Regional Attractor and Discouragement Parameters

Industrial Attractor/Detractor Parameters	Buffer Size (ft.)	Weight
Bus Lines (Interval 1)	400	10
Bus Lines (Interval 2)	800	6
Rail Stations (Interval 1)	1,320	10
Rail Stations (Interval 2)	2,640	6
Commercial High Attractor/Detractor Parameters	**Buffer Size (ft.)**	**Weight**
Bus Lines (Interval 1)	400	20
Bus Lines (Interval 2)	800	12
Rail Stations (Interval 1)	1,320	40
Rail Stations (Interval 2)	2,640	24
1990 High Density Residential	3,000	25
Commercial Low Attractor/Detractor Parameters	**Buffer Size (ft.)**	**Weight**
Bus Lines (Interval 1)	400	15
Bus Lines (Interval 2)	800	9
Rail Stations (Interval 1)	1,320	20
Rail Stations (Interval 2)	2,640	12
1990 High Density Residential	5,000	10
Residential High Attractor/Detractor Parameters	**Buffer Size (ft.)**	**Weight**
Bus Lines (Interval 1)	400	25
Bus Lines (Interval 2)	800	15
Rail Stations (Interval 1)	1,320	50
Rail Stations (Interval 2)	2,640	30
1990 Commercial	3,000	25
Residential Medium Attractor/Detractor Parameters	**Buffer Size (ft.)**	**Weight**
Bus Lines (Interval 1)	400	15
Bus Lines (Interval 2)	800	9
Rail Stations (Interval 1)	1,320	20
Rail Stations (Interval 2)	2,640	12
1990 Commercial	5,000	10
Residential Low Attractor/Detractor Parameters	**Buffer Size (ft.)**	**Weight**
Bus Lines (Interval 1)	400	5
Bus Lines (Interval 2)	800	3
Rail Stations (Interval 1)	1,320	10
Rail Stations (Interval 2)	2,640	6

Source: DVRPC July 2009

Setting up the attractor and detractor values for each scenario by county is the first step in UPlan. Following this, the UPlan model is executed separately for each scenario to allocate new footprint development to specific development sites. It requires several simulations to fine tune the UPlan allocation methods to achieve reasonable results, especially for the Growth Area and Sprawl scenarios. For the Growth Area scenario, the density parameters were increased incrementally from the calibrated values as described in Chapter II until the county new footprint population and employment totals fit into the available space in the FGAs, after the 2000-2005 development increment is removed. For the Sprawl scenario, development densities were increased as described in the section above, and the preserved land masks expanded to include additional areas that have or are likely to be protected by some form of preservation. The results of the UPlan allocations are described, documented in tabular form, and mapped at the regional level below.

UPlan New Footprint Land Use Allocation Results

Each scenario varies in regard to the magnitude and density of new footprint households, as well as the infill assumptions. These assumptions reflect the scenario specific demographic forecasts for each county. A regional snap shot of the new footprint development under each scenario is given in Figure 15 for the Trend scenario, Figure 16 for the Growth Area scenario, Figure 17 for the Sprawl scenario and Figure 18 for the Recentralization scenario. It is immediately apparent upon comparing these figures that both the extent and distribution of new footprint development varies dramatically by scenario. Appendix D provides illustrative maps of each county by scenario.

Scenario Development Patterns

The new footprint land consumption patterns under the Trend scenario are shown in Figure 15. It is immediately striking upon comparison of the settlement patterns in the Trend and Growth Area (Figure 16) scenarios, that development footprint expands towards the nine-county boundary under the Trend scenario. The land use patterns do not represent total build-out of available open space, but development goes well beyond the region's core transportation system into significant open space areas albeit at relatively low development densities. This consumes open space without accommodating large numbers of people in newly developed areas. In any case, Trend scenario new development patterns are less severe in terms of open space consumption than the Sprawl scenario which produces near total build-out of the unprotected, undeveloped areas of the region.

Figure 17 presents a snap shot of new footprint development patterns under the Sprawl scenario. Except for the Pine Barrens in Burlington, Lower Camden, and Lower Gloucester counties, protected open spaces tend to be rather small and isolated. Sprawl consumes most remaining open space by inundating it with relatively low density new footprint development. Older, high density portions of the region undergo significant population and employment losses. This scenario is included for analytical and illustrative purposes only, to understand the effects of advanced sprawling tendencies.

Figure 20. Trend: Allocation New Footprint Development

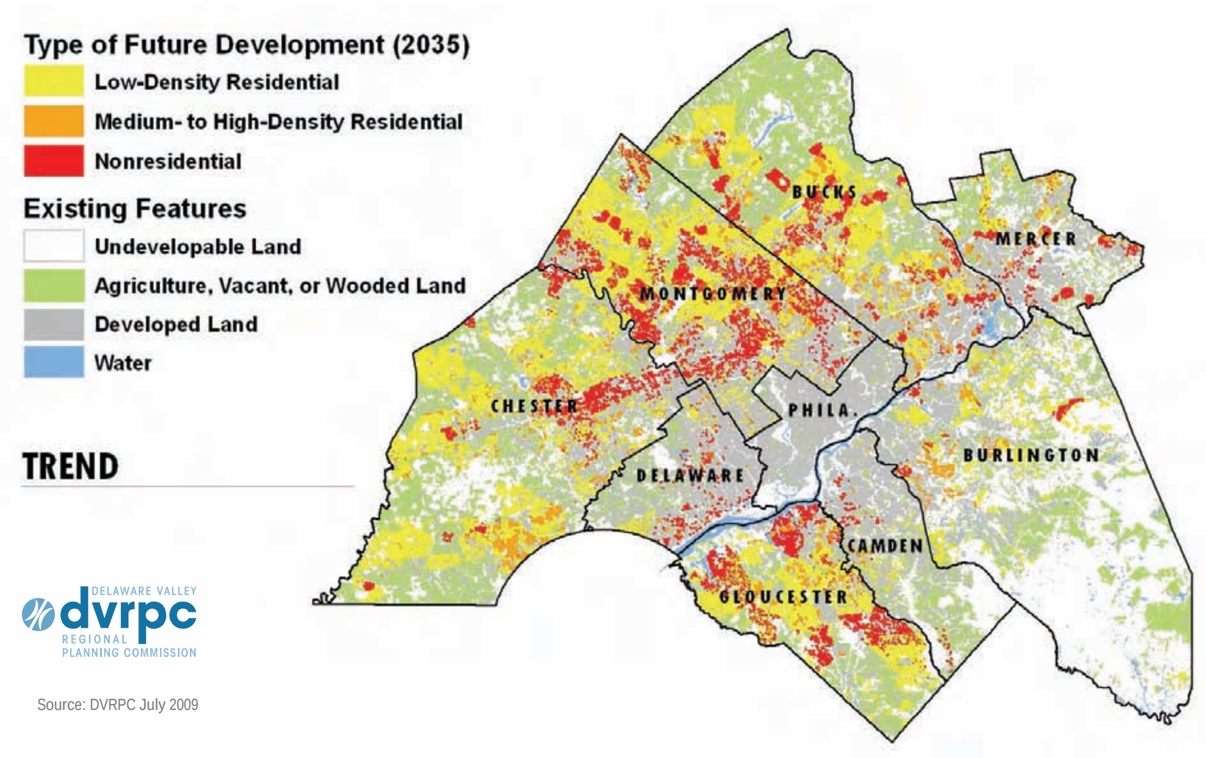


Figure 21. Growth Area: Allocation New Footprint Development

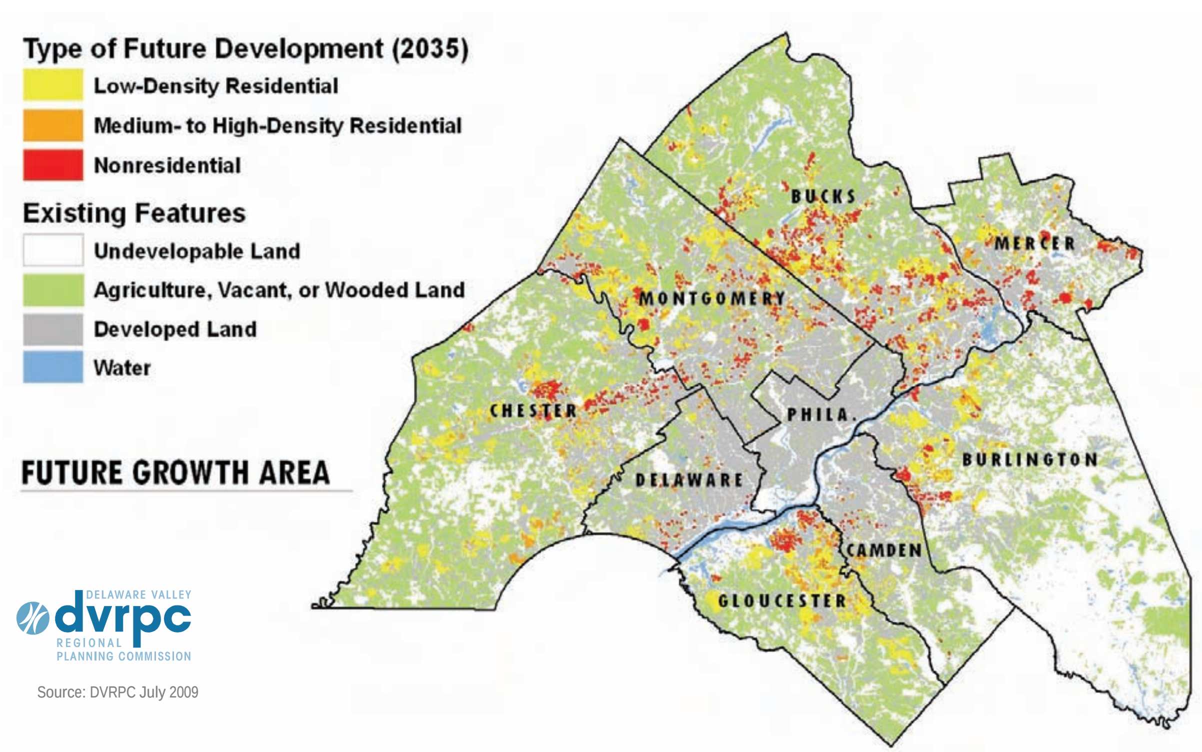
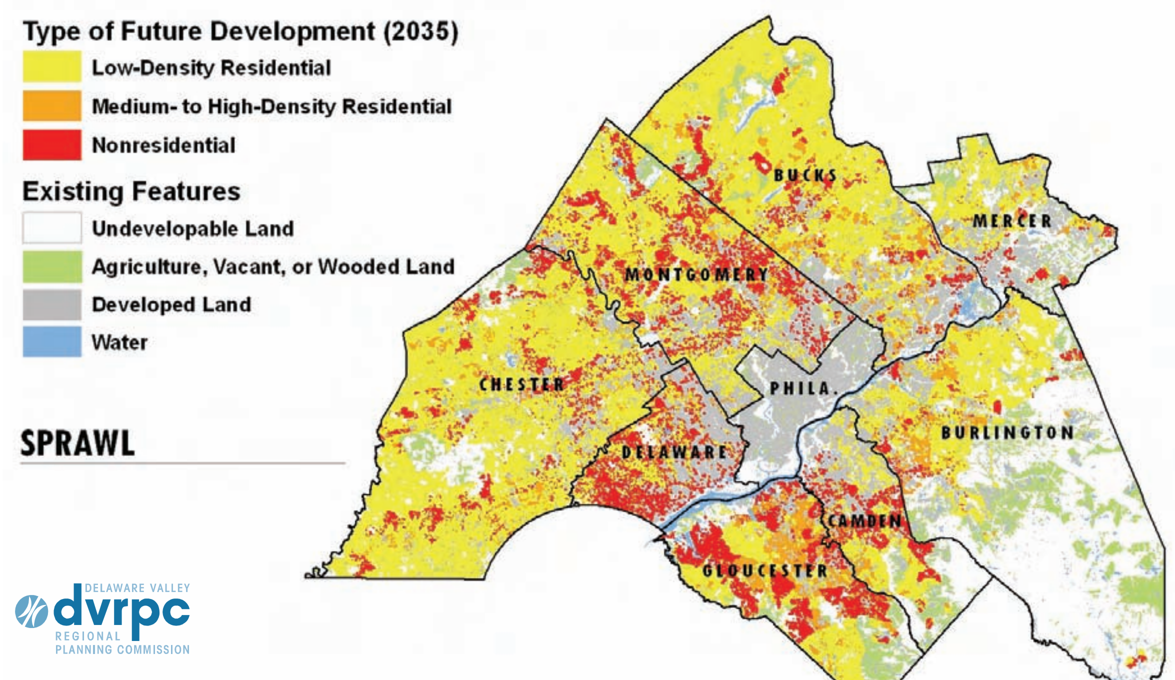
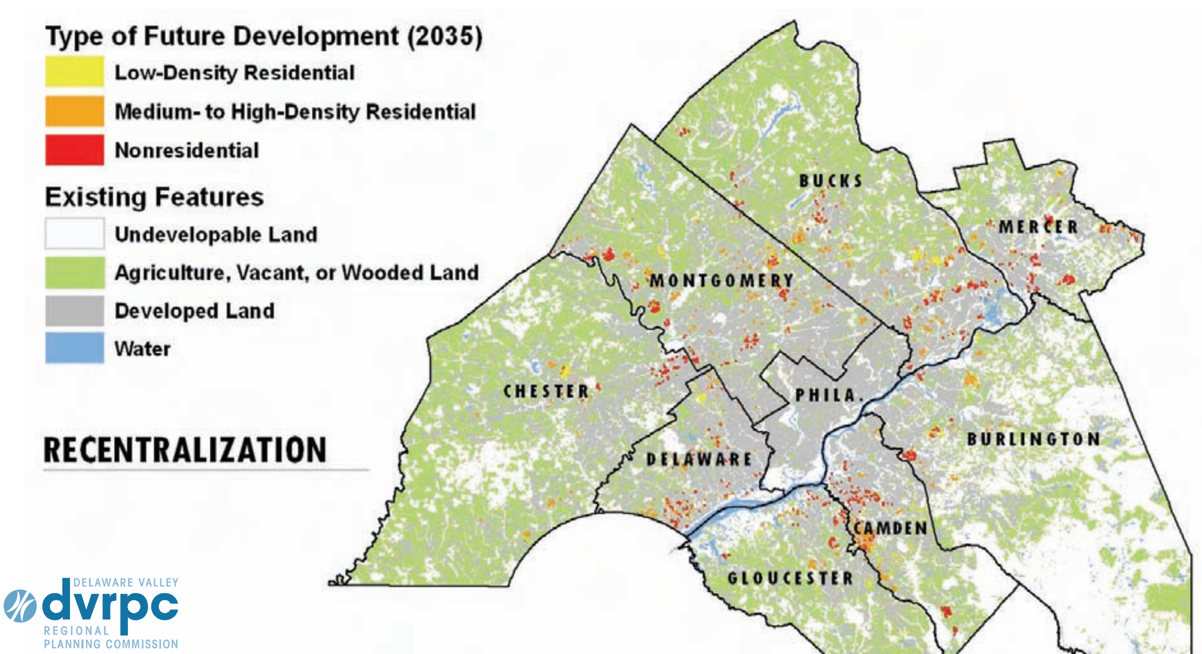


Figure 22. Sprawl: Allocation of New Footprint Development



Source: DVRPC July 2009

Figure 23. Recentralization: Allocation of New Footprint Development



Source: DVRPC July 2009

The Recentralization scenario, shown in Figure 18, produces comparatively little new footprint development. What does occur tends to be tightly clustered commercial development around freeway interchanges. Under this scenario, only the most desirable locations receive new footprint development.

In the Growth Area scenario, FGAs are fully utilized by new footprint development (Figure 16). These areas are identified as being suitable for high density development in support of a number of regional goals detailed in Destination 2030 and the upcoming Connections regional plans. New development is clustered around currently developed areas, which taken together, are more extensive than the Recentralization scenario, but considerably less than under the Trend scenario.

Table 47. 2035 New Footprint Residential Land Consumption by Scenario

	Trend			Growth Area		
County	New Footprint Population	Land Consumption (acres)	Acres per Capita	New Footprint Population	Land Consumption (acres)	Acres per Capita
Bucks	72,419	19,963	0.276	75,109	8,518	0.113
Chester	66,666	45,592	0.684	79,748	7,364	0.092
Delaware	2,646	431	0.163	4,788	403	0.084
Montgomery	67,916	11,519	0.17	71,445	7,062	0.099
Philadelphia	na	na	na	na	na	na
PA Sub-Total	**209,647**	**77,504**	**0.37**	**231,090**	**23,347**	**0.101**
Burlington	40,475	6,580	0.163	54,650	4,817	0.088
Camden	2,395	1,239	0.517	2,928	290	0.099
Gloucester	64,094	15,621	0.244	71,120	7,785	0.109
Mercer	17,084	1,671	0.098	23,093	1,670	0.072
NJ Sub-Total	**124,048**	**25,110**	**0.202**	**151,791**	**14,562**	**0.096**
Total	**333,695**	**102,614**	**0.308**	**382,881**	**37,909**	**0.099**
	Sprawl			**Recentralization**		
County	**New Footprint Population**	**Land Consumption (acres)**	**Acres per Capita**	**New Footprint Population**	**Land Consumption (acres)**	**Acres per Capita**
Bucks	299,225	104,737	0.35	14,268	295	0.021
Chester	373,086	124,046	0.332	7,578	404	0.053
Delaware	109,486	14,491	0.132	7,826	388	0.05
Montgomery	269,192	51,067	0.19	18,775	95	0.005
Philadelphia	na	na	na	na	na	na
PA Sub-Total	**1,050,988**	**294,341**	**0.28**	**48,447**	**1,182**	**0.024**
Burlington	225,551	36,672	0.163	9,325	488	0.052
Camden	110,596	12,703	0.115	13,902	658	0.047
Gloucester	217,670	36,633	0.168	4,649	300	0.065
Mercer	79,805	11,671	0.146	4,436	901	0.203
NJ Sub-Total	**633,621**	**97,679**	**0.154**	**32,312**	**2,347**	**0.073**
Total	**1,684,610**	**392,020**	**0.233**	**80,759**	**3,529**	**0.044**

Source: DVRPC July 2009

Residential Land Consumption and Density

Residential land consumption is presented in Table 47; commercial land consumption is given in Table 48. The overall amount of open space consumed for residential uses varies over the range of scenarios from 3,500 acres under the Recentralization scenario to 392,000 acres under the Sprawl scenario. The Recentralization and Growth Area scenarios have the highest residential density -- 0.044 and 0.099 acres per new footprint resident, respectively. This represents a consistent policy of high density development across the region coupled with a strong preference towards infill in the Recentralization and Growth Area scenarios. The Sprawl scenario has significantly lower overall new footprint residential density (0.233 acres per capita) with no policy commitment to infill; while the Trend scenario produces the lowest density of new footprint development (0.308 acres per capita).

Table 48. 2035 New Footprint Commercial Land Consumption by Scenario

	Trend			Growth Area		
County	New Footprint Employment	Land Consumption (acres)	Acres per Employee	New Footprint Employment	Land Consumption (acres)	Acres per Employee
Bucks	30,009	3,556	0.119	47,418	3,965	0.084
Chester	50,089	3,355	0.067	44,844	1,308	0.029
Delaware	295	268	0.91	5,299	73	0.014
Montgomery	45,158	7,481	0.166	52,617	1,525	0.029
Philadelphia	na	na	na	na	na	na
PA Sub-Total	**125,551**	**14,661**	**0.117**	**150,178**	**6,871**	**0.046**
Burlington	10,780	310	0.029	23,056	673	0.029
Camden	2,635	153	0.058	1,537	46	0.03
Gloucester	16,975	3,508	0.207	28,099	814	0.029
Mercer	21,303	581	0.027	24,148	952	0.039
NJ Sub-Total	**51,693**	**4,552**	**0.088**	**76,840**	**2,485**	**0.032**
Total	**177,244**	**19,213**	**0.108**	**227,018**	**9,356**	**0.041**

	Sprawl			Recentralization		
County	New Footprint Employment	Land Consumption (acres)	Acres per Employee	New Footprint Employment	Land Consumption (acres)	Acres per Employee
Bucks	79,738	20,928	0.262	7,547	286	0.038
Chester	185,308	16,340	0.088	4,482	165	0.037
Delaware	50,978	3,384	0.066	6,828	128	0.019
Montgomery	118,167	20,343	0.172	12,447	183	0.015
Philadelphia	na	na	na	na	na	na
PA Sub-Total	**434,100**	**60,995**	**0.141**	**31,304**	**762**	**0.024**
Burlington	114,872	3,682	0.032	2,765	103	0.037
Camden	54,521	6,568	0.12	5,644	210	0.037
Gloucester	74,485	14,014	0.188	1,894	72	0.038
Mercer	26,723	925	0.035	4,342	471	0.108
NJ Sub-Total	**270,601**	**25,189**	**0.093**	**14,645**	**856**	**0.058**
Total	**704,792**	**86,184**	**0.122**	**45,949**	**1,618**	**0.035**

Source: DVRPC July 2009

Commercial Land Consumption and Density

For commercial development, land consumption ranges from 1,600 acres under the Recentralization scenario to 86,000 acres under the Sprawl scenario. The land consumption variation for commercial activities is significantly less than for residential uses because about one in two new footprint persons is employed in the county of residence, and because commercial development is denser than residential development and locates along principal roadways and at highly desirable freeway interchanges, particularly under the Growth Area and Sprawl scenarios.

