Threat Assessment
For
Smart Conservation

Prepared by the Delaware Valley Regional Planning Commission

For

Natural Lands Trust

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I. INTRODUCTION

The Smart Conservation project, originated and developed by the Natural Lands Trust of Media, Pennsylvania, evaluates ecological assets, conservation potential, long-term viability, threat of development, and community interest to establish a systemized hierarchy of lands that can be incorporated into conservation funding decisions. The "Threat Assessment" component is designed to consider growth trends and other conditions that reveal the likelihood of development in any location within the region, defined as Bucks, Chester, Delaware, Montgomery and Philadelphia counties. Although the entire five county region of southeastern Pennsylvania (SEPA) is said to be under development threat, the task of the Threat Assessment (TA) is to incorporate the most important indicators of likelihood of development into a useful index that quantifies *relative* threat across the region. The method currently applies to the 5-county SEPA area, but could be transferred to other regions by replicating the data sets and analyses.

II. PROJECT PARTNERS

The Natural Lands Trust (NLT) subcontracted with the Delaware Valley Regional Planning Commission (DVRPC) to conduct the Threat Assessment portion of the Smart Conservation project. DVRPC is the federally designated metropolitan planning organization (MPO) for the nine-county Philadelphia region, including Bucks, Chester, Delaware, Montgomery and Philadelphia counties in southeastern Pennsylvania, and Burlington, Camden, Gloucester and Mercer counties in New Jersey. (The Threat Assessment, however, only addresses conditions in the five Pennsylvania counties at this time.) As the MPO, DVRPC is considered uniquely qualified to conduct the Threat Assessment due to its access to data across the region, its relationship with its county member governments and its previous work on regional plans, growth forecasts, municipal assessments, and travel time analysis that contributed to the Threat Assessment project.

A core advisory committee comprised of representatives from the Natural Lands Trust, Pennsylvania Department of Conservation and Natural Resources, Montgomery County Planning Commission, Montgomery County Lands Trust, Chester County Planning Commission, 10,000 Friends of Pennsylvania, and Penn State University Goddard School of Forestry, plus various other stakeholders who participated intermittently, met approximately 9 times from January 2002 to November 2002 to review progress on the project and provide feedback and guidance. The Threat Assessment project was also presented to the broader Smart Conservation consortium made up of representatives from the plants, herps, mammals, birds, aquatics, and inverts groups. Feedback from each meeting was incorporated into the threat assessment project.

III. BACKGROUND ON AND INFLUENCE OF SIMILAR EFFORTS

At the beginning of the Threat Assessment process, members of the advisory committee were polled on their awareness of similar efforts to assess development threat. At that time, two approaches were known and discussed: a 1990 analysis created by the Montgomery County Planning Commission called the "Future Growth Index", and the agricultural preservation criteria used by the state and county purchase of development rights programs. In addition, a special meeting with a major residential developer who has been in business for over 25 years was set up as a "reality check" and to glean what developers look for when selecting land for development. Much later in the process, another effort developed for the New York-New Jersey Highlands was discovered. Each of the methods, and the developer's advice were examined for applicability to the southeastern Pennsylvania study area in terms of data availability, ease of transferability, and consistency of purpose. The following summarizes how each parallel method influenced the Threat Assessment:

A. Montgomery County Future Growth Index

The Montgomery County Planning Commission developed a "Future Growth Index" (FGI) in 1990 which had a very similar goal to the Threat Assessment – to develop a quantifiable index that measured municipalities' relative threat of development. The FGI was applied to twenty-six (26) municipalities pre-selected for their available land and suspected development threat. The following thirteen factors were determined for each municipality:

1. Developable land
2. Percent of total municipal land area that is developable
3. Public sewer capacity
4. Proximity of municipality to significant employment centers
5. Accessibility of municipality to limited access highway interchanges
6. Total linear miles of principal arterials
7. Acreage of approved plans, 1987-1989
8. Percent of total municipal land area that had approved plans, 1987 – 1989
9. Acres of land area involved in development submittals, 1987-1989
10. Percent of total municipal land area involved in development submittals, 1987-1989
11. Number of proposed housing units, 1987-1989
12. Percent increase in number of housing units, 1987-1989
13. Availability of public water services

The results for each factor were divided into three categories based on standard deviations from the mean, and then assigned a score of 1, 2, or 3 based on their category. Each of the scores for the thirteen factors were then weighted on a scale of 1 to 5 to comprise a final composite weighted index for the 26 high growth municipalities.