Overall Land Consumption by Scenario

Table 49 presents a summary of residential and commercial new footprint land consumption in acres and as a percentage of developable land for each scenario. These statistics mirror the new footprint development patterns displayed in Figures 15 through 18, but quantify the UPlan results both as developed acres and the percentage of total build-out of the developable land. As noted above, the degree of build-out varies tremendously by scenario, but also by county within each scenario. This variation in new development is a function of increasing the population and employment forecasts and as noted in the first two sections of this chapter, degree of infill, assumed development densities, and in the case of the Growth Area scenario, the distribution of FGAs.

Overall, the Recentralization scenario produces the least new footprint development, with relatively uniform land consumption rates by county -- less than 4 percent of available land consumed in all counties and 0.7 percent of developable space overall.

The Growth Area scenario new footprint development is evenly distributed by state. It consumes 6.4 percent of available land in both Pennsylvania and 6.5 percent in New Jersey and 6.4 percent overall. However, new footprint development is not evenly distributed by county. It tends to be concentrated in Bucks, Chester, Montgomery, and Gloucester counties, where significant acreages of FGAs are located.

The Trend scenario significantly increases open space land consumption for all counties except Delaware and Mercer counties, where relatively low demographic forecasts moderate land consumption. Similar to the Growth Area scenario, new footprint development tends to be concentrated in current high growth counties such as Chester, Bucks, Montgomery, and Gloucester counties. The overall magnitude of open space consumption triples in Pennsylvania (6.4 to 19.4 percent of available land) and almost doubles in New Jersey (6.5 to 11.3 percent).

The Sprawl scenario approaches total build-out in Pennsylvania with about 75 percent of 2005 available space consumed by new development. New Jersey fares somewhat better with 46.8 percent of available land consumed. However, these acreages and percentages do not include the land consumed by current 2005 development, and the overall percentage of county area covered by development is much higher.

As noted in the first two sections of this chapter, sprawling development patterns resulted from three major assumptions – all new development occurs as new footprint (no infill), migration continues away from these same areas, and a reduction in the calibrated 1990 to 2000 development density distribution. The infill percentages assumed in the Growth Area and Trend are higher than those observed during 1990 to 2000 calibration period and unless policies are enacted to realize these high infill percentages, actual future development patterns may fall somewhere between the Trend and Sprawl scenarios.

Table 49. Residential, Commercial, and Total Land Consumption by Scenario

County	Trend				Growth Area			
	Residential	Commercial	Total	Build-out Percent	Residential	Commercial	Total	Build-out Percent
Bucks	19,963	3,556	**23,519**	15.4%	8,518	3,965	**12,483**	8.2%
Chester	45,592	3,355	**48,947**	23.2%	7,364	1,308	**8,672**	4.1%
Delaware	431	268	**699**	3.8%	403	73	**476**	2.6%
Montgomery	11,519	7,481	**19,000**	20.4%	7,062	1,525	**8,587**	9.2%
Philadelphia	na	na	**na**	na	na	na	**na**	na
PA Sub-Total	**77,504**	**14,661**	**92,165**	**19.4%**	**23,347**	**6,871**	**30,218**	**6.4%**
Burlington	6,580	310	**6,890**	5.4%	4,817	673	**5,490**	4.3%
Camden	1,239	153	**1,392**	4.4%	290	46	**336**	1.1%
Gloucester	15,621	3,508	**19,129**	29.6%	7,785	814	**8,599**	13.3%
Mercer	1,671	581	**2,252**	5.9%	1,670	952	**2,622**	6.8%
NJ Sub-Total	**25,110**	**4,552**	**29,663**	**11.3%**	**14,562**	**2,485**	**17,047**	**6.5%**
Total	**102,614**	**19,213**	**121,828**	**16.5%**	**37,909**	**9,356**	**47,265**	**6.4%**
County	**Sprawl**				**Recentralization**			
	Residential	**Commercial**	**Total**	**Build-out Percent**	**Residential**	**Commercial**	**Total**	**Build-out Percent**
Bucks	104,737	20,928	**125,665**	82.3%	295	286	**581**	0.4%
Chester	124,046	16,340	**140,386**	66.5%	404	165	**569**	0.3%
Delaware	14,491	3,384	**17,875**	96.5%	388	128	**516**	2.8%
Montgomery	51,067	20,343	**71,410**	76.7%	95	183	**278**	0.3%
Philadelphia	na	na	**na**	na	na	na	**na**	na
PA Sub-Total	**294,341**	**60,995**	**355,336**	**74.7%**	**1,182**	**762**	**1,944**	**0.4%**
Burlington	36,672	3,682	**40,354**	31.5%	488	103	**591**	0.5%
Camden	12,703	6,568	**19,271**	61.3%	658	210	**868**	2.8%
Gloucester	36,633	14,014	**50,647**	78.3%	300	72	**372**	0.6%
Mercer	11,671	925	**12,596**	32.8%	901	471	**1,372**	3.6%
NJ Sub-Total	**97,679**	**25,189**	**122,868**	**46.8%**	**2,347**	**856**	**3,203**	**1.2%**
Total	**392,020**	**86,184**	**478,204**	**64.8%**	**3,529**	**1,618**	**5,147**	**0.7%**

Source: DVRPC July 2009

The Travel Demand Model / Land Use Model Connection

UPlan has the capability to summarize new footprint development and the associated population and employment increases by TAZ. New footprint population and employment growth is added to corresponding TAZ infill and migration and existing 2005 estimates to produce the TAZ level population and employment forecasts under each scenario. These TAZ allocations are input to the TDM to simulate the impact on regional travel patterns. Each scenario is simulated independently.

The TDM is prepared for each of the four scenarios assuming the same "existing plus committed" highway and transit networks which include existing (2005) highway facilities and public transit routes plus committed facility improvements that will be in service by 2009. The differences between scenarios are characterized at the TAZ level demographic and employment estimates prepared by UPlan using methods described previously. These socioeconomic data sets are input to the TDM, followed by the mobile source emissions postprocessor, and simulated separately for each scenario. The resulting highway link and transit line volumes are summarized to quantify the transportation impacts of the land use scenarios.

Municipal and Zonal Socioeconomic Projections for Trip Generation

The trip generation step of the TDM chain requires estimates of several socioeconomic variables that are transformed in the trip generation step to estimates of travel by trip purpose and time period. UPlan tabulates new footprint acreage by TAZ to develop these socioeconomic variables. The new footprint allocations are converted into equivalent estimates using the inverse of the assumed development densities. Totals of both population and employment are calculated as the sum of the 2005 estimates, plus infill or minus migration, plus forecast new footprint development. Prior to preparing the full set of trip generation input variables, an accuracy check is performed by tabulating the forecasts for each scenario by MCD and by county and comparing the results with the county control totals developed above.

The remaining demographic variables for trip generation are calculated for each scenario by factoring the estimates in the Trend scenario by the ratio of each scenario forecast to the Board-forecast population. In addition to population, demographic variables include: group quarters population, total households, households by auto ownership (0-car, 1-car, 2-car, 3+ car), and employed residents.

Similarly, the categories of employment for trip generation are factored under each scenario use the employment estimates in the Board-forecasts. Total employment is divided into the following categories: agriculture, mining, construction, manufacturing, transportation, wholesale, retail, finance and insurance and real estate (together), service, government, and military.

Brief Description of the DVRPC Travel Demand Model

The DVRPC travel demand model follows the traditional four-step travel demand simulation process that consists of:

- The first of the four steps, trip generation, estimates the number of trips produced within specific areas (TAZs) based on the population and employment characteristics of that area. Trips are generated for a number of different trip purposes.
- Trip distribution, which occurs next, determines where the trips produced in the first step will travel to by looking at the ease of getting to every possible location and draw of that area for that trip purpose. This establishes an origin and destination for each trip.

- The next step, mode choice, determines how a particular trip will be made, such as by driving a car, carpooling, riding transit, or walking.
- Finally, the TDM determines which paths along the road or transit network each trip will take to reach its final destination. This step is called trip assignment. Paths are calculated to find those that minimize travel time and cost.

The enhanced travel simulation process utilizes the Evans Algorithm to iterate the process (see Appendix E). The purpose of iteration is to achieve, in future forecasts, a balance between input travel speeds and other assumptions and the corresponding simulated outputs from the TDM. This balance between inputs and outputs is required by federal regulations.

DVRPC uses the Environmental Protection Agency (EPA) mandated application, MOBILE6, to estimate mobile source emissions produced in the region based on inputs from the TDM. MOBILE6 is a program that provides estimates of current and future emissions from highway motor vehicles for hydrocarbons, carbon monoxide, and oxides of nitrogen from the following sources: gas, diesel, and natural gas fueled cars, tracks, buses, and motorcycles.

Forecasts that result from the TDM and MOBILE6 models are used for many purposes, such as to determine the usage of a proposed transportation improvement (new road or transit line), the impact on area facilities of a change in roadway operational features or transit service features, or to evaluate the effects of the transportation system on regional air quality.

A more extensive overview of the TDM is included as Appendix E. An exhaustive description is given in the DVRPC report entitled *2000 and 2005 Validation of the DVRPC Regional Simulation Models* (Publication# 08095, DVRPC 2008).

Regional Overview of Transportation and Pollutant Impacts

As noted in previous sections, the impacts of the scenarios differ significantly by county. Rapidly growing counties (Bucks, Chester, Montgomery, Burlington, and Gloucester) have similarities in the impacts of the various scenarios on land use, transportation, and environmental indicators, as do stable counties (Delaware, Camden, and Mercer), but significant individualities in county behavior also exist that warrant individual analysis.

Regionally, the scenarios are clearly differentiated in terms of travel and emissions measures, though some trade-offs become apparent in the analysis of individual indicators and time periods. Table 50 presents selected average daily indicators of highway travel demand and transport network performance. For daily totals, the Sprawl scenario generates the greatest highway vehicle miles traveled (VMT), allows for the slowest average highway speed leading to largest highway vehicle hours traveled (VHT). The compact land development associated with the Recentralization scenario generates both the least highway VMT and VHT, but with second fastest average highway speed reflecting increased congestion in currently developed areas in need of transportation investment. The Trend scenario generates the second greatest highway VHT while the Growth Area scenario provides the highest average highway speed.

Table 50. Regional Daily Highway Travel Indicators

Average Daily	Scenario	Highway Vehicle Trips	Highway VMT (mi)	Highway VHT (hr)	Highway Average Vehicle Trip Length (mi)	Highway Average Speed (mph)
	Recentralization	20,831,929	128,835,424	4,182,967	6.0	30.8
	Growth Area	21,154,481	130,029,380	4,208,067	5.9	30.9
	Trend	21,478,785	133,359,424	4,343,954	6.1	30.7
	Sprawl	22,774,026	136,856,304	4,487,091	5.9	30.5

Source: DVRPC July 2009

Table 51 presents the comparable regional daily indicators for transit travel in the region. The most striking difference is that the Recentralization scenario generates the most transit boardings, fifty percent greater than in the Sprawl scenario, but it also interesting to note that Sprawl has the lowest total travel hours (highway + transit) of any scenario. Sprawl promotes balkanization of the region into localized, relatively self-contained low density areas that increase the number of trips generated and the mileage of travel, but still serve personal transport needs more effectively in terms of hours devoted to travel because of higher speeds. The Growth Area and Trend scenarios are similar in terms of transit ridership with overall ridership at roughly current levels.

Table 51. Regional Daily Transit Travel Indicators

Average Daily	Scenario	Transit Boardings	Transit Passenger Miles	Transit Passenger Hours	Transit Avg. Trip Length (mi)	Transit Avg. Speed (mi/hr)
	Recentralization	1,192,606	5,009,687	275,556	4.2	18.2
	Plan	1,086,532	4,544,584	248,185	4.2	18.3
	Trend	1,051,441	4,441,300	242,740	4.2	18.3
	Sprawl	761,330	3,288,139	174,778	4.3	18.8

Source: DVRPC July 2009

Overall, transit average in-vehicle trip lengths tend to be shorter than highway -- 4.2 miles versus about 6 for highway. However, about 35 percent of transit trips involve a transfer between routes which increases the average origin to destination transit trip to about 6 miles as well. Transit trips take about 50 percent longer because the transit average speed is about 18 miles per hour versus about 30 miles per hour for highway.

Table 52 presents a regional analysis of the mobile source emissions consequences of each of the four scenarios. Because of the large co-linearity between scenario highway VMT, speed, and mobile source emissions consequences, the pattern of emissions and fuel consumption results strongly resemble the highway network consequences in Table 50. For this reason, the scenarios have the same overall order of environmental desirability noted for highway and transit travel above, that is; Recentralization, followed by Growth Area, then Trend, and finally the Sprawl scenario.

Table 52. Regional Mobile Source Emissions by Scenario

Scenario	VOC (tons/day)	NOX (tons/day)	PM2.5 (tons/day)	CO2 (tons/day)	Fuel Consumption (gal/day)
Recentralization	29.6	21.1	1.7	72,984.9	7,289,625
Growth Area	29.9	21.3	1.8	73,687.7	7,360,581
Trend	30.7	21.8	1.8	75,551.2	7,546,695
Sprawl	31.5	22.2	1.8	77,607.1	7,750,904

Source: DVRPC July 2009

Evaluation of Scenario Results

This analysis is configured as a simple goals achievement matrix, centered on the Trend scenario. The Trend scenario results are used as the point of reference for this analysis because it represents the 2035 regional outcome, without additional planning interventions. Forecast results for other scenarios are characterized with a "plus" if the indicator is judged to be more desirable than the Trend result, a "minus" if the scenario results are less desirable than the Trend, and a "zero" if the scenario indicator is judged to be the same as the Trend scenario. The final score for each scenario vis-à-vis the Trend scenario is determined by simply adding up the negatives and positives across the goals achievement matrix to determine a net scenario score.

Table 53. Average Daily Transport Goals Achievement

<table>
<tr><th></th><th>Mode</th><th>Measure</th><th>Recentralization</th><th>Growth Area</th><th>Trend</th><th>Sprawl</th></tr>
<tr><td rowspan="11">Average Daily</td><td rowspan="5">Highway</td><td>Vehicle Trips</td><td>+</td><td>+</td><td rowspan="11">Baseline Scenario</td><td>-</td></tr>
<tr><td>VMT</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td>VHT</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td>Average Trip Length</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td>Average Speed</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td rowspan="5">Transit</td><td>Transit Boardings</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td>Passenger Miles</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td>Passenger Hours</td><td>+</td><td>+</td><td>-</td></tr>
<tr><td>Average Trip Length</td><td>0</td><td>0</td><td>+</td></tr>
<tr><td>Average Speed</td><td>-</td><td>0</td><td>+</td></tr>
<tr><td colspan="2">Sub-total</td><td>+7</td><td>+7</td><td>-6</td></tr>
</table>

Source: DVRPC July 2009

Average daily highway and transit goals achievement are summarized in Table 53. The detailed results have already been described above. Overall, the Growth Area and Recentralization scenarios fare similarly on average daily transport goals, each receiving a rating of +7. These scenarios are equal for all measures except for highway speed, which is worse for the Recentralization scenario because of the concentration of new residents into the already congested core of the system without any additional transportation investment. The Sprawl scenario has a higher transit average trip length and faster transit speed because diffuse settlement patterns mean transit dependant (0-car and 1-car) households have to travel farther to their destinations (jobs, shopping, etc) but fewer boardings allow busses to travel faster by not stopping as frequently. Sprawl does worse than Trend for all other average transport measures, for a net rating of -6.

Mobile source emissions and fuel consumption indicators, shown in Table 54, display the advantage of the Recentralization scenario over the Growth Area scenario vis-à-vis the Trend scenario. As in all other composite measures, the Sprawl scenario is much worse than the Trend scenario. Finally, Table 55 provides a regional summary of the land consumption/open space preservation impacts of the Recentralization, Growth Area, and Sprawl scenarios. At the regional level, the Recentralization and Growth Area scenarios consume fewer acres of open space than the Trend or Sprawl scenarios, although, in this case, the degree of difference is not small. As described previously, the magnitude of open space preservation varies by county in response to current open space availability and the degree of coverage by current development patterns. Overall, the Recentralization and Growth Area scenarios each get +2 versus the baseline scenario. Sprawl is rated at -2 against the baseline.

Table 54. Mobile Source Emissions Goals Achievement

	Measure	Recentralization	Plan	Trend	Sprawl
Peak Period	VOC (tons/day)	+	+	Baseline Scenario	-
	NOX (tons/day)	+	+		-
	PM2.5 (tons/day)	+	0		0
	CO2 (tons/day)	+	+		-
	Consumption (gal/day)	+	+		-
	Sub-total	**+5**	**+4**		**-4**

Source: DVRPC July 2009

The net score of the Recentralization, Growth Area, and Sprawl scenarios versus the base scenario is presented in Table 56. These scores are simply the sum of the component scores for Transport, Environmental, and Land Consumption indicators described above. The Recentralization scenario comes in first, but only by a small margin over the Growth Area scenario. Sprawl comes in a distant third at -12. Although these outcomes are not surprising given the assumptions in each scenario, it also highlights that the many of the benefits of the Recentralization scenario can be achieved through the less intensive land development policies in the Growth Area scenario.

Table 55. Land Consumption Goals Achievement

Land Use	Recentralization	Growth Area	Trend	Sprawl
Residential	+	+	Baseline	-
Commercial	+	+		-
Sub Total	**+2**	**+2**		**-2**

Source: DVRPC July 2009

Including additional planned transportation improvements might change the highway, transport, and emissions differences between the Recentralization and Growth Area scenarios and widen the gap. Transport facility improvements included in the TIP have a tendency to resolve existing congestion problems which may be located near FGAs. Congestion mitigation may also reduce mobile source emissions by increasing highway speeds. The high density settlement patterns in Growth Area scenario may be configured to capture other benefits of compact development such as fostering walk and bicycle trips and promoting TOD in coordination with new public transit facilities. Addressing these problems through the planning process may reduce highway VMT by reducing trip generation and increasing transit ridership.

Table 56. Final Goals Achievement Evaluation

Category	Recentralization	Growth Area	Trend	Sprawl
Transport	+7	+7	Baseline Scenario	-6
Emissions	+5	+4		-4
Land Consumption	+2	+2		-2
Net Score	**+14**	**+13**		**-12**

Source: DVRPC July 2009

CHAPTER VI

Conclusion

UPlan allows the planner to visualize the hidden landscape effects of socioeconomic forces under alternative transportation improvements and environmental and policy constraints. UPlan is not intended to produce definitive development recommendations, particularly for individual land use parcels. Rather, UPlan is intended to assist planners in making land use recommendations given the transportation infrastructure, environmental constraints, as well as local community and developer preference.

The validated UPlan model calibration has produced parameter estimates that are generally consistent with Census data and reasonably conform to development patterns in the DVRPC 1990 and 2000 Land Use Survey.

The rule-based UPlan build-out estimates of new households and new commercial/industrial square footage estimates in the US 322 corridor compared acceptably well with alternate estimates prepared by DVRPC's regional planning staff and municipal planning officials. When the new land uses allocated under the various build-out scenarios were input to the TDM, the resulting traffic volumes were reasonable and provided insight into adequacy of the transportation facility improvements currently planned.

Forecasting Trials in Gloucester County produced two acceptable forecasts:

- Simulation 7 produces the best allocation results when allowing UPlan to allocate the least constrained allocation area. Growth areas are defined as the combination of wooded, non-preserved agricultural, and vacant (cleared brownfields) land areas in the 2000 inventory. This allows flexibility to study policies and land patterns that are different from the Board-adopted socioeconomic forecasts.

- Simulation 10 produces the most comparable allocation results to DVRPC long-range land use planning policy because it is constrained to Destination 2030 allocations. This reinforces UPlan's planning and forecasting capabilities.

The UPlan model, as implemented by DVRPC, is useful in predicting the effects of new transportation facilities, both highway and transit, on future population and employment allocation within a county. In Gloucester County, the NJ 55 freeway through the center of the county, spurs the growth of employment land uses along the corridor.

Final Thoughts on What-If Scenarios

Except for the Sprawl scenario, all of the scenarios tested here include substantial infill into existing urban areas – the cities of Philadelphia, Trenton, Chester, and Camden and adjacent older, high density suburban communities. The Trend and Growth Area scenarios assumed that about 50 percent of 2005 to 2035 population and employment growth would be accommodated by infill into these areas. The Recentralization scenario assumes that a much larger portion of growth will be accommodated by infill. Existing open lots and other developable areas in existing communities are known to UPlan because the underlying GIS layers have 2 meter (six foot) precision. However, both the Growth Area and Recentralization scenarios assume a substantial policy commitment to encourage redevelopment of existing developed parcels to support higher density. Updated FGAs and complementary transport improvements are a necessary component of the upcoming regional plan, entitled Connections: The Regional Plan of a Sustainable Future, to insure that suburban new footprint growth and transport investment is consistent with regional planning goals.

Given the results of this exercise, DVRPC should strive to prepare land use and transportation plans that implement policies to coordinate land use and transportation planning. Such coordination should include a range of development densities in both FGAs and more rural portions of the region. Transport policy should provide for needed highway improvements, as well as enhanced public transportation services through transit-oriented development (TOD) and other infrastructure investments, as needed; to strike a balance between environmental consequences and individual time costs.

Land Use Density and Transportation Trade-offs

These results suggest significant trade-offs that may be exploited through the planning process. Selected trade-offs between dense or scattered settlement patterns, additional transport investment, and optimization of existing facility performance are presented here.

Densely developed communities tend toward less highway travel, in general, because origins and destinations are closer together then in a scattered settlement pattern. However, highway trips in dense communities tend to encounter slower travel speeds because of increased congestion. On the other hand, scattered settlement patterns lead to increased trip making and longer trips resulting in more VMT, but at higher speeds due to spread out origins and destinations.

Dense communities are easier to serve with transit, which promotes transit ridership, and takes many vehicles off the street network, especially during peak hours. Scattered settlement patterns are also very difficult to serve with transit, lowering ridership.

These trade-offs are also qualified by the environmental impacts of emissions generated by mobile source producers. Across the board, the Recentralization scenario generates the lowest emission rates and consumes the least amount of fuel because trips tend to be shorter in dense communities. This is also due to assumptions in the scenario that reduce the reliance on personal vehicles by substituting walk, bike, and transit modes of travel in dense communities. Conversely, the large magnitude of travel in the Sprawl scenario generates the highest emission rates and consumes the most fuel. Sprawled settlement patterns require heavy use of personal vehicles for all trip purposes because origins and destinations tend of be farther apart.

Future Considerations

Finally, future iterations of this exercise can be improved through the enhancement of both the input data and the methods employed in the analysis. It may be useful to simulate the land use and transportation elements of Connections to estimate the effects on regional emissions, transportation service levels, and land consumption. Furthermore, this kind of scenario planning should become part of DVRPC standard planning activities so the process can be refined and improved as the staff becomes more efficient at performing the analysis and gain experience with the specific data and methods needed to achieve optimal results. The analysis could be used to provide crucial insights to stakeholders and policymakers about the long-term regional impacts of planning strategies implemented at the municipal and county level.

Glossary

AADT- Annual Average Daily Traffic

Allocation- the configuration of new footprint development assigned by UPlan

Allocation Area- the combination of land classified as agricultural, vacant, or wooded less masked areas

Attractor- a feature that certain development types prefer to locate near

Average Daily- all time periods together

Board-forecast- official policies adopted by the DVRPC Board

Connections- the DVRPC regional plan for the year 2035 (in development)

Destination 2030- the DVRPC regional plan for the year 2030

Discouragement- a feature that certain development types prefer to avoid

DVRPC- Delaware Valley Regional Planning Commission

EPA- Environmental Protection Agency

Evening (time period)- 6:00 PM to 7:00 AM

FAR- Floor-Area Ratio

FGA- Future Growth Area

GIS- Geographic Information System

Grid- a single raster cell (50 x 50 meter resolution in UPlan)

Growing (county)- counties that are expected to experience significant new footprint development in the future

LRT- Light Rail Transit

Mask- a feature that precludes development

MOBILE6- an EPA program that estimates future emissions levels based of the output of a travel demand model

MCD- Minor Civil Division

Midday (time period)- 9:00 AM to 3:00 PM

New Footprint- development that enlarges the urbanized area by consuming vacant, wooded, or agricultural land

PAT- Planning Area Type

Peak (time period)- 7:00 AM to 9:00 AM – 3:00 PM to 6:00 PM

Raster- a GIS data format that consist of a matrix of discrete grids representing physical locations

SIC- Standard Industrial Code

Sim #- Model simulation run number

Stable (county)- counties that are not expected to experience significant new footprint development in the future

TAZ- Transportation Analysis Zone

TDM- Travel Demand Model

TIP- Transportation Improvement Program

TOD- Transit Oriented Development

Transit Score- a composite index of land use and transportation features that relate to public transit access or ‘friendliness’

VHT- Vehicle Hours Traveled

VMT- Vehicle Miles Traveled

UPlan- a rule-based land planning model developed by the University of California

APPENDIX A

Final Attraction Parameters by County

Table A-1. Final Attractor/Discouragement Parameters by County

Source: DVRPC July 2009

Attractor/ (Discouragement)	Industrial															
	Buffer Size (feet)								Weight							
	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer
Freeway Ramps	1,000	1,000	3,000	1,000	1,000	3,000	1,500	1,000	10	10	15	10	10	15	10	10
Major Arterials	1,000	1,000	3,000	1,000	1,000	3,000	1,000	1,000	10	10	15	10	10	10	10	10
Minor Arterials	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Collectors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Medium Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5)
Census Blocks with Pop Growth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Industrial	1,500	1,500	3,000	1,500	1,000	3,000	1,500	1,500	50	30	50	50	50	50	50	30
1990 Commercial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 High Density Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodplains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5)

Attractor/ (Discouragement)	Commercial High															
	Buffer Size (feet)								Weight							
	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer
Freeway Ramps	1,000	1,000	3,000	1,000	1,000	3,000	1,000	1,000	15	15	15	20	15	15	15	15
Major Arterials	1,000	1,000	3,000	1,000	1,000	1,000	1,000	1,000	10	10	10	10	10	10	10	10
Minor Arterials	1,000	1,000	-	1,000	1,000	-	1,000	1,000	10	10	-	10	10	-	10	10
Collectors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Medium Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Census Blocks with Pop Growth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Commercial	1,000	1,000	3,000	1,000	1,000	3,000	1,000	1,000	50	50	40	50	50	40	50	50
1990 High Density Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodplains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10)

Notes *: Dash indicates no buffer or weight assigned, while zero buffer value indicates attraction or discouragement only within feature boundary; weights indicate attraction values, except for numbers in parentheses, which indicate discouragement values.*

Table A-2. Final Attractor/Discouragement Parameters by County

Source: DVRPC July 2009

Attractor/ (Discouragement)	Commercial Low															
	Buffer Size (feet)								Weight							
	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer
Freeway Ramps	1,000	1,000	3,000	1,000	1,000	3,000	3,000	1,000	10	10	15	15	10	15	15	10
Major Arterials	1,000	1,000	3,000	1,000	1,000	3,000	3,000	1,000	10	10	15	15	10	15	15	10
Minor Arterials	1,000	1,000	1,500	1,000	1,000	1,500	2,000	1,000	10	10	10	15	10	10	10	10
Collectors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Medium Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Census Blocks with Pop Growth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Commercial	1,000	1,000	3,000	1,500	1,500	3,000	3,000	1,000	10	40	40	40	40	40	15	40
1990 High Density Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 2)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodplains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10)

Attractor/ (Discouragement)	Residential High															
	Buffer Size (feet)								Weight							
	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer
Freeway Ramps	1,000	1,000	1,500	1,000	1,000	1,500	1,000	1,000	10	10	15	10	10	15	10	10
Major Arterials	1,000	1,000	1,000	-	1,000	1,000	1,000	3,000	10	10	10	-	10	10	10	-
Minor Arterials	800	800	800	800	800	800	800	800	15	15	10	15	15	10	10	15
Collectors	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 1)	400	-	400	400	400	400	400	400	10	-	10	10	10	10	10	15
Bus Lines (Interval 2)	800	-	800	800	800	800	800	800	6	-	6	6	6	6	6	10
Rail Stations (Interval 1)	400	-	400	400	400	400	400	400	10	-	10	10	10	10	10	15
Rail Stations (Interval 2)	800	-	800	800	800	800	800	800	6	-	6	6	6	6	6	10
Low Congestion Area	-	-	-	-	-	-	-	-	5	5	-	5	5	5	5	5
Medium Congestion Area	-	-	-	-	-	-	-	-	2	2	-	2	2	2	2	5
High Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10)
Census Blocks with Pop Growth	-	-	-	-	-	-	-	-	20	20	-	20	20	-	-	20
1990 Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Commercial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 High Density Residential	1,000	1,000	1,000	1,000	1,000	1,000	2,000	-	50	50	10	50	50	40	50	-
1990 Single-Family Residential (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodplains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(10)

Notes *: Dash indicates no buffer or weight assigned, while zero buffer value indicates attraction or discouragement only within feature boundary; weights indicate attraction values, except for numbers in parentheses, which indicate discouragement values.*

Table A-3. Final Attractor/Discouragement Parameters by County

Source: DVRPC July 2009

Attractor/ (Discouragement)	Residential Medium															
	Buffer Size (feet)								Weight							
	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer
Freeway Ramps	1,000	1,000	3,000	1,000	1,000	3,000	3,000	1,000	10	10	10	10	10	10	10	10
Major Arterials	1,000	1,000	3,000	1,000	1,000	3,000	3,000	1,000	10	10	10	10	10	10	10	10
Minor Arterials	1,000	1,000	1,000	1,000	1,000	1,000	3,000	1,000	10	10	10	10	10	10	10	10
Collectors	-	-	1,000	1,000	1,000	-	3,000	-	10	-	10	10	10	-	10	-
Bus Lines (Interval 1)	400	-	400	400	400	400	400	400	10	-	10	10	10	10	10	10
Bus Lines (Interval 2)	800	-	800	800	800	800	800	800	6	-	6	6	6	6	6	6
Rail Stations (Interval 1)	400	400	400	400	400	400	400	400	10	10	10	10	10	10	10	10
Rail Stations (Interval 2)	800	800	800	800	800	800	800	800	6	6	6	6	6	6	6	6
Low Congestion Area	-	-	-	-	-	-	-	-	5	-	5	5	5	5	5	6
Medium Congestion Area	-	-	-	-	-	-	-	-	2	3	2	2	2	2	2	3
High Congestion Area	-	-	-	-	-	-	-	-	-	-	(5)	-	-	-	-	(10)
Census Blocks with Pop Growth	-	-	-	-	-	-	-	-	30	30	30	-	30	30	30	30
1990 Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Commercial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 High Density Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 1)	1,500	1,500	3,000	1,500	1,500	3,000	3,000	1,000	40	30	50	40	50	30	50	30
1990 Single-Family Residential (Interval 2)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Floodplains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(5)

Attractor/ (Discouragement)	Residential Low															
	Buffer Size (feet)								Weight							
	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer	Bucks	Chester	Delaware	Montgomery	Burlington	Camden	Gloucester	Mercer
Freeway Ramps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Arterials	1,000	1,000	-	1,000	-	-	-	1,000	10	10	-	10	-	-	-	10
Minor Arterials	1,000	1,000	3,000	1,000	1,000	3,000	3,000	1,000	10	10	10	10	10	10	10	10
Collectors	1,000	1,000	3,000	1,000	1,000	3,000	3,000	-	10	10	10	10	10	10	10	-
Bus Lines (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bus Lines (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rail Stations (Interval 2)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Low Congestion Area	-	-	3,000	-	-	3,000	-	-	-	-	5	-	5	5	5	20
Medium Congestion Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
High Congestion Area	-	-	-	-	-	-	-	-	-	-	(5)	-	-	-	-	(10)
Census Blocks with Pop Growth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Industrial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Commercial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 High Density Residential	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1990 Single-Family Residential (Interval 1)	500	300	500	500	500	5,000	500	1,000	-	-	-	-	-	-	-	20
1990 Single-Family Residential (Interval 2)	1,000	1,000	3,000	1,000	1,000	3,000	3,000	-	30	40	30	30	30	30	30	-
Floodplains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(2)

Notes *: Dash indicates no buffer or weight assigned, while zero buffer value indicates attraction or discouragement only within feature boundary; weights indicate attraction values, except for numbers in parentheses, which indicate discouragement values.*

APPENDIX B

Municipal Policy Coeffecients

Table B-1. Municipality Policy Coefficients for Bucks County

Municipality	IND	CH	CL	RH	RM	RL
Bedminster Township			15		-40	-45
Bensalem Township			13			-6
Bridgeton Township		-80				-20
Bristol Borough		-80	-60			-26
Bristol Township			-50		-40	-42
Buckingham Township			20			5
Chalfont Borough			-40	-60		15
Doylestown Borough		-80	-80		-80	-60
Doylestown Township			15			5
Dublin Borough						-15
Durham Township						-12
East Rockhill Township			13			
Falls Township			-5	-60	-40	-55
Haycock Township			14			-22
Hilltown Township			18			-24
Hulmeville Borough						
Ivyland Borough						
Langhorne Borough						23
Langhorne Manor Borough			16			
Lower Makefield Township			15	10		-8
Lower Southampton Township						-50
Middletown Township						-21
Milford Township						-11
Morrisville Borough		-80	-40			20
New Britain Borough			20			20
New Britain Township			23			-1
New Hope Borough			-40			
Newtown Borough						
Newtown Township			18			15
Nockamixon Township			15			-25
Northampton Township			10			5
Penndel Borough			12			
Perkasie Borough						5
Plumstead Township			17			
Quakertown Borough			-50			-40
Richland Township			15			-5
Richlandtown Borough						
Sellersville Borough						
Silverdale Borough						
Solebury Township			23		-15	-14
Springfield Township			22			-50
Telford Borough			31			28
Tinicum Township			13		-40	-35
Trumbauersville Borough						
Tullytown Borough			12			
Upper Makefield Township			15		-5	-21

Table B-1. Municipality Policy Coefficients for Bucks County (Continued)

Municipality	IND	CH	CL	RH	RM	RL
Upper Southampton Township			23			-40
Warminster Township			-60		-50	-50
Warrington Township			10	10		
Warwick Township			18	10		10
West Rockhill Township			20			-50
Wrightstown Township			13		-20	-21
Yardley Borough						

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-2. Municipality Policy Coefficients for Chester County

Municipality	IND	CH	CL	RH	RM	RL
Atglen Borough						
Avondale Borough		-80				
Birmingham Township						
Caln Township		-80		-80	-80	-140
Charlestown Township	50					
Coatesville City		-80		-80	-80	-80
Downingtown Borough						
East Bradford Township				30		
East Brandywine Township						-10
East Caln Township	50	30	-20			
East Coventry Township						-10
East Fallowfield Township						
East Goshen Township		-10				20
East Marlborough Township			-5			
East Nantmeal Township						
East Nottingham Township			-20			-25
East Pikeland Township						
Easttown Township				-50		-10
East Vincent Township			-10			-20
East Whiteland Township		20	25			10
Elk Township						-10
Elverson Borough			45			
Franklin Township						-8
Highland Township		-80		-80	-80	-130
Honey Brook Borough		-80	-25			
Honey Brook Township						
Kennett Township			-25		30	
Kennett Square Borough		-80				
London Britain Township						
Londonderry Township						
London Grove Township						
Lower Oxford Township						15
Malvern Borough		-80	-50			
Modena Borough		-80				10
New Garden Township		30		30	30	30
Newlin Township						-10
New London Township						10
North Coventry Township			15	-80	-80	-140
Oxford Borough		-80	-50			-15
Parkesburg Borough		-80	-50			20
Penn Township		30				-15
Pennsbury Township						-13
Phoenixville Borough		-80	-50	-80	-80	-80
Pocopson Township						-45
Sadsbury Township			-10			
Schuylkill Township			-40			-35

Table B-2. Municipality Policy Coefficients for Chester County (Continued)

Municipality	IND	CH	CL	RH	RM	RL
South Coatesville Borough				-80	-80	-80
South Coventry Township						-8
Spring City Borough		-80		-80	-80	-80
Thornbury Township					30	5
Tredyffrin Township		60	40			-7
Upper Oxford Township			-5	-20		
Upper Uwchlan Township		30	8	30	30	25
Uwchlan Township		30	45			75
Valley Township			10	30		15
Wallace Township						-25
Warwick Township				-80	-80	-80
West Bradford Township			-20			-20
West Brandywine Township			-15	-20		
West Caln Township						
West Chester Borough		-80		-80	-80	-80
West Fallowfield Township						
West Goshen Township		20	5			70
West Grove Borough				30		10
West Marlborough Township				-80	-80	-100
West Nantmeal Township					-20	-35
West Nottingham Township						
West Pikeland Township			-15			
West Sadsbury Township						
Westtown Township			-5			-30
West Vincent Township			-5			-7
West Whiteland Township		40	20	30	30	25
Willistown Township		-80	-130			-15

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-3. Municipality Policy Coefficients for Delaware County

Municipality	IND	CH	CL	RH	RM	RL
Aldan Borough						
Aston Township		-20	-15			
Bethel Township	-50		-15	10	10	10
Brookhaven Borough			70			
Chadds Ford Township		-10	-10	-10	-10	-10
Chester City						
Chester Heights Borough						
Chester Township	-30					
Clifton Heights Borough						
Collingdale Borough						
Colwyn Borough						
Concord Township	-50		-10			
Darby Borough						
Darby Township						
East Lansdowne Borough						
Eddystone Borough						
Edgmont Township		-10	-10			
Folcroft Borough						
Glenolden Borough						
Haverford Township						
Lansdowne Borough						
Lower Chichester Township	-50					
Marcus Hook Borough						
Marple Township						
Media Borough						
Middletown Township		-15	-25			
Millbourne Borough						
Morton Borough						
Nether Providence Township						
Newtown Township						
Norwood Borough						
Parkside Borough						
Prospect Park Borough						
Radnor Township				10	15	15
Ridley Park Borough						
Ridley Township						
Rose Valley Borough						
Rutledge Borough						
Sharon Hill Borough						
Springfield Township						
Swarthmore Borough						
Thornbury Township			-15		-10	-10
Tinicum Township	150	150	60			
Trainer Borough						

Table B-3. Municipality Policy Coefficients for Delaware County (Continued)

Municipality	IND	CH	CL	RH	RM	RL
Upland Borough						
Upper Chichester Township	-30		-10			
Upper Darby Township						
Upper Providence Township						
Yeadon Borough						

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-4. Municipality Policy Coefficients for Montgomery County

Municipality	IND	CH	CL	RH	RM	RL
Abington Township		-75		-70	-70	-75
Ambler Borough					-70	-80
Bridgeport Borough						
Bryn Athyn Borough						
Cheltenham Township		-80	-70			3
Collegeville Borough			5			
Conshohocken Borough			13			
Douglass Township			-20			5
East Greenville Borough			-65			-10
East Norriton Township			-65	-70	-70	-20
Franconia Township			-3			
Green Lane Borough			9			
Hatboro Borough			11			
Hatfield Borough			-70			-10
Hatfield Township		-70	-70			-8
Horsham Township			6			-4
Jenkintown Borough			9			-20
Lansdale Borough			5			-40
Limerick Township			-8		-5	
Lower Frederick Township			3			
Lower Gwynedd Township			-14			-14
Lower Merion Township		-70	-70			-2
Lower Moreland Township		-80	-70		-50	-70
Lower Pottsgrove Township			5			5
Lower Providence Township			-8			
Lower Salford Township			5		-5	-8
Marlborough Township						-65
Montgomery Township			-3			10
Narberth Borough						
New Hanover Township			-3			
Norristown Borough			-70			
North Wales Borough			15			-20
Pennsburg Borough						
Perkiomen Township			9			12
Plymouth Township			3	-70		-20
Pottstown Borough			-70			-15
Red Hill Borough						
Rockledge Borough						-65
Royersford Borough			5		-65	
Salford Township						
Schwenksville Borough						6
Skippack Township			9		-10	-5
Souderton Borough			-70			9
Springfield Township		-70	-70	-70	-70	
Telford Borough			-70			-20
Towamencin Township			8			

Table B-4. Municipality Policy Coefficients for Montgomery County (Continued)

Municipality	IND	CH	CL	RH	RM	RL
Trappe Borough						-5
Upper Dublin Township		-80	-70			-6
Upper Frederick Township						
Upper Gwynedd Township			8			-3
Upper Hanover Township			8			-5
Upper Merion Township			10			
Upper Moreland Township				-70	-70	-45
Upper Pottsgrove Township			17			
Upper Providence Township		12	12	-5		
Upper Salford Township						
West Conshohocken Borough			5			
West Norriton Township						-3
West Pottsgrove Township						-20
Whitemarsh Township			8			
Whitpain Township			5			-8
Worcester Township			8			-5

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-5. Municipality Policy Coefficients for Burlington County

Municipality	IND	CH	CL	RH	RM	RL
Bass River Township		-70	-3			
Beverly City						-70
Bordentown City			-70		-70	-70
Bordentown Township		-70				4
Burlington City					-70	-40
Burlington Township			-5	10	10	10
Chesterfield Township			-70			
Cinnaminson Township			-5			-10
Delanco Township			15			
Delran Township			-3			34
Eastampton Township						4
Edgewater Park Township			-70		-70	-70
Evesham Township		10	5	10	10	15
Fieldsboro Borough						
Florence Township			-70			-4
Hainesport Township			3			3
Lumberton Township			3		20	13
Mansfield Township			2			
Maple Shade Township			-15			-10
Medford Lakes Borough			-70			-70
Medford Township						5
Moorestown Township			2			5
Mount Holly Township			-70			
Mount Laurel Township		10	1	10	20	12
New Hanover Township		-70	-70			
North Hanover Township					-70	-70
Palmyra Borough			-70			
Pemberton Borough						
Pemberton Township			9			-70
Riverside Township			-70			
Riverton Borough						
Shamong Township			-2			-2
Southampton Township			-2			-2
Springfield Township			-2			-2
Tabernacle Township			-4			-40
Washington Township			30			
Westampton Township						
Willingboro Township		-70	-70		-70	-70
Woodland Township						-70
Wrightstown Borough			55			-70

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-6. Municipality Policy Coefficients for Camden County