Because over 10 years had passed since the FGI had been developed in 1990, it was possible to conduct a quick measure of its accuracy by ranking the amount of land developed in each of the 26 municipalities compared to the composite weighted indices of the municipalities. This comparison showed an 80% consistency between the top 10 ranked FGI municipalities and the municipalities which experienced the most land developed over the decade.

The FGI method was therefore deemed a good indicator of development pressures. The next step was to re-examine each of the 13 factors to determine its current applicability and the feasibility of obtaining such data for all 239 municipalities in the SEPA region. Feedback from the advisory committee and the residential developer, along with research into data availability across the region, resulted in the following conclusions regarding the FGI:

1. Developable land – incorporate in Threat Assessment (TA)
2. Percent of total municipal land area that is developable – incorporate in TA
3. Public sewer capacity – incorporate in TA but lower the weight, because the improved technology and sometimes preference for spray and drip irrigation systems are lessoning large scale developments' reliance on connections to public sewer systems
4. Proximity of municipality to significant employment centers – incorporate in TA
5. Accessibility of municipality to limited access highway interchanges – related to proximity to employment centers and incorporated through that factor
6. Total linear miles of principal arterials – related to proximity to employment centers and incorporated through that factor
7. Acreage of approved plans, 1987-1989 – data not readily available across the five county region, but should go back 10 years if it were available
8. Percent of total municipal land area that had approved plans, 1987 – 1989 – data not readily available across the five county region, but should go back 10 years if it were available
9. Acres of land area involved in development submittals, 1987-1989 – Data not readily available, but go back 10 years if it were
10. Percent of total municipal land area involved in development submittals, 1987-1989 – data not readily available across the region, but go back 10 years if it were
11. Number of proposed housing units, 1987-1989 – Go back 10 years if available because longer lag time needs to be taken into account
12. Percent increase in number of housing units, 1987-1989 Go back 10 years if available because longer lag time needs to be taken into account
13. Availability of public water services – Only 1992 data for region currently available, but not thought to be a determining factor for developers

In sum, the Montgomery County Planning Commission's Future Growth Index was thought to be a very helpful model on which to base the Threat Assessment. However, data for about half of the factors was not readily available for the 239 municipalities across the 5 county region, and some of the factors, such as sewer and water service, were thought to be less important in 2002 than they were in 1990. Therefore, the above

referenced changes to the factors were incorporated, in various ways described later in the report, into the Friction Map, Building Activity Map, Employment Center Travel Times Analysis and Sewer Service Areas components of the Threat Assessment.

B. Agricultural Preservation Program Criteria

The state and county farmland preservation programs incorporate a ranking system where farms are rated against other eligible parcels according to the quality of the farmland, stewardship and their likelihood of conversion. The program's criteria for likelihood of conversion involves parcel specific information on the prospective farm's proximity to sewer and water lines, the extent and type of non-agricultural uses nearby, the amount and type of agricultural uses in the vicinity, and the amount of other preserved farmland in close proximity. The two main differences between the Threat Assessment approach and the farmland preservation program's likelihood of conversion approach are that the Threat Assessment looks at broader landscapes while the farmland program looks at individual parcels, and the Threat Assessment looks at development threat to all lands while the farmland program looks at threat of conversion to agricultural lands only, based on agricultural-related factors. For these reasons, the likelihood of conversion approach applied in the ranking of farms for purchase of development rights programs was not further incorporated into the Threat Assessment.

C. Residential Developer Input

In February of 2002, early in the development of the Threat Assessment method, an experienced residential developer who also sits on the Chester County Planning Commission was invited to an advisory committee meeting to offer insight into what developers look for in selecting sites for residential development, and to provide a "reality check" to the method developed to date, which largely involved re-working the Montgomery County Future Growth Index. The developer claimed that all of SEPA was under threat of development, but that some areas were more "threatened" than others. He said that developers do not use a quantitative, scientific model to show them where to develop next, but rather, they mainly look at an area's proximity to employment centers, size of the land, the views from the road, and the zoning to select parcels for development.

In addition, the developer said that, while residential development does not typically follow retail development, tracking new Walmarts and Home Depots could be excellent indicators of where residential development will shortly occur. New Walmarts, especially, seem to pre-date new residential development, which inevitably follows. However, in SEPA, new Walmarts and Home Depots are also popping up in older suburban and even urban areas, making this theory less predictive in this region of the state.

The developer also explained that connections to public sewer service were no longer as important as they used to be, at least in Chester County, where good soils and technology have married to produce spray or drip irrigation systems that can serve larger subdivisions. In addition, he said connections to public water are almost never a

limitation. The importance of the sewer connections was therefore lessened in the weighting, and dropping water was justified, at least until a more up-to-date data layer for it is created.

Another factor discussed with the developer was land value. It was previously assumed that lower land values would increase attractiveness to developers, thereby heightening threat. However, the developer explained that, while land value was somewhat important, it was not the driving force in land selection, because the cost of the land is tied to its overall marketability, and higher cost can be recouped in higher priced home sales.

Finally, the developer reminded the advisory committee that the cumulative effect of small subdivisions has as great, or even greater impact on the landscape than the large subdivisions. In Chester County, he cited the median size development as eight (8) lots. This meant that the Threat Assessment should be careful to incorporate factors influencing small-scale residential development as well as large-scale developments.

In sum, the main point that the developer emphasized was the importance of incorporating proximity to employment centers in the Threat Assessment as a major indicator of growth. A more minor point was reducing the importance of public sewer and especially public water in the equations.

D. Forest Service "Likelihood of Land Use Change – Econometric Modeling"

In the fall of 2002, after the bulk of the Threat Assessment had been developed and agreed upon, another, similar effort coordinated by the USDA Forest Service and carried out in cooperation with the State Foresters of New York and New Jersey, Rutgers University, the U.S. Geological Survey and the Regional Plan Association, for the NY-NJ Highlands, was discovered and briefly examined. The report, *NY-NJ Highlands Regional Assessment Study Update 2002 Technical Report, Land Resources Component*, was shared with DVRPC for internal review only, because it was still undergoing revisions.

Peter Parks, David Tulloch and Richard Lathrop developed a "Likelihood of Land Use Change: Econometric Model" for the NY-NJ Highlands region. Their econometric model involves very complex equations incorporating 28 variables and land use data for 1995 and 2000 constructed as a stratified random sample of 5750 points that were in rural use in 1995. Variables are combined to measure land quality, block-level Census information, and policy variables influencing land use, such as maximum housing density permitted by zoning, and the proportion of nearby lands in forest stewardship programs.

This model is clearly part of a larger, more extensive and expensive effort by multiple parties to develop a detailed assessment for the NY-NJ Highlands. The end result, however, appears similar to the end result of the Smart Conservation Threat Assessment: a chromatic map of a region showing color graduations representing likelihood of change, or threat of development. Both maps reveal general patterns and highlight probable hotspots of future development.

IV. OVERALL PROJECT APPROACH

Building on the Montgomery County Future Growth Index, feedback from the residential developer, and the ability to incorporate previous work that DVRPC had completed that supported the Threat Assessment goal, the advisory committee agreed to the following five (5) analyses, or components, that would be combined into a composite threat assessment map. The five components vary from municipal-based scores to geographically specific spatial analysis, but all five components can still be combined to create one analytical score-based map. The five analyses are:

A. Trend Friction Map
B. Employment Center Travel Times
C. Building Activity - Proposed Housing Units Relative to Municipal Size and Available Land
D. Vulnerability Index
E. Sewer Service Areas

These five analyses account for multiple variables including: Population and employment forecasts; designated growth, rural, and open space areas; land use consumption trends; employment center growth, location and actual travel times to; proposed housing units over a seven (7) year period, total municipal size, and developable land by municipality; municipal use of natural resource protection tools; and existing and proposed sewer service areas. A sixth component, developable lands, blocks out existing developed land and protected open space, showing only lands that can still be developed. This map can be used as an overlay to remove "unthreatened" land from the final composite map. The details of each component are reported in following sections.

The compilation of data for each component is followed by translating results into workable indices that lend themselves to a composite map. Three of the components (Trend Friction Map, Building Activity, and Vulnerability Index) result in municipal scores; scores are classified into five categories and each category is given a value relative to the others. *Table 1* shows the friction map legend as an example of how the classification system works. A municipality that scores in a particular range will receive the respective category score. Category scores are determined by taking the midpoint of each range and normalizing them on a ten-point scale.

Table 1 **Friction Map Distribution**

Degree of Threat	Friction Score Range	Category Score
Least Threatened	1-200	0.36
	201-500	1.25
	501-1000	2.68
	1001-2000	5.36
Most Threatened	2001-3600	10.0

The travel time and sewer maps are also on a ten-point scale, but scores are assigned to specific polygons rather than municipalities. The sewer scoring system also differs by using qualitative categories, which is explained in section E. The developable land map has no scoring system and is just a tool to emphasize the areas where threat can occur.