Municipality	IND	CH	CL	RH	RM	RL
Audubon Borough		-30	-60			
Audubon Park Borough			-50			-50
Barrington Borough			-30			
Bellmawr Borough			-9	-30	-70	-70
Berlin Borough		-30	-43			-3
Berlin Township			5			-30
Brooklawn Borough						6
Camden City				-30	-70	-70
Cherry Hill Township		-30	-60	-60	-20	-5
Chesilhurst Borough						-40
Clementon Borough				-30	-70	-70
Collingswood Borough				-30	-70	-72
Gibbsboro Borough		-30	-60			-8
Gloucester City City			-10	-30	-70	-70
Gloucester Township			-12			
Haddon Heights Borough				-30	-70	-70
Haddon Township			-60			-20
Haddonfield Borough		-30	-60			
Hi-Nella Borough						
Laurel Springs Borough				-30	-70	-70
Lawnside Borough			-10			-40
Lindenwold Borough			6	-30	-70	-70
Magnolia Borough			-20	-30	-70	-70
Merchantville Borough				-30	-70	-70
Mount Ephraim Borough		-30	-90			-10
Oaklyn Borough		-30	-60	-30	-70	-70
Pennsauken Township		-30	-60			
Pine Hill Borough			5			
Runnemede Borough				-30	-70	-70
Somerdale Borough		-30	-60	-30	-70	-70
Stratford Borough		-30	-60	-30	-70	-70
Voorhees Township			5		4	4
Waterford Township				-30	-70	-70
Winslow Township			-18			-15
Woodlynne Borough						9

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-7. Municipality Policy Coefficients for Gloucester County

Municipality	IND	CH	CL	RH	RM	RL
Clayton Borough		-80	-80	-80		
Deptford Township			-5			
East Greenwich Township		-80	-30		-12	-5
Elk Township		-80		-80		-20
Franklin Township		-80	-2	-80	-8	-2
Glassboro Borough		-80	-80	-80	-2	2
Greenwich Township		-80	-30			
Harrison Township		-80		-80	10	6
Logan Township	20	-80			-13	-5
Mantua Township		-80	-70	-80	10	10
Monroe Township		-80	15	-80		
National Park Borough		-80		-80		
Newfield Borough		-80	-80	-80		
Paulsboro Borough		-80	-80	-80		
Pitman Borough		-80	-80	-80		
South Harrison Township		-80	15	-80		-2
Swedesboro Borough		-80	27	-80		
Washington Township				-80	10	10
Wenonah Borough		-80		-80		
West Deptford Township		-80	80		-60	
Westville Borough		-80	-80	-80		
Woodbury City		-80		-80		
Woodbury Heights Borough		-80	-80	-80		
Woolwich Township		-80		-80	-10	

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

Table B-8. Municipality Policy Coefficients for Mercer County

Municipality	IND	CH	CL	RH	RM	RL
East Windsor Township		-20	-30	40	30	
Ewing Township		-30	-30		30	
Hamilton Township		23	15	-30		-15
Hightstown Borough		-20				
Hopewell Borough			40	-20		15
Hopewell Township			40	-20		15
Lawrence Township		-50	-10		25	5
Pennington Borough		15	10			
Princeton Borough		32	40	40	40	20
Princeton Township		32	40	40	40	20
Trenton City		-40	-10			-50
Robbinsville Township			40		30	
West Windsor Township		30	33	40	25	

Note: IND = Industry, CH = Commercial High density, CL = Commercial Low density, RH = Residential High density, RM = Residential Medium density, RL = Residential Low density

Source: DVRPC July 2009

APPENDIX C

US 322 Corridor Study Land Use Parameters

Table C-1. UPlan Clustered Land Use Categories and Development Densities in US 322 Build-out Corridor Study, Gloucester County

Municipality	Zoning Category	Updated UPlan Codes	Zoned Density	UPlan Density
Harrison Twp	C-55 - industrial	2	0.54	0.38
Harrison Twp	PI	2	1.15	0.38
Logan Twp	LI	2	0.21	0.38
Logan Twp	LI	2	0.21	0.38
Logan Twp	LI -planned industrial	2	0.50	0.38
Woolwich Twp	KINGSWAY	2	0.44	0.38
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-1H	3	0.24	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-2	3	0.22	0.26
Harrison Twp	C-4	3	0.22	0.26
Harrison Twp	C-55 - office	3	0.33	0.26
Harrison Twp	C-55 - retail	3	0.23	0.26
Harrison Twp	C-55- office	3	0.33	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26

Note: The UPlan land use categories are:

2 = industrial

3 = high density commercial, three stories or more

4 = low density commercial, two stories or one story

5 = high density residential

6 = medium density residential

7 = low density residential

8 = public land, open space

9 = water

13 = very low density residential

Table C-1. UPlan Clustered Land Use Categories and Development Densities in US 322 Build-out Corridor Study, Gloucester County (Continued)

Municipality	Zoning Category	Updated UPlan Codes	Zoned Density	UPlan Density
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	INS	3	0.27	0.26
Harrison Twp	O-INS-20-1999	3	0.27	0.26
Harrison Twp	O-INS-20-1999	3	0.27	0.26
Harrison Twp	O-INS-7-1997	3	0.27	0.26
Harrison Twp	O-INS-7-1997	3	0.27	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Harrison Twp	VB	3	0.28	0.26
Logan Twp	IC	3	0.35	0.26
Logan Twp	IC	3	0.35	0.26
Logan Twp	MC-R	3	0.50	0.26
Logan Twp	PPC	3	0.24	0.26
Logan Twp	RC	3	0.27	0.26
Logan Twp	RC	3	0.27	0.26
Logan Twp	REDEV_A	3	0.23	0.26

Note: The UPlan land use categories are:

2 = industrial

3 = high density commercial, three stories or more

4 = low density commercial, two stories or one story

5 = high density residential

6 = medium density residential

7 = low density residential

8 = public land, open space

9 = water

13 = very low density residential

Table C-1. UPlan Clustered Land Use Categories and Development Densities in US 322 Build-out Corridor Study, Gloucester County (Continued)

Municipality	Zoning Category	Updated UPlan Codes	Zoned Density	UPlan Density
Logan Twp	REDEV_B	3	0.23	0.26
Logan Twp	REDEV_C	3	0.23	0.26
Logan Twp	RFI	3	0.40	0.26
Logan Twp	VC	3	0.33	0.26
Swedesboro Bor.	LM	3	0.26	0.26
Swedesboro Bor.	LM	3	0.26	0.26
Swedesboro Bor.	LM	3	0.26	0.26
Woolwich Twp	LIO	3	0.25	0.26
Woolwich Twp	LIO	3	0.25	0.26
Woolwich Twp	LIO	3	0.25	0.26
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	C-1	4	0.16	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-15-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	O-PO-22-1997	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15

Note: The UPlan land use categories are:

2 = industrial

3 = high density commercial, three stories or more

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5 = high density residential

6 = medium density residential

7 = low density residential

8 = public land, open space

9 = water

13 = very low density residential

Table C-1. UPlan Clustered Land Use Categories and Development Densities in US 322 Build-out Corridor Study, Gloucester County (Continued)

Municipality	Zoning Category	Updated UPlan Codes	Zoned Density	UPlan Density
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Harrison Twp	PO	4	0.14	0.15
Swedesboro Bor.	C	4	0.20	0.15
Swedesboro Bor.	C	4	0.20	0.15
Swedesboro Bor.	C	4	0.20	0.15
Woolwich Twp	FOC 10 acre	4	0.12	0.15
Woolwich Twp	FOC - 25 acre	4	0.15	0.15
Woolwich Twp	FOC - 4-acre	4	0.10	0.15
Swedesboro Bor.	R2	5	14.52	12.77
Swedesboro Bor.	R2	5	14.52	12.77
Woolwich Twp	PAC - Townhouses	5	18.15	12.77
Woolwich Twp	PAC -planned adult	5	7.62	12.77
Woolwich Twp	PUD - duplex	5	14.52	12.77
Woolwich Twp	PUD - single family	5	6.70	12.77
Woolwich Twp	PUD - townhouse	5	17.42	12.77
Woolwich Twp	PUD- age restricted	5	8.71	12.77
Harrison Twp	AC	6	4.00	4.55
Harrison Twp	AC	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Harrison Twp	R-4	6	4.00	4.55
Logan Twp	VR-A	6	5.50	4.55
Logan Twp	VR-B	6	5.50	4.55
Logan Twp	VR-C	6	4.00	4.55
Swedesboro Bor.	R1	6	6.05	4.55
Swedesboro Bor.	R1	6	6.05	4.55
Woolwich Twp	RLM	6	6.00	4.55
Woolwich Twp	RLM	6	6.00	4.55
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10

Note: The UPlan land use categories are:

2 = industrial

3 = high density commercial, three stories or more

4 = low density commercial, two stories or one story

5 = high density residential

6 = medium density residential

7 = low density residential

8 = public land, open space

9 = water

13 = very low density residential

Table C-1. UPlan Clustered Land Use Categories and Development Densities in US 322 Build-out Corridor Study, Gloucester County (Continued)

Municipality	Zoning Category	Updated UPlan Codes	Zoned Density	UPlan Density
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-1s	7	2.00	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Harrison Twp	R-2	7	2.30	2.10
Logan Twp	R-1	7	1.50	2.10
Logan Twp	R-1	7	1.50	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Woolwich Twp	R-3	7	2.00	2.10
Logan Twp	HI	8	0.20	**NO DEVELOPABLE LAND AVAILABLE**
Logan Twp	NC	9	0.00	**NO DEVELOPABLE LAND AVAILABLE**
Harrison Twp	R-1	13	1.00	0.60
Harrison Twp	R-1	13	1.00	0.60
Harrison Twp	R-1	13	1.00	0.60
Harrison Twp	R-1	13	1.00	0.60
Harrison Twp	RR	13	0.50	0.60
Logan Twp	R-2	13	0.50	0.60
Logan Twp	R-5	13	0.20	0.60
Swedesboro Bor.	R3	13	0.33	0.60
Swedesboro Bor.	R3	13	0.33	0.60
Woolwich Twp	5A	13	0.20	0.60
Woolwich Twp	R-1	13	0.50	0.60
Woolwich Twp	R-1	13	0.50	0.60
Woolwich Twp	R-1	13	0.50	0.60
Woolwich Twp	R-2	13	0.66	0.60
Woolwich Twp	R-2	13	0.66	0.60
Woolwich Twp	R-2	13	0.66	0.60

Note: The UPlan land use categories are:

2 = industrial

3 = high density commercial, three stories or more

4 = low density commercial, two stories or one story

5 = high density residential

6 = medium density residential

7 = low density residential

8 = public land, open space

9 = water

13 = very low density residential

APPENDIX D

UPlan New Footprint Allocation by County

Figure D-1. Recentralization Scenario
Bucks County

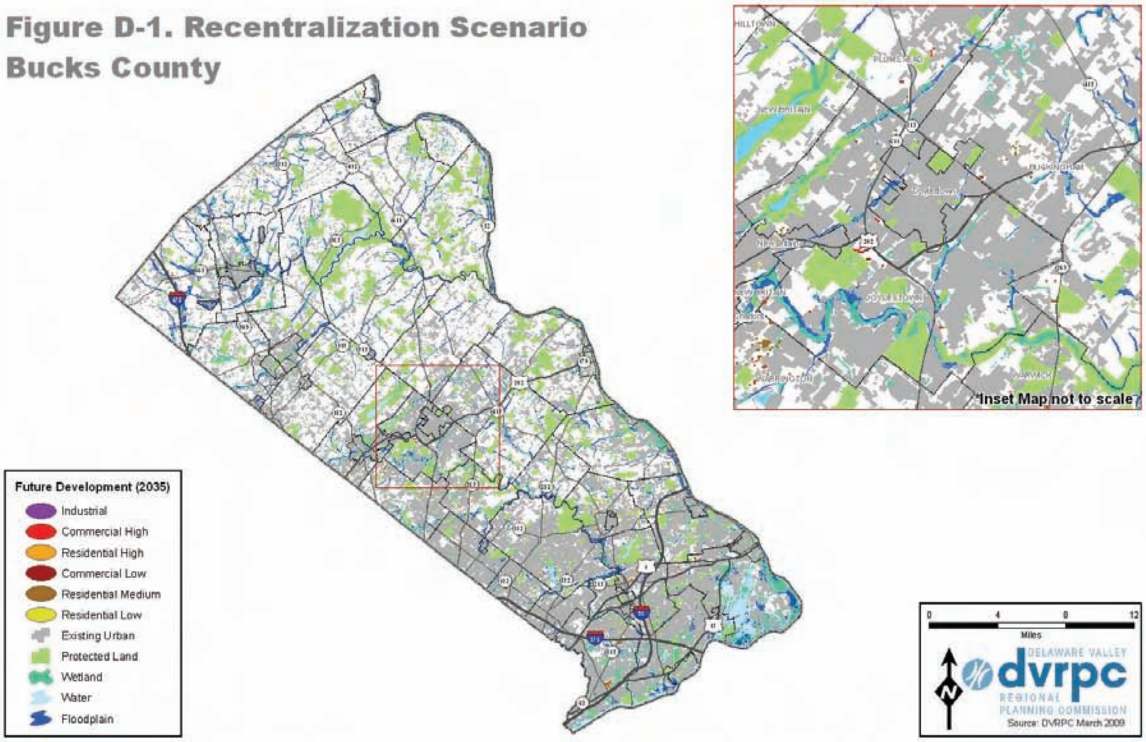


Figure D-2. Sprawl Scenario
Bucks County

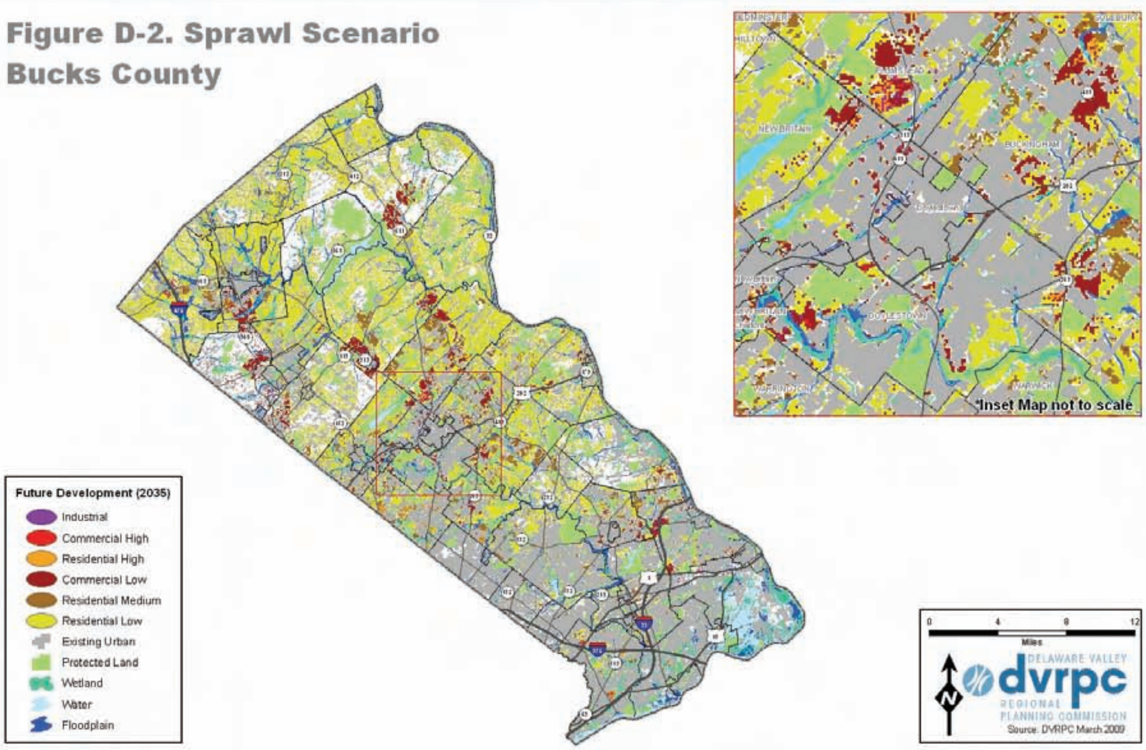


Figure D-3. Growth Area Scenario Bucks County

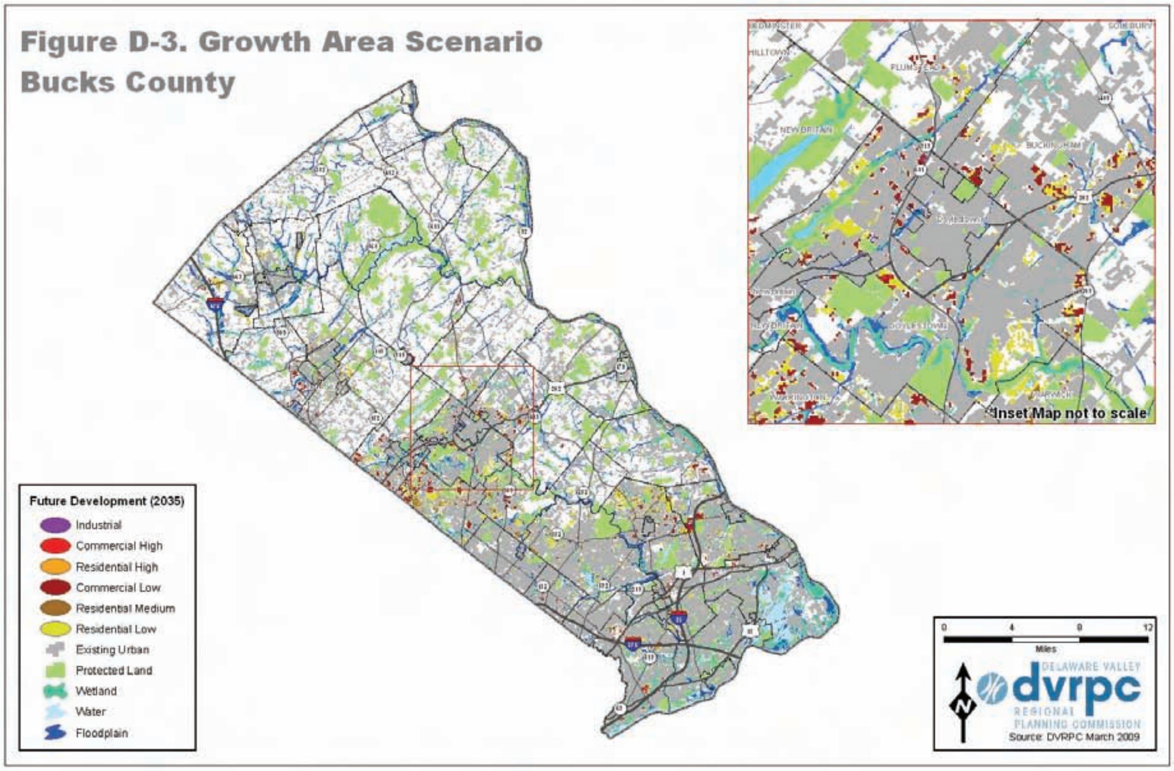


Figure D-4. Trend Scenario Bucks County

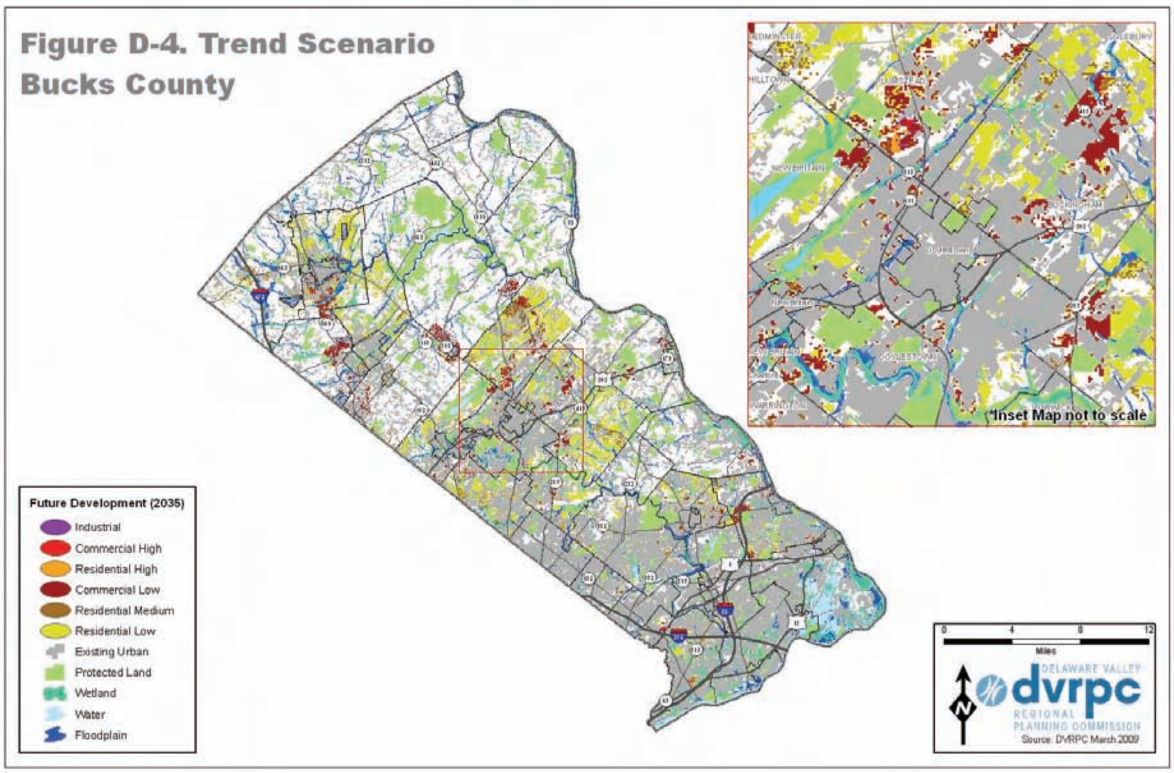


Figure D-5. Recentralization Scenario Burlington County

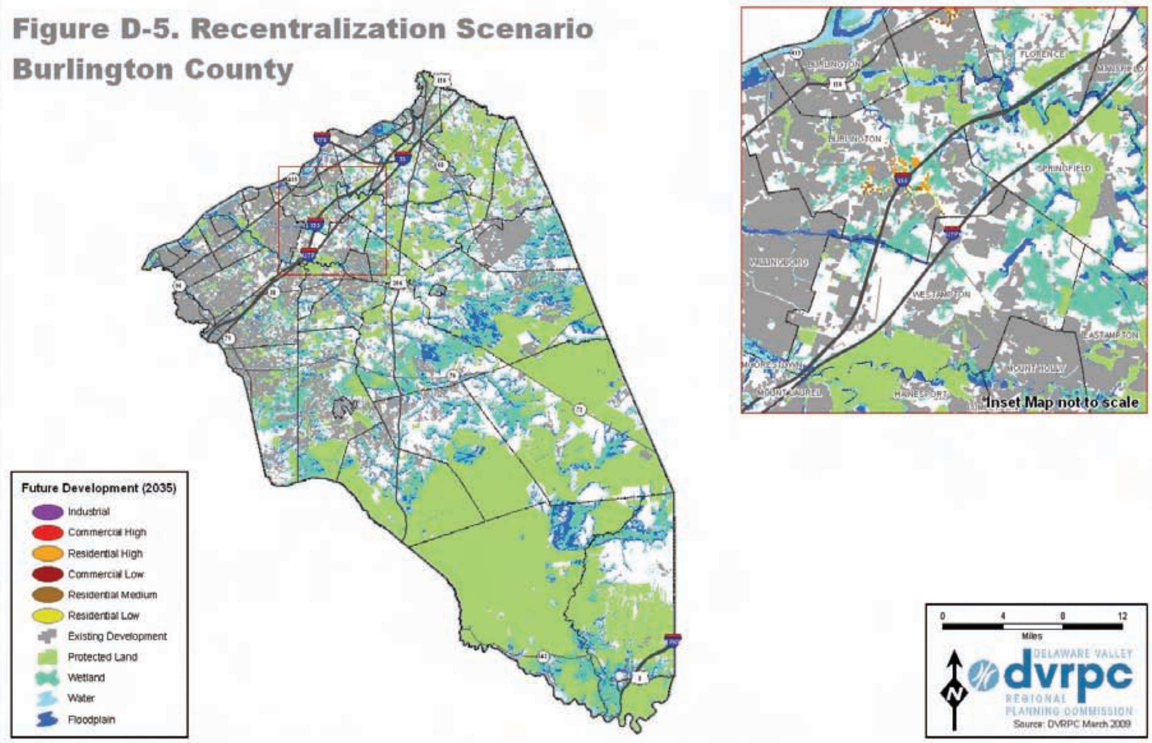


Figure D-6. Sprawl Scenario Burlington County

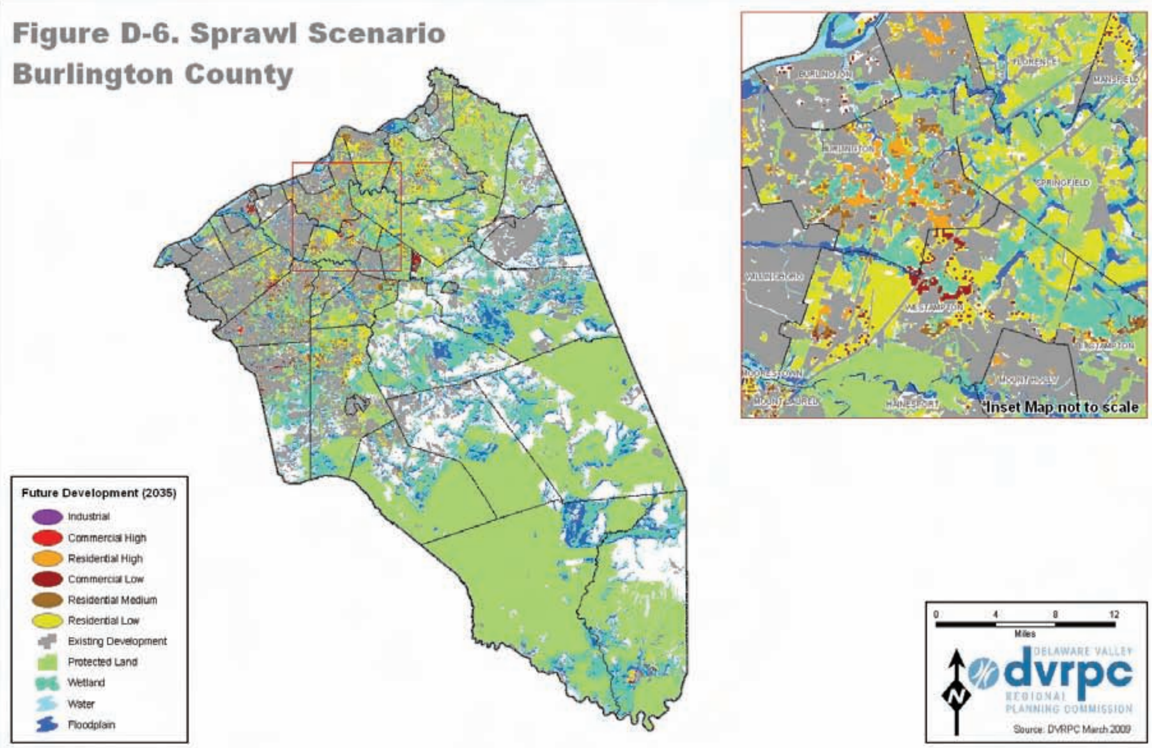


Figure D-7. Growth Area Scenario Burlington County

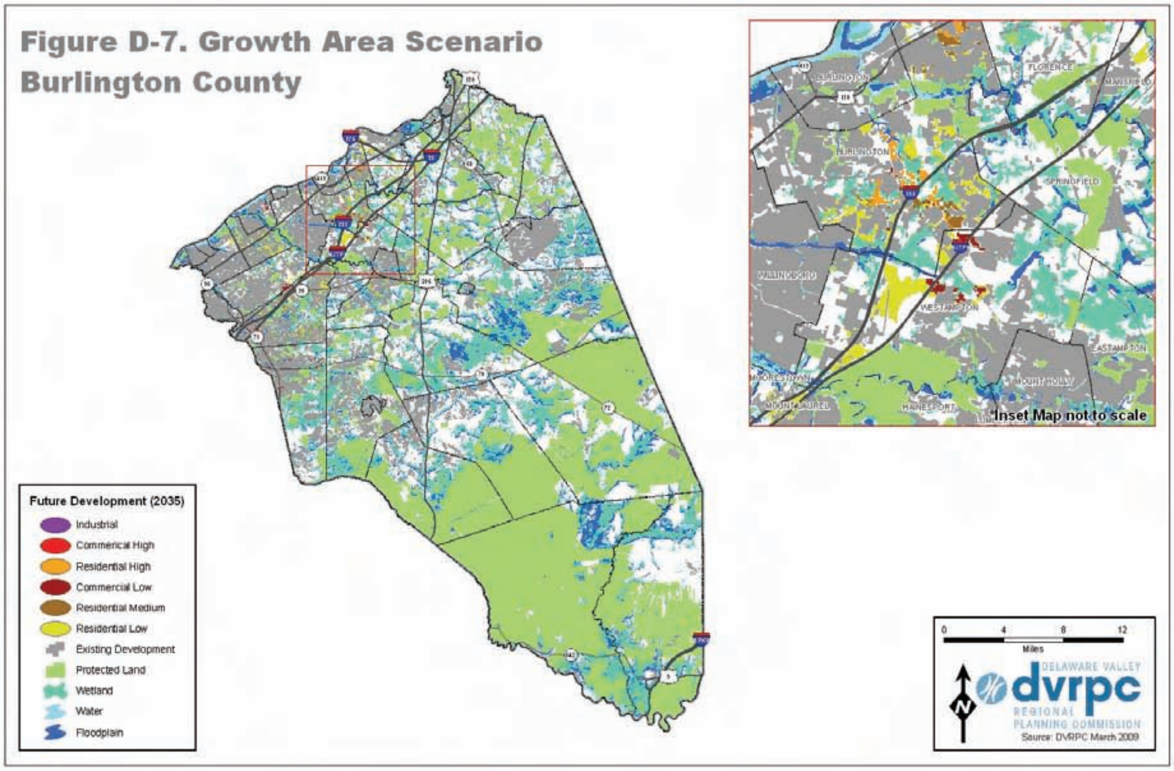


Figure D-8. Trend Scenario Burlington County

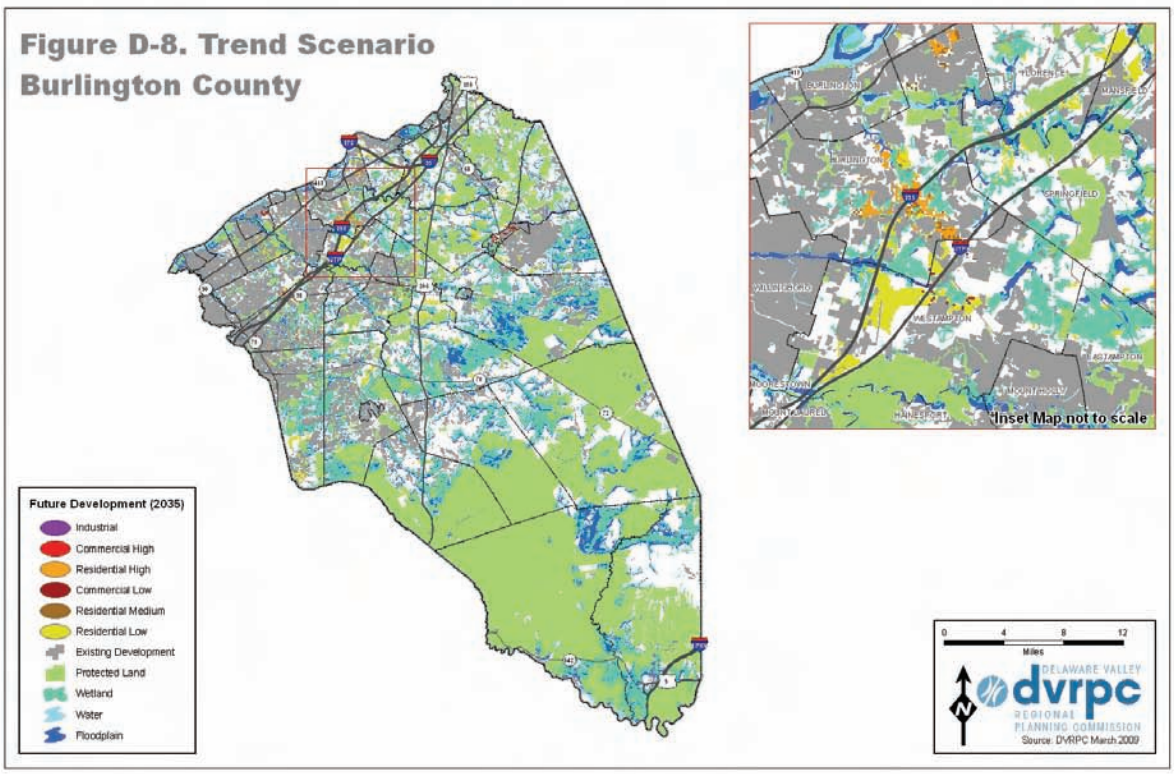


Figure D-9. Sprawl Scenario Camden County

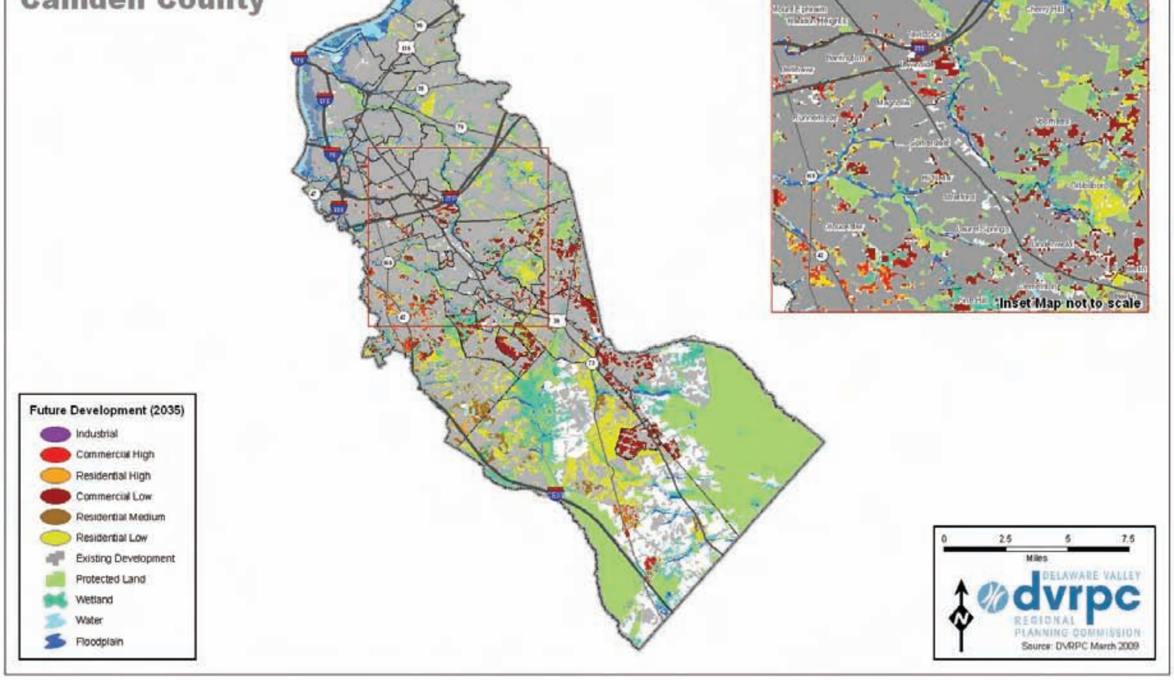


Figure D-10. Recentralization Scenario Camden County

Figure D-11. Growth Area Scenario Camden County

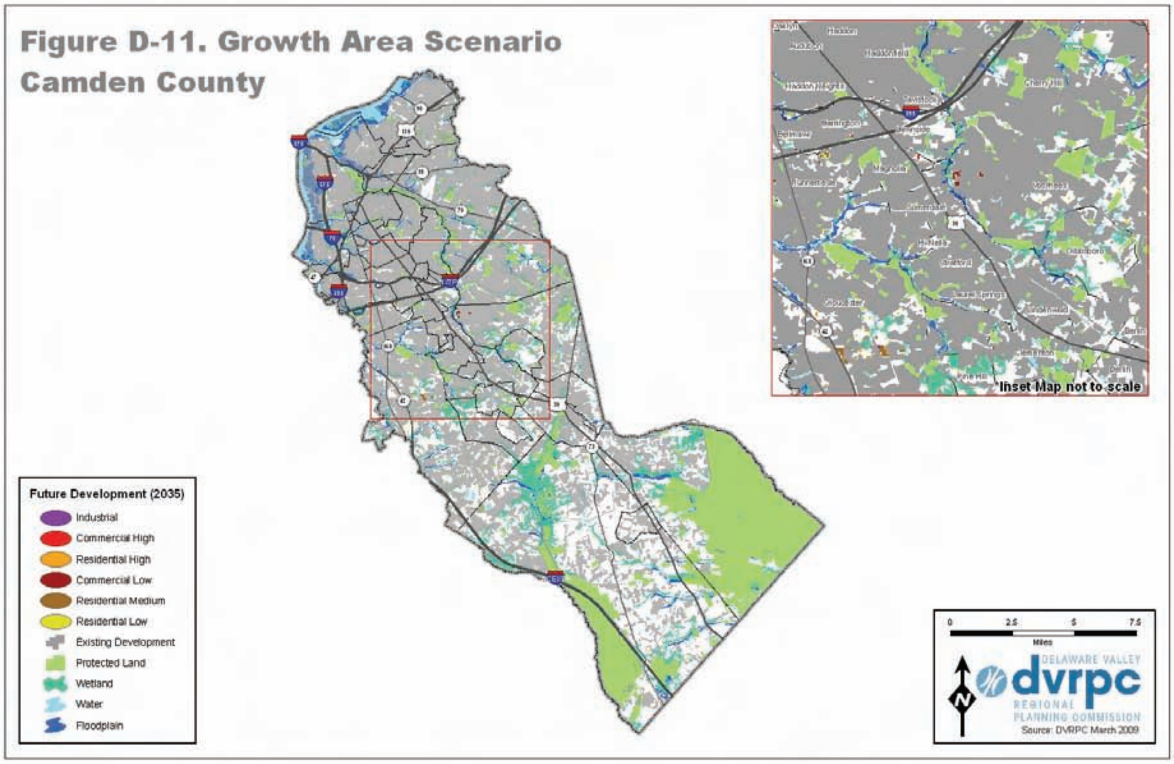
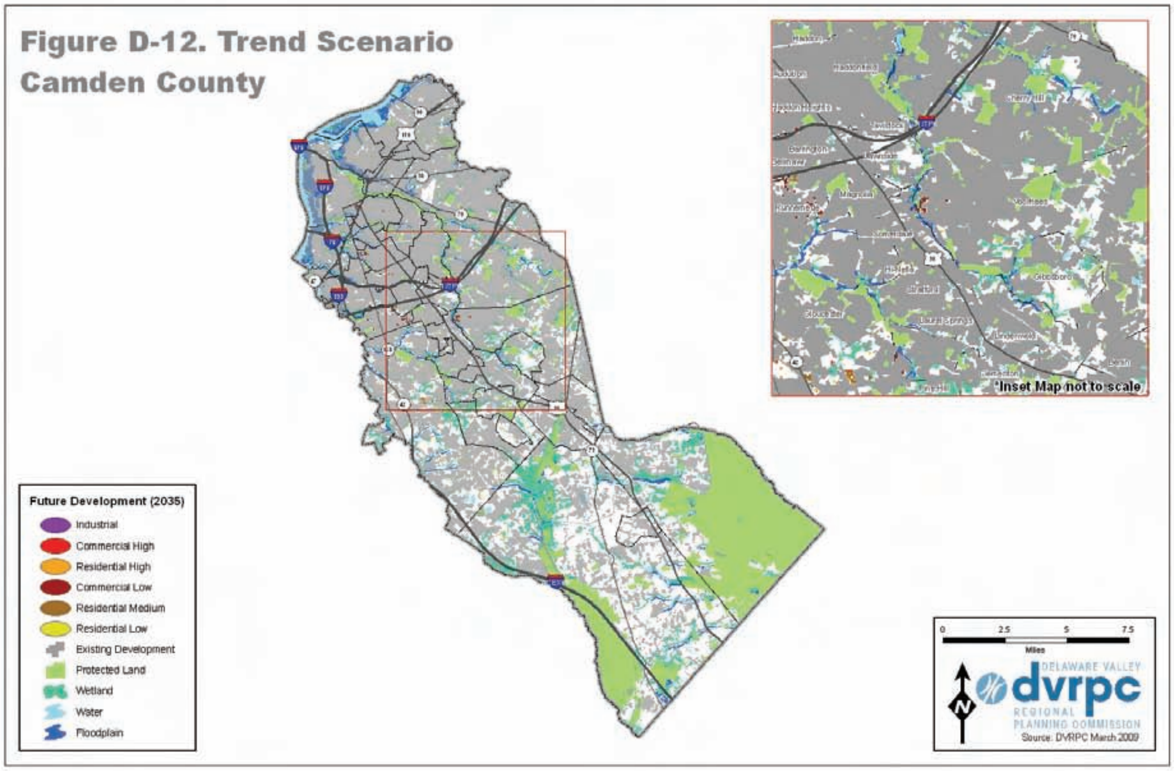