Each component is then weighted as a whole based upon its significance to the overall threat assessment. A composite map is formed when the individual scores of a municipality or polygon are adjusted depending on the relative importance of the factor. *Table 2* lists the relative weights of the components.

Table 2 **Comparative Weights**

Component	Weight
Trend Friction Map	25%
Employment Center Travel Time	25%
Building Activity	25%
Vulnerability Index	10%
Sewer Service Areas	15%

This weighting can easily be adjusted in the future if so desired. The application in *Table 2* gives equal weight to the Trend Friction Map, Employment Center Travel Time Analysis, and Building Activity, because the advisory committee thought that they were the strongest indicators of future threat of development. The travel time map is also noteworthy because it heavily weighted data disassociated from municipal boundaries. The remaining two components, the Vulnerability Index and Sewer Service Areas, have less influence for reasons specified in their respective sections.

V. MODEL COMPONENTS

A. TREND FRICTION MAP

The Trend Friction Map analysis highlights municipalities in the five-county southeastern Pennsylvania region whose forecasted growth contradicts the DVRPC Horizons 2025 Land Use Plan based on a trend development scenario. A growth mismatch, also referred to as friction, is observed when expected development outpaces the amount of land allocated toward future growth as determined by the adopted DVRPC plan. The end product identifies municipalities threatened by a growth mismatch and distinguishes the level of threat by the amount and type of land likely to be consumed.

METHOD

The Land Use Forecast Model (LUFM) used for this study converts municipally forecasted population and employment growth to acres of land consumed and then compares the acres consumed to the future growth area by municipality, as designated in

the 2025 Plan. Municipalities with insufficient capacity to accommodate forecasted growth in designated growth areas are noted as having a mismatch. The model assumes that once future growth area is completely developed, rural / agricultural land will be used up next, followed by proposed open space. If even more land is needed for growth, then that municipality is designated as having a land deficit by the amount of needed acres. See the *2025 Land Use Plan* map on the following page.

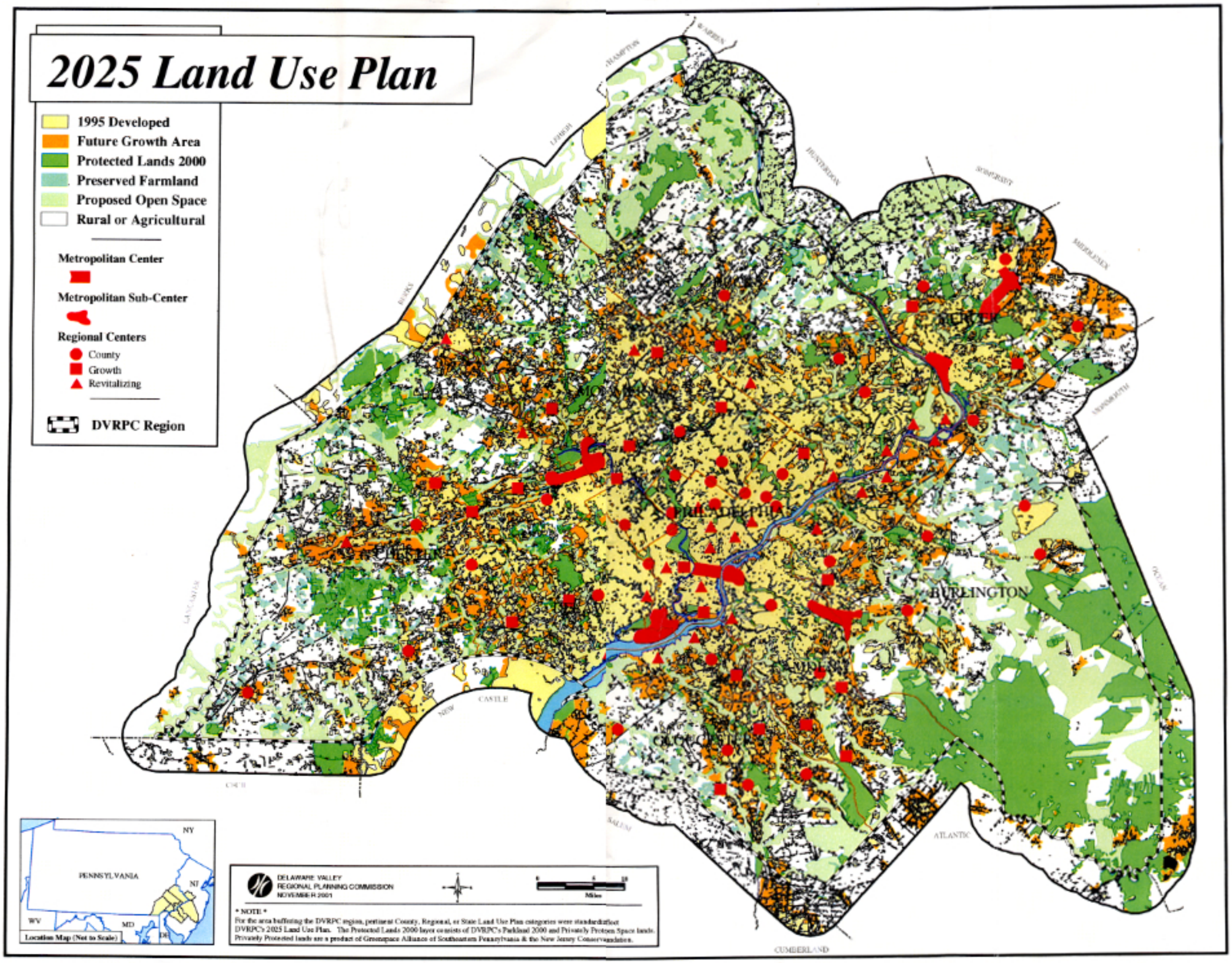
The conversion of growth in terms of people to acreage consumed is performed via a Land Use Consumption Factor (LUCF). Municipalities are classified into nine different density categories with each type assigned a different LUCF based on 1990 consumption trends. There is also a different LUCF for either residential or employment figures. Multiplying the LUCF times the forecasted population or employment growth results in the estimated acreage needed to accommodate that growth. A margin of 5% is allowed before a mismatch is declared in order to account for some of the uncertainty.