Figure D-12. Trend Scenario Camden County



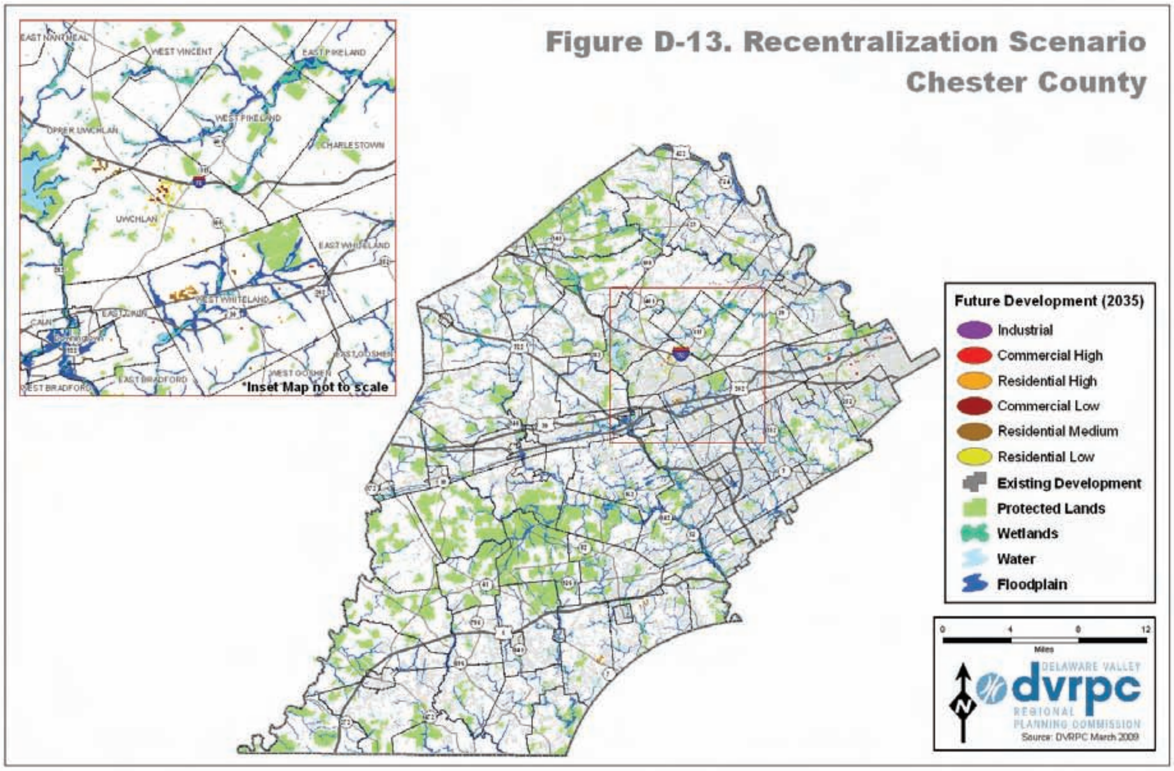


Figure D-13. Recentralization Scenario
Chester County

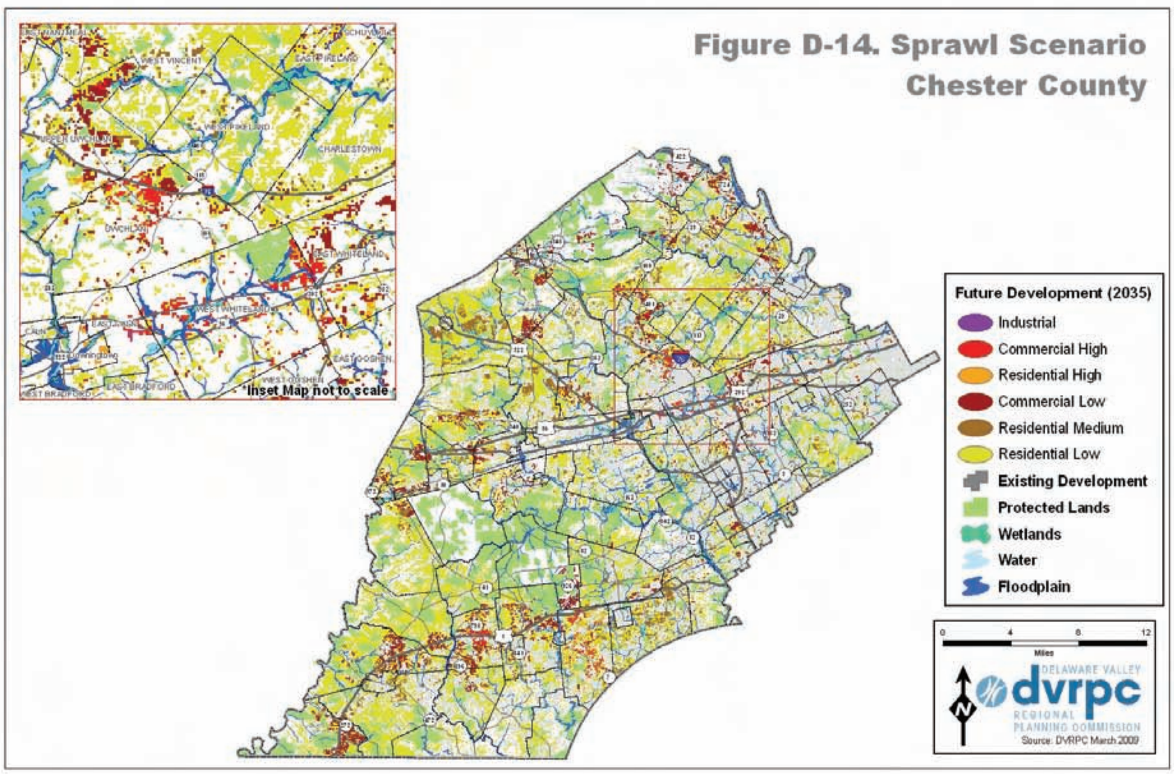


Figure D-14. Sprawl Scenario
Chester County

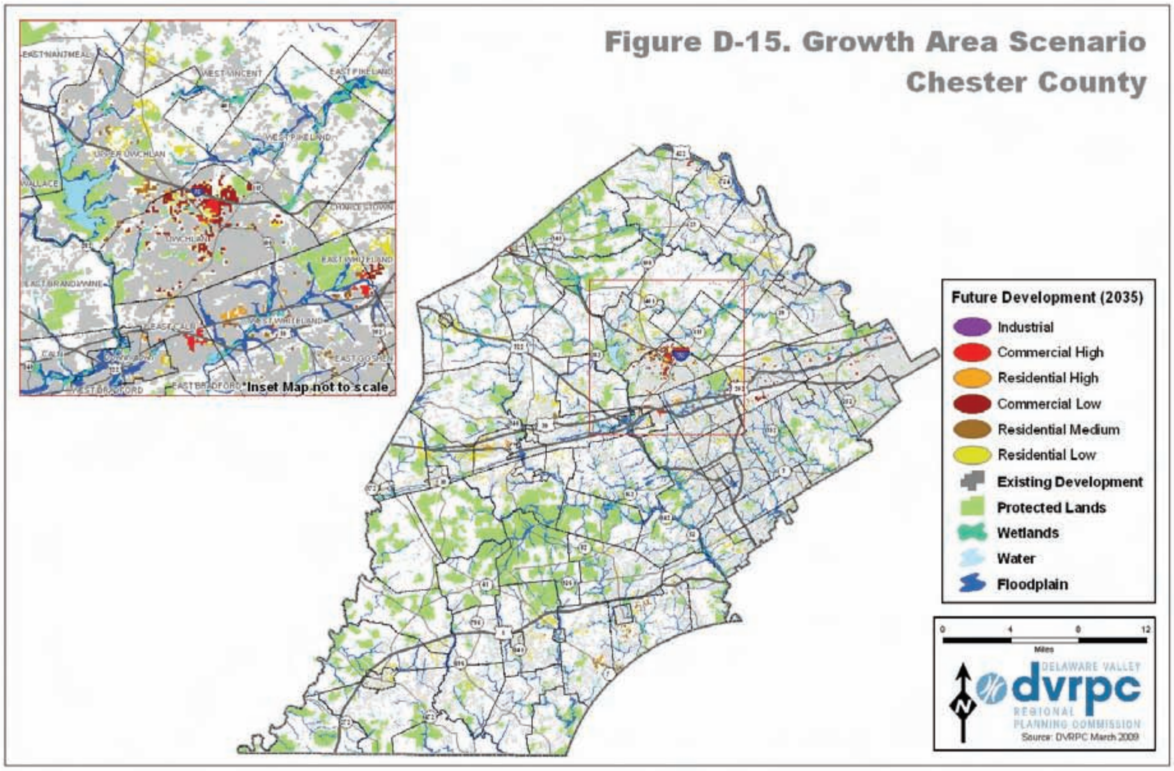


Figure D-15. Growth Area Scenario
Chester County

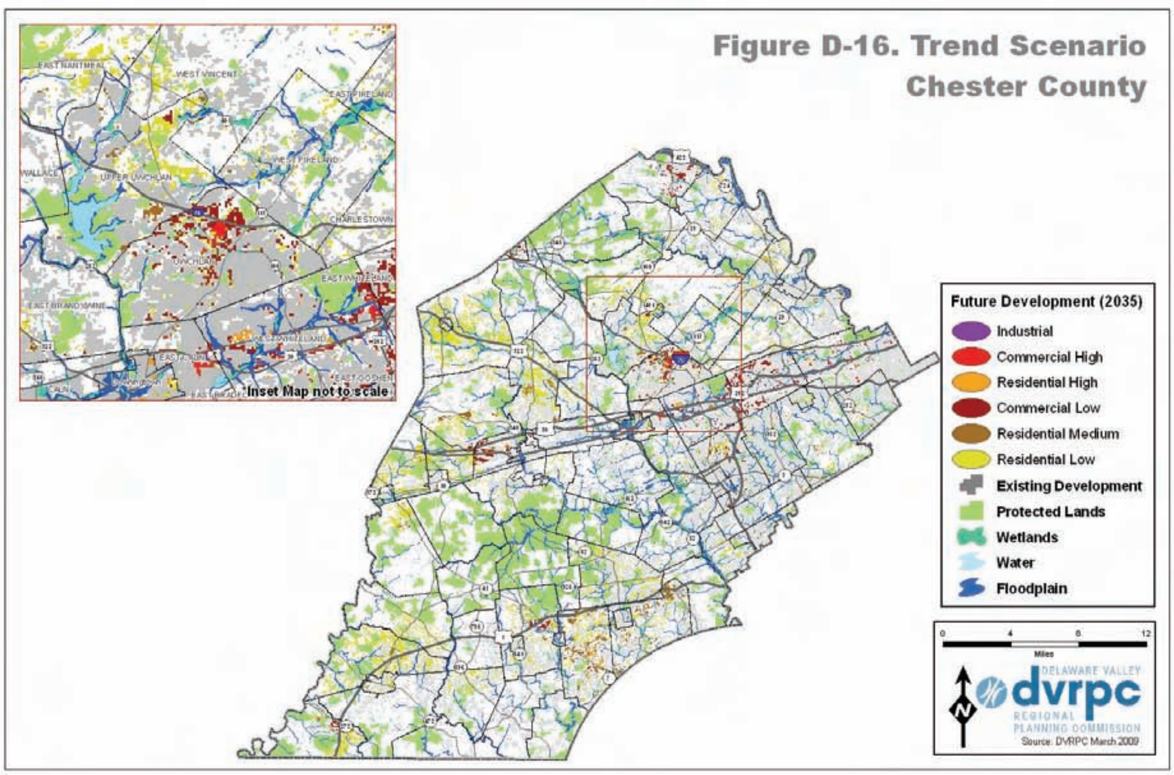


Figure D-16. Trend Scenario
Chester County

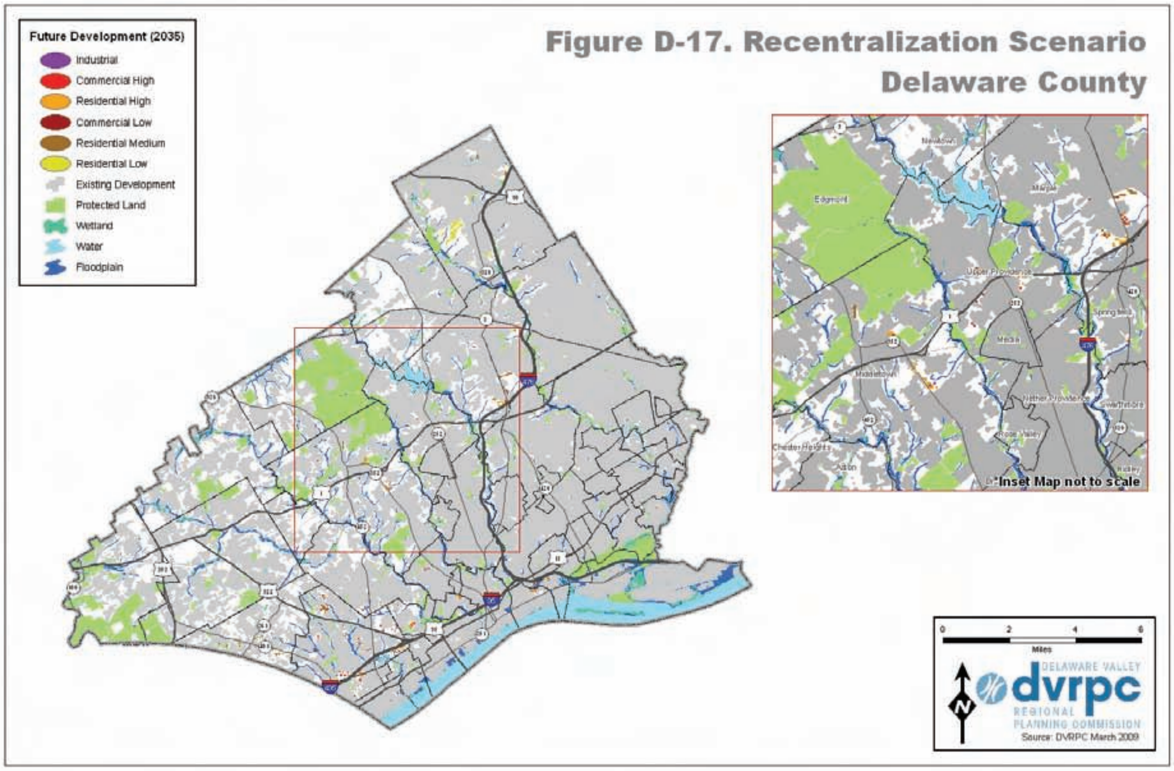


Figure D-17. Recentralization Scenario
Delaware County

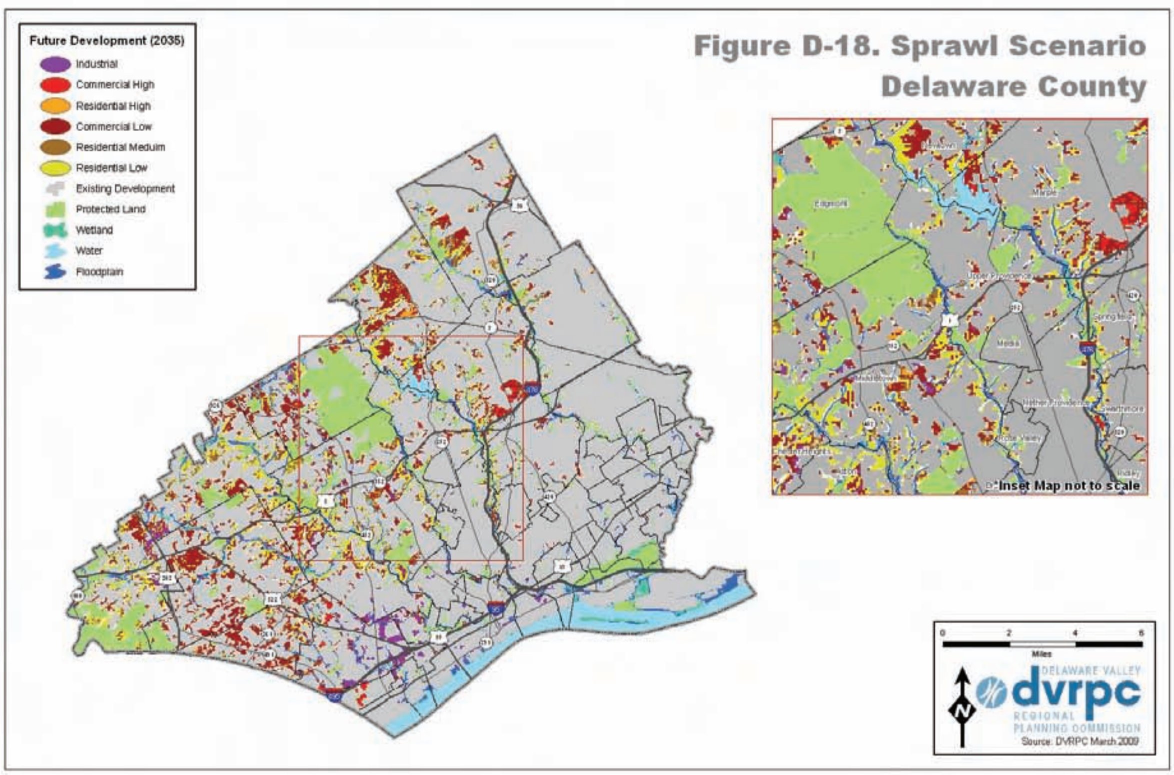


Figure D-18. Sprawl Scenario
Delaware County

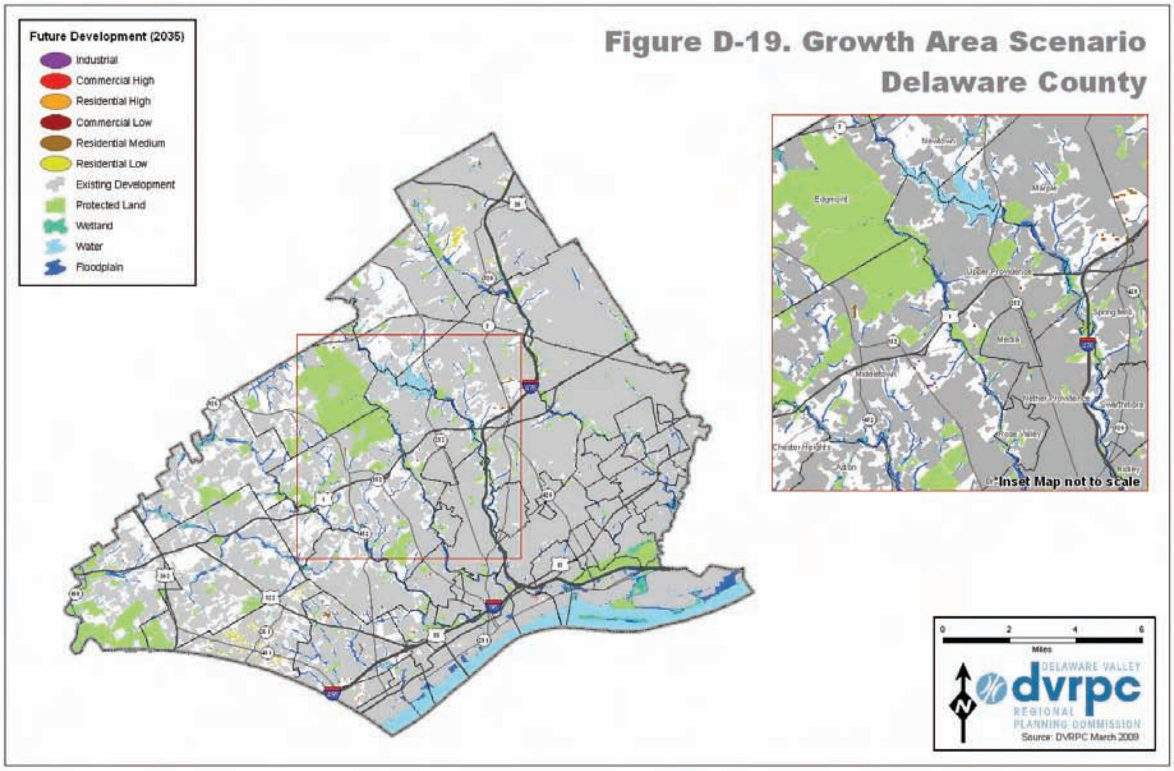


Figure D-19. Growth Area Scenario
Delaware County

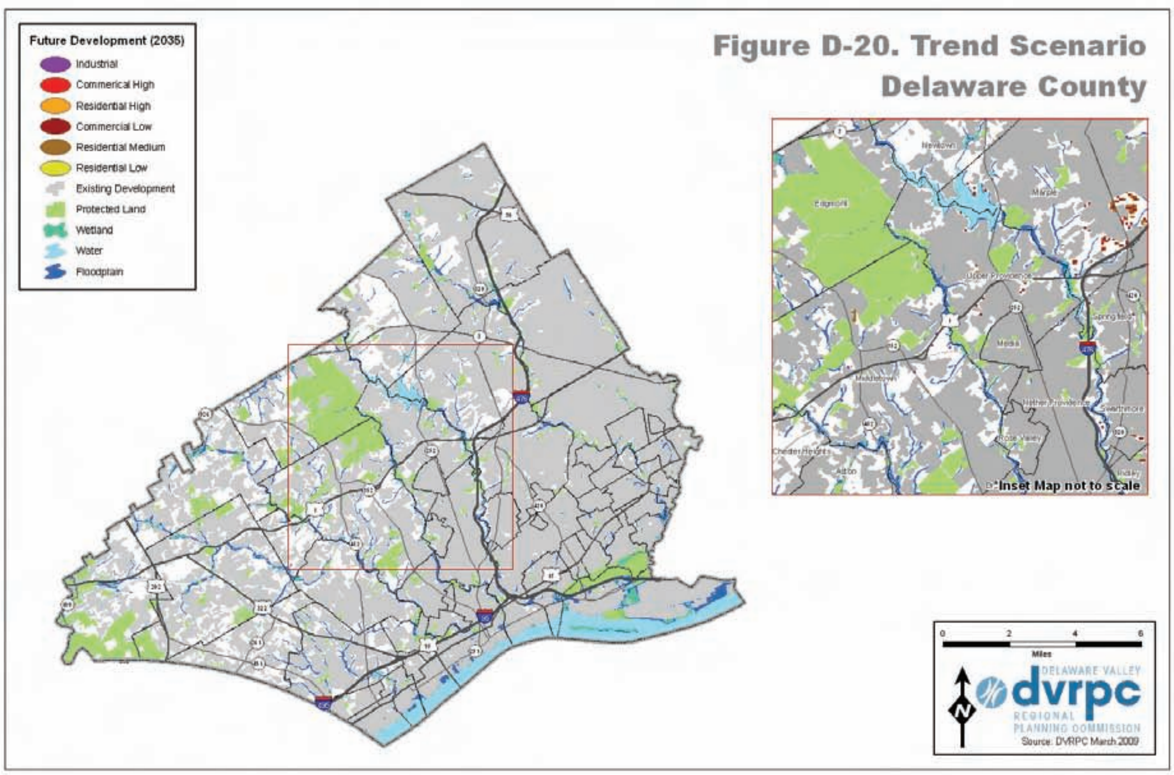


Figure D-20. Trend Scenario
Delaware County

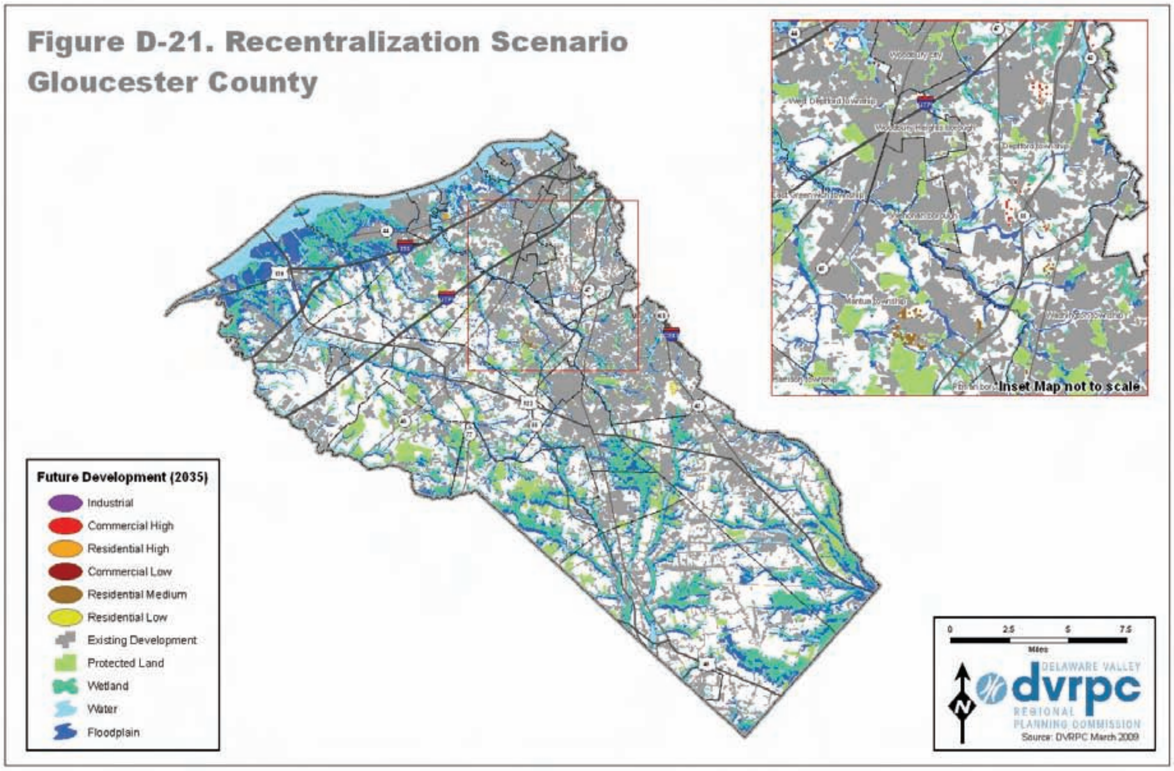


Figure D-21. Recentralization Scenario Gloucester County

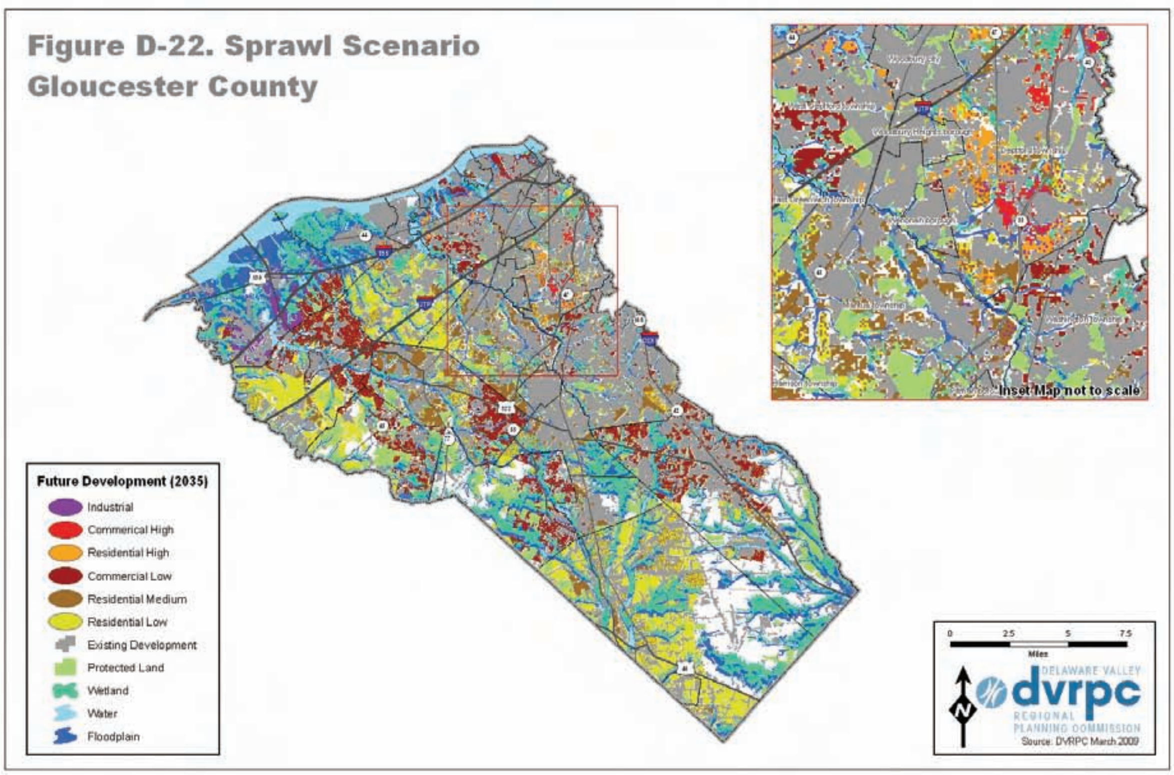


Figure D-22. Sprawl Scenario Gloucester County

Figure D-23. Growth Area Scenario Gloucester County

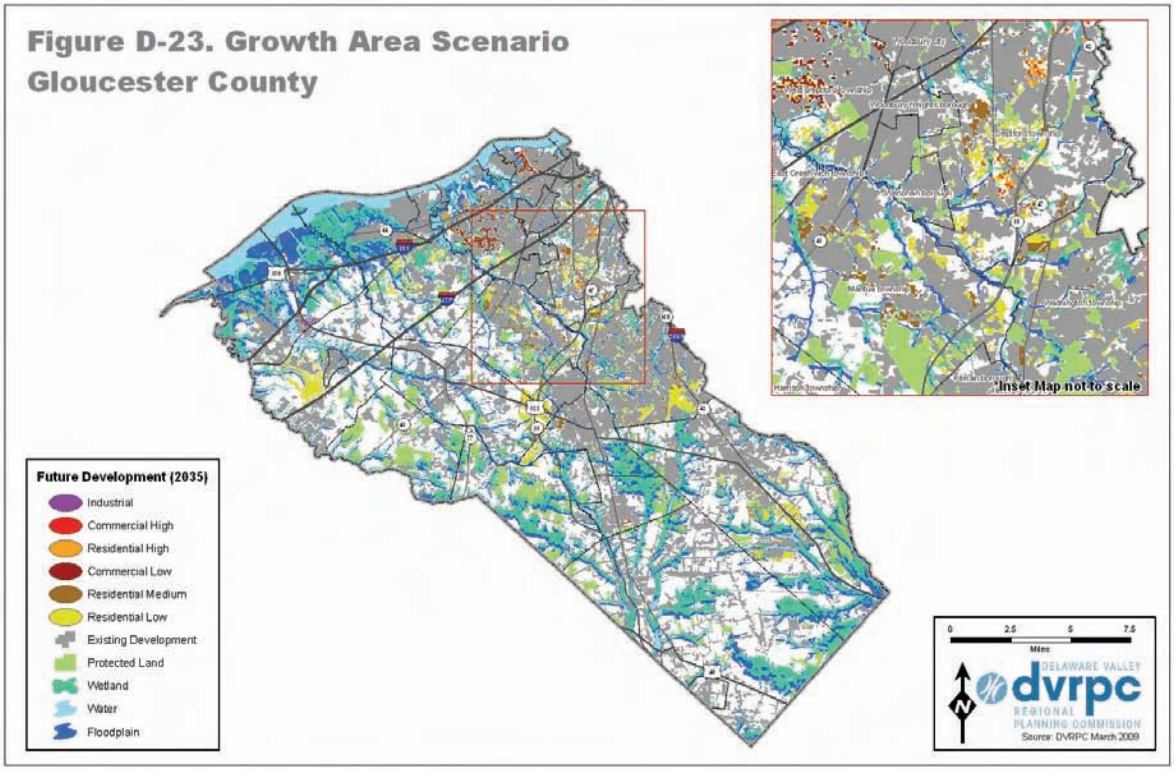


Figure D-24. Trend Scenario Gloucester County

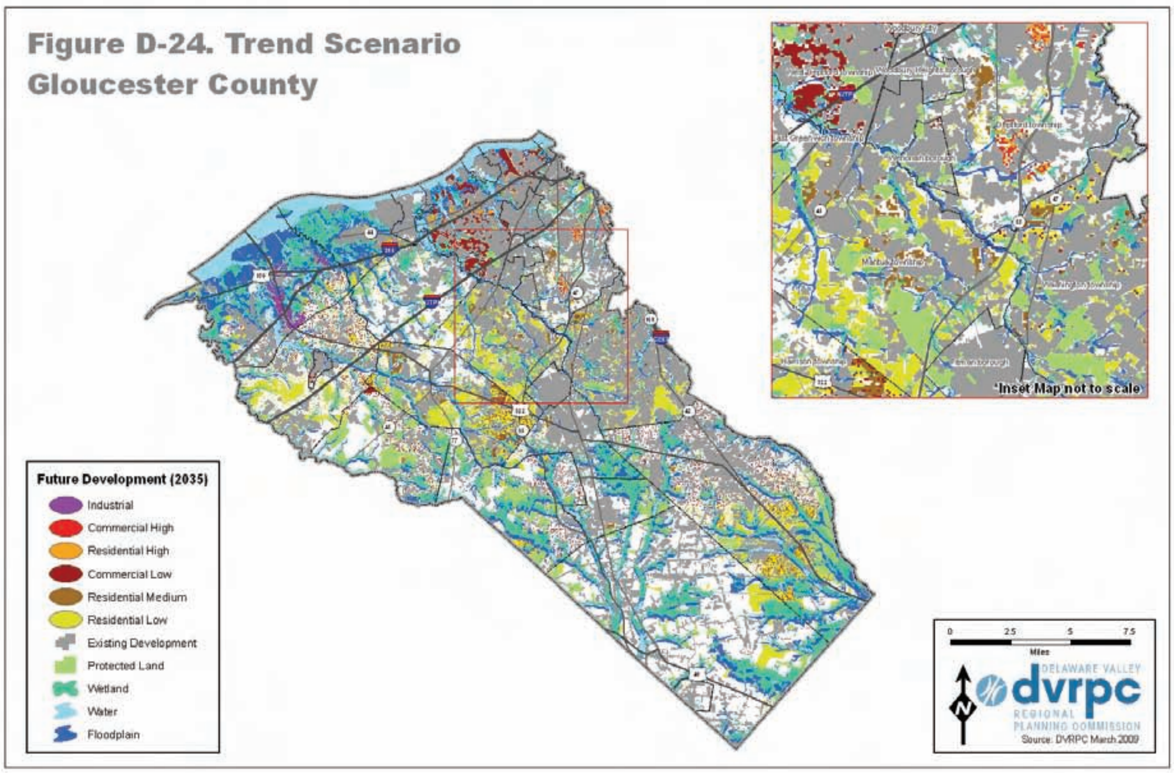


Figure D-25. Recentralization Scenario
Mercer County

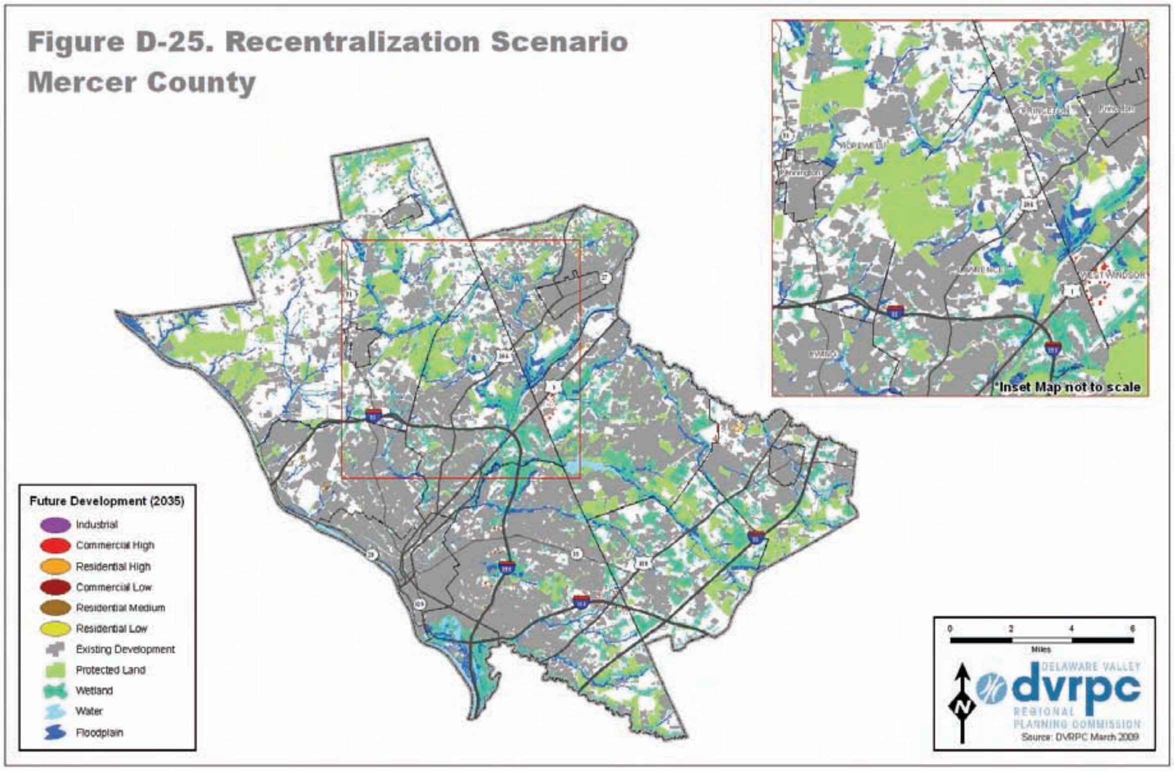


Figure D-26. Sprawl Scenario
Mercer County

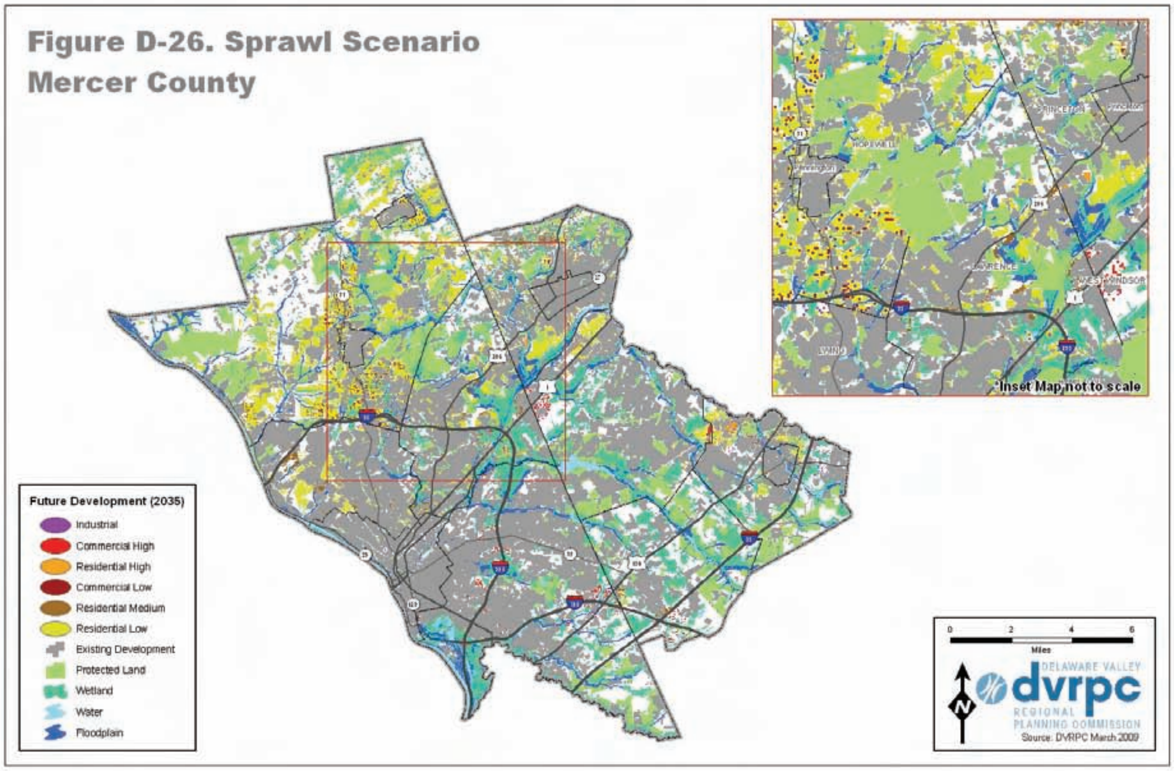


Figure D-27. Growth Area Scenario Mercer County

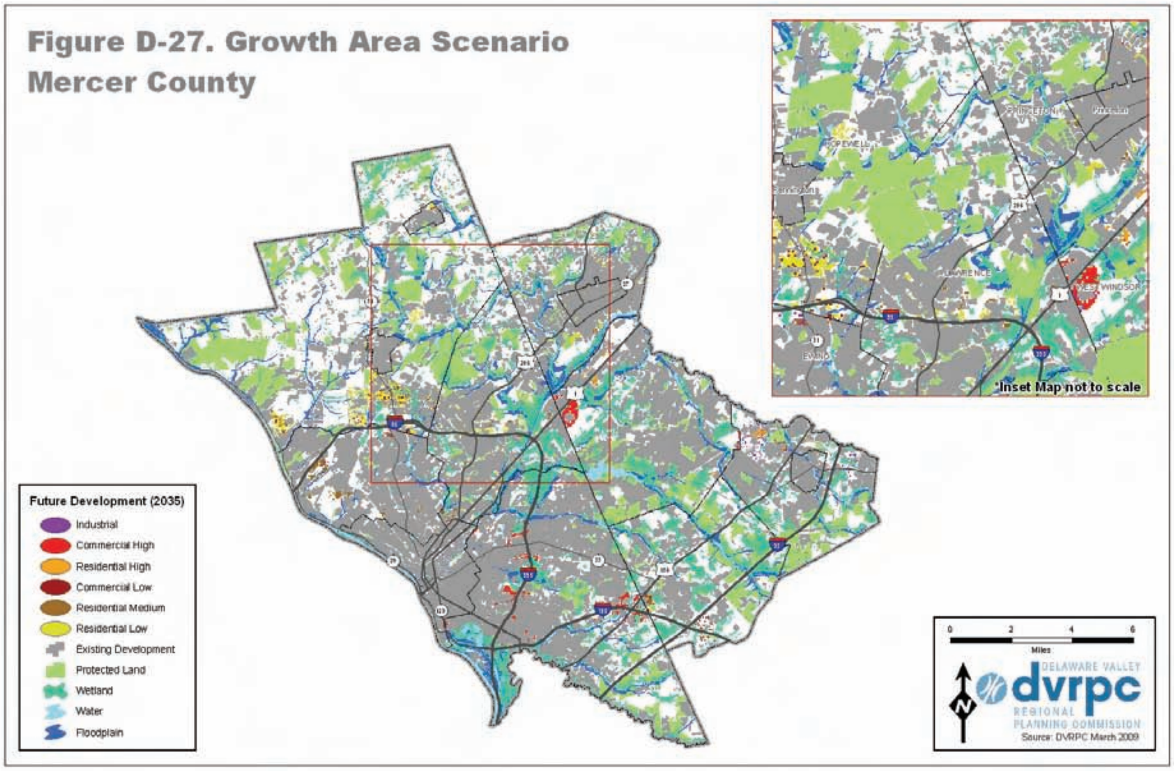


Figure D-28. Trend Scenario Mercer County

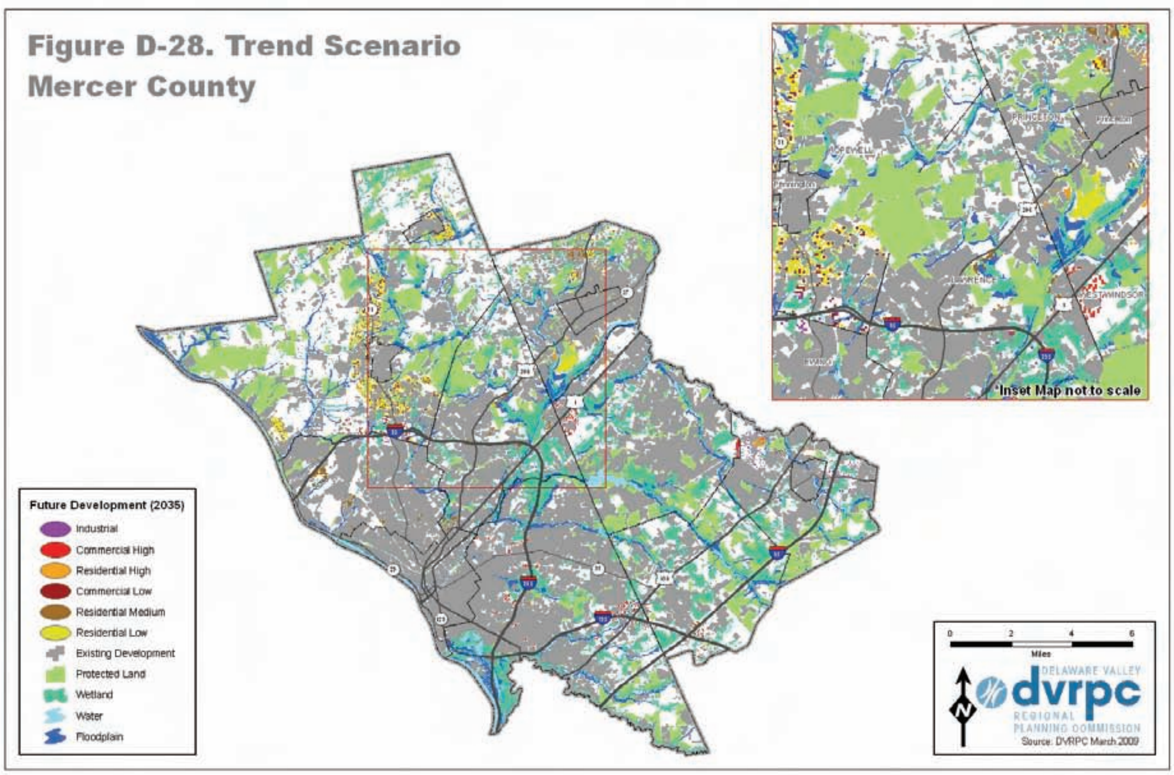


Figure D-29. Recentralization Scenario Montgomery County

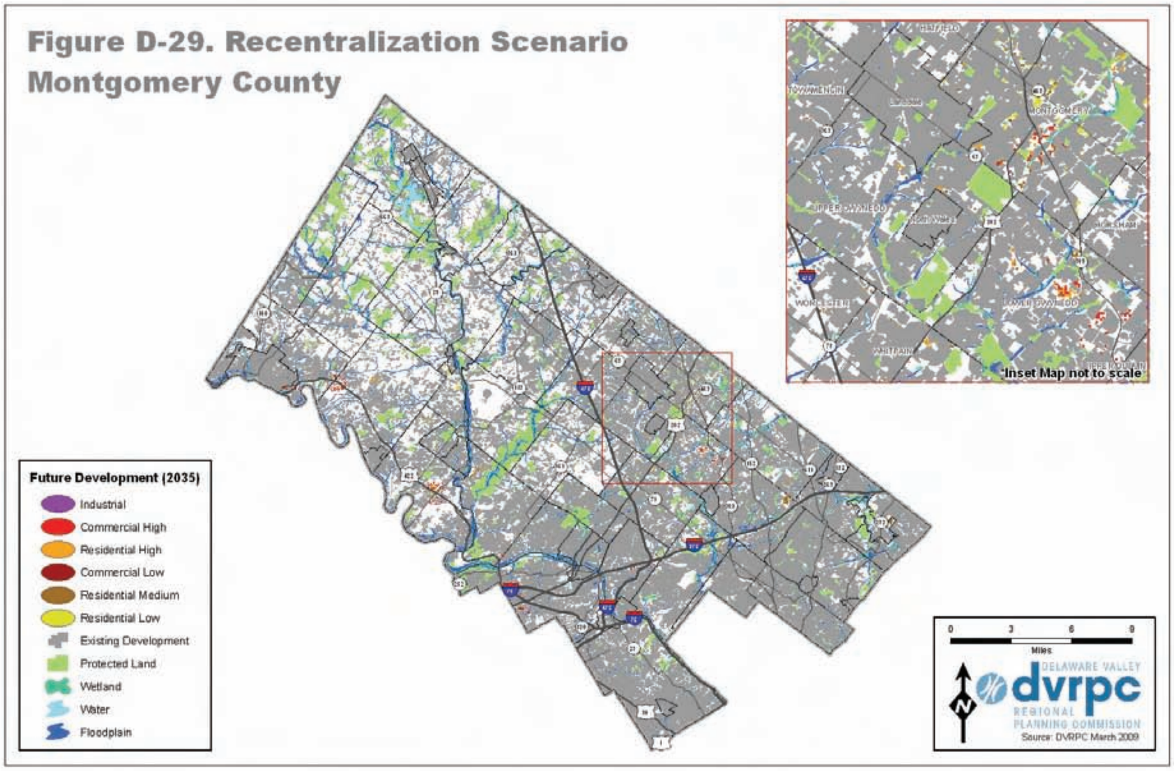


Figure D-30. Sprawl Scenario Montgomery County

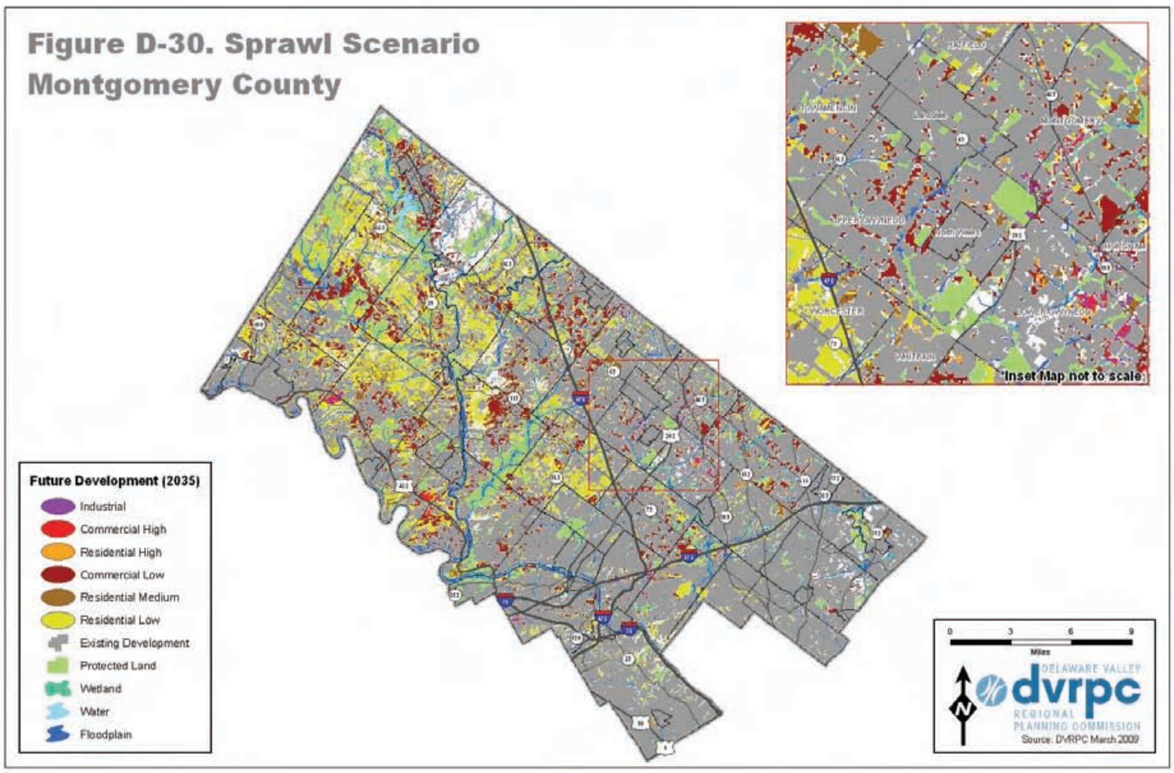


Figure D-31. Growth Area Scenario Montgomery County

Figure D-32. Trend Scenario Montgomery County

APPENDIX E

Description of the DVRPC Travel Demand Model

The enhanced DVRPC travel simulation process utilizes the Evans Algorithm to iterate the model. The purpose of iteration is to achieve, in future forecasts, a balance between input travel speeds and other assumptions and the corresponding simulated outputs from the model. This balance between inputs and outputs is required by federal regulations.

The Evans Algorithm solves for the equilibrium transportation solution in terms of travel demand (trip distribution) and travel assignment. This is an extension of the well-known equilibrium highway assignment model to consider equilibrium trip distribution as well. Evans solves for the equilibrium solution by minimizing an objective function. This objective function considers the travel time and cost aspects of travel by highway and/or transit. The well-known Frank-Wolf partial linearization algorithm used in the equilibrium highway assignment is extended to the trip table estimation as well. Evans re-executes the trip distribution and a modal split model based on updated highway speed after each iteration of highway assignment and assigns a weight (λ) to each iteration. This weight is then used to prepare a convex combination of the link volumes and trip tables for the current iteration and a running weighted average of the previous iterations. This algorithm converges rapidly to the equilibrium solution on highway travel speeds and congestion levels. About seven iterations are required for the process to converge to the approximate equilibrium state for travel patterns. After equilibrium is achieved, the weighted average transit trip tables are assigned to the transit networks to produce link and route passenger volumes.

Separate Peak, Midday, and Evening Models

The enhanced DVRPC travel simulation models are disaggregated into separate peak period, midday, and evening time periods. This disaggregating begins in trip generation where factors are used to separate daily trips into peak, and midday travel. Evening travel is then defined as the residual after peak and midday travel are removed from daily travel. The enhanced process then utilizes completely separate model chains for peak, midday, and evening travel simulation runs. The peak period (combined AM and PM) is defined as 7:00 AM to 9:00 AM and 3:00 PM to 6:00 PM, midday is defined as 9:00 AM to 3:00 PM and evening as 6:00 PM to 7:00 AM. Time of day sensitive inputs to the models such as highway capacities and transit service levels are disaggregated to be reflective of time-period specific conditions. Capacity factors are used to allocate daily highway capacity to the peak, midday, and evening time periods. Separate transit networks were required to represent the different levels of transit service that occur in the various time periods.

External-local productions at the nine-county cordon stations are disaggregated into peak, midday, and evening components using percentages derived from the temporal distribution of traffic counts taken at each cordon station.

Free Flow Highway Speeds, Highway Capacities, and Toll Collections

Input highway operating speeds for the enhanced DVRPC model are estimated from a special highway travel time survey conducted as part of the Model Enhancement Study. The study, completed in 1997, surveyed about 2,000 miles of roadways within the DVRPC region using floating car techniques. Several additional changes were required to produce reasonably accurate estimates of highway traffic volumes and operating speeds directly from the highway assignment model. The number of functional classes in the highway link speed/capacity lookup table was increased from 9 to 27 to better account for detailed design capacity variations within the general functional class designations (freeway, parkway, principal arterial, etc.). The initial highway network speeds were modified to reflect free-flow speeds (speed limits or measured operating speeds, which ever is higher). Finally, a formal toll plaza queuing model was implemented to better model the toll collection congestion and delay on the Turnpikes and Toll Bridges within the region. These changes improved the accuracy of the highway link volumes produced by the Evans process and brought the model into full compliance with recent federal requirements.

DVRPC Travel Simulation Process

The DVRPC model is charted in Figure E-1. The first step in the process involves generating the number of trips that are produced by and destined for each traffic zone and cordon station throughout the nine-county region.

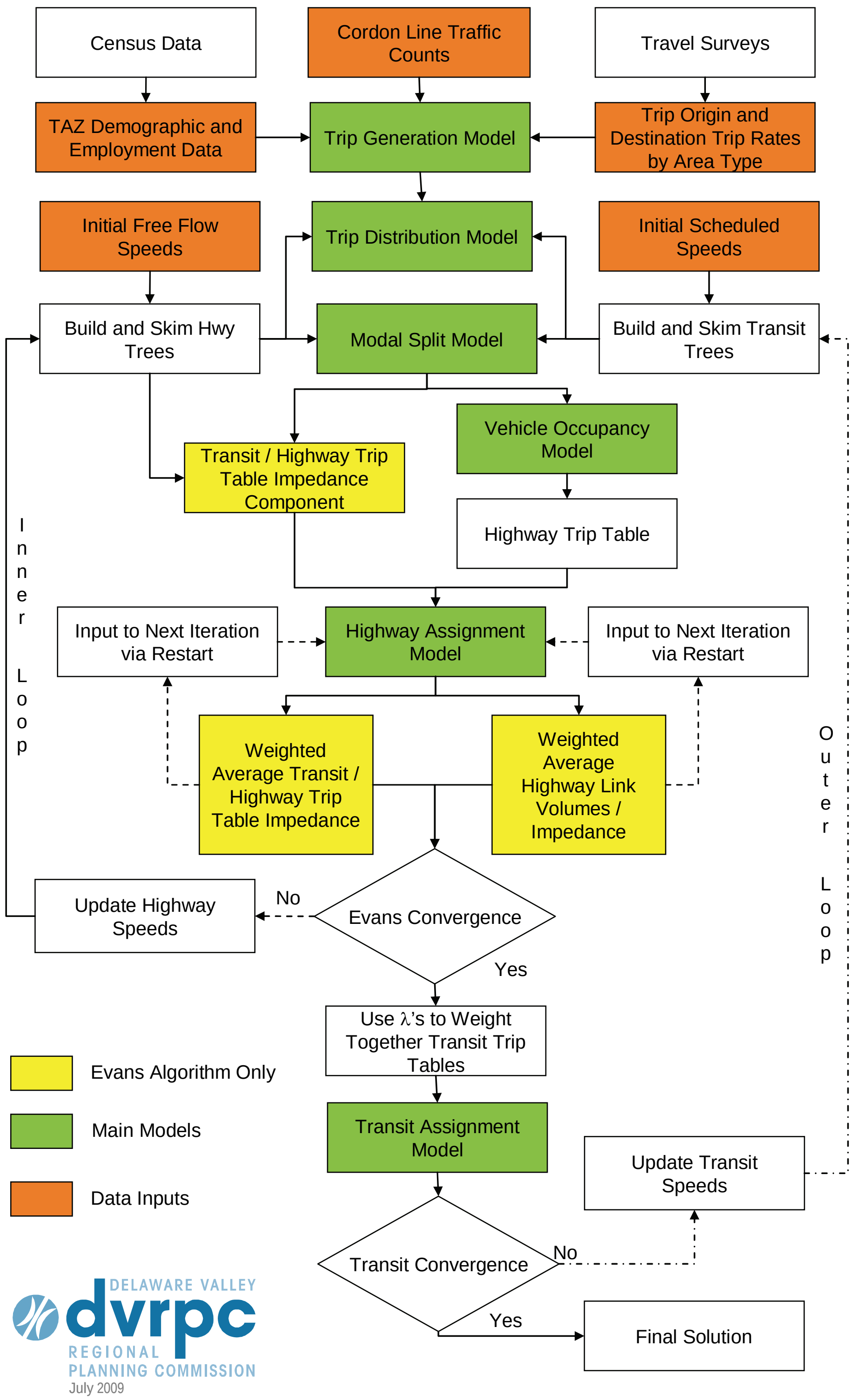
Trip Generation

Both internal trips (those made within the DVRPC region) and external trips (those which cross the boundary of the region) must be considered in the simulation of regional travel. Internal trip generation is based on zonal forecasts of population and employment, whereas external trips are estimated from cordon line traffic counts. The latter also includes trips which pass through the Delaware Valley region. Estimates of internal trip productions and attractions by zone are established on the basis of trip rates applied to the zonal estimates of demographic and employment data. This part of the DVRPC model is not iterated on highway travel speed; rather, estimates of daily trip making by traffic zone are calculated and then disaggregated into peak, midday, and evening time periods.

Evans Iterations

The iterative portion of the Evans forecasting process involves updating the highway network restrained link travel speeds, rebuilding the minimum time paths through the network, and skimming the inter-zonal travel time for the minimum paths. Then the trip distribution, modal split, and highway assignment models are executed in sequence for each pass through the model chain (see Figure E-1, inner loop). After convergence is reached, the transit trip table for each iteration is weighted together and the weighted average table assigned to the transit network. The highway trip tables are loaded onto the network during each Evans iteration. A composite highway trip table is not required to perform the highway assignment. For each time period, seven iterations of the Evans process are performed to ensure that convergence on travel times is reached.

Figure E-1. DVRPC Travel Simulation Process



Trip Distribution

Trip distribution is the process whereby the zonal trip ends established in the trip generation analysis are linked together to form origin-destination patterns in the trip table format. Peak, midday, and evening trip ends are distributed separately. For each Evans iteration, a series of eight gravity-type distribution models are applied at the zonal level. These models follow the trip purpose and vehicle type stratifications established in trip generation. Documentation of the trip distribution models is included in the commission report entitled *1997 Travel Simulation Model for the Delaware Valley Region (Publication#: 00001, DVRPC 2000)*.

Modal Split

The modal split model is also run separately for the peak, midday, and evening time periods. The modal split model calculates the fraction of each person-trip interchange in the trip table which should be allocated to transit, and then assigns the residual to highway. The choice between highway and transit usage is made on the basis of comparative cost, travel time, and frequency of service, with other aspects of modal choice being used to modify this basic relationship. In general, the better the transit service, the higher the fraction assigned to transit, although trip purpose and auto ownership also affects the allocation. The model subdivides highway trips into auto drivers and passengers. Auto driver trips are added to the truck, taxi, and external vehicle trips in preparation for assignment to the highway network. See *1997 Travel Simulation Model for the Delaware Valley Region* for a detailed description of the model parameters. The model is nested by transit approach method (walk/bus versus automobile) and is individually calibrated to each time period.

Highway Assignment

The final step in the simulation process is the assignment of vehicle trips to the highway network. For peak, midday, and evening travel, this assignment model produces the future traffic volumes for individual highway links that are required for planning analyses. The regional nature of the highway network and trip table underlying the assignment process allow the diversion of travel into and through the study area to various points of entry and exit in response to the characteristics of the transportation system. For each Evans iteration, highway trips are assigned to the network by determining the best (minimum time) route through the highway network for each zonal interchange and then allocating the inter-zonal highway travel to the highway facilities along that route. This assignment model is “capacity restrained” in that congestion levels are considered when determining the best route. The Evans equilibrium assignment method is used to implement the capacity constraint. When the assignment and associated trip table reach equilibrium, no path faster than the one actually assigned can be found through the network, given the capacity restrained travel times on each link.

Transit Assignment

After equilibrium is achieved, the weighted average transit trip tables (using the λ's calculated from the overall Evans process as weights) are assigned to the transit network to produce link and route passenger volumes. The transit person trips produced by the modal split model are "linked" in that they do not include any transfers that occur either between transit trips or between auto approaches and transit lines. The transit assignment procedure accomplishes two major tasks. First, the transit trips are "unlinked" to include transfers, and second, the unlinked transit trips are associated with specific transit facilities to produce link, line, and station volumes. These tasks are accomplished simultaneously within TRANPLAN, which assigns the transit trip matrix to minimum impedance paths built through the transit network. There is no capacity restraining procedure in the transit assignment model.

Mobile Source Emissions Postprocessor

DVRPC uses the EPA mandated application, MOBILE6, to estimate mobile source emissions produced in the region based on inputs from the travel demand model. MOBILE6 is a program that provides estimates of current and future emissions from highway motor vehicles for hydrocarbons, carbon monoxide, and oxides of nitrogen from the following sources: gas, diesel, and natural-gas-fueled cars, tracks, buses, and motorcycles. DVRPC uses a postprocessor to convert the TRANPLAN output into MOBILE6 format. See *2000 and 2005 Validation of The DVRPC Regional Simulation Models* (Publication # 08095, DVRPC July 2008) report for a more detailed description of MOBLIE6 and the DVRPC Postprocessor.

Abstract Page

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Geographic Area Covered: Delaware Valley Region comprised of five counties in Pennsylvania (Bucks, Chester, Delaware, Philadelphia, and Montgomery) and four counties in New Jersey (Burlington, Camden, Gloucester, and Mercer

Key Words: UPlan, Geographical Information System (GIS), transportation/land use link, land use model, land use policy, corridor planning, model implementation, calibration, parameters, variables

Abstract: This report documents the completion of the UPlan calibration process and presents the development and application of a generalized forecasting methodology for applying UPlan in ongoing DVRPC studies. UPlan is a GIS-based land use planning and forecasting model with a sophisticated embedded transportation/land use interface. The implementation strategy involves emulating ongoing DVRPC 2030 Land Use and Transportation planning activities within UPlan as much as possible while implementing the transportation/land use linkage recommended by federal guidelines. Ultimately, the goal is to integrate UPlan into ongoing regional, county, and local land use/transportation planning activities. This report documents two pilot studies, as well as the first scenario planning project based on the fully validated land use model.

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