The baseline, or trend version of the model, is used here, and does not account for the possibility of infill, or future higher densities, when determining consumption. Adjusted density and infill versions of the model exist, but were not used here, because they represent a future preferred scenario dependent on policy or market changes. Instead, the trend scenario, which replicates existing 1990 conditions, is used. See *Appendix A* for the technical documentation of the Land Use Forecast Model including a general LUCF table.

While the LUFM is an established tool used by DVRPC, a new scoring system had to be created for use in the TA project. The least threatened municipalities are able to contain all forecasted growth within designated future growth areas, registering no threat of inappropriate development, and therefore no contradiction with the land use plan. The remaining municipalities have some combination of designated rural/agricultural and proposed open space consumption. Each acre of rural/agricultural land consumed counts as one unit towards a municipality's friction score. Each acre of proposed open space consumed counts as two units. A third category, land deficit, correlates to three units per acre and is applied only when no rural/agricultural or proposed open space land remains. All units are added together to establish a municipality's total friction score.

Municipalities that have a score above zero have been grouped into five categories as shown by *Table 1* in the previous section. Each category was given a final TA score based upon the range midpoints relative to each other on a ten point scale. This is the score to be applied toward the composite map to determine overall threat.

2025 Land Use Plan



RESULTS

Table 3 lists the 84 municipalities that had significant mismatches between forecasted growth and available future growth area under the trend scenario. To be considered significant, the total acres of the mismatch must be over 5% of the total land consumed by 2025. According to the model, sixteen (16) of those 84 municipalities would experience development of *over* 1,000 acres of land designated to remain rural/agricultural. Twenty-five (25) municipalities would be forced to develop some land proposed for open space preservation. Eleven (11) municipalities would have insufficient land to accommodate growth even after designated future growth areas, rural/agricultural areas, and proposed open space lands were consumed, and would have a land deficit of 50 acres or more. The resultant final scores are also noted in the table. One hundred fifty four (154) municipalities (155 including Philadelphia) did not show any significant mismatch and would therefore receive a final score of 0 (no threat) for this component. See *Friction Map of Southeastern Pennsylvania – Trend Scenario* for results of LUFM, and see *Friction Map of Southeastern Pennsylvania – Trend Scenario: Ranking of Land Consumption Beyond Designated Growth Areas* for map of total scores.

***Table 3*- Friction Map Data (In Acres)**

Municipality	Rural / Ag Consumed 2025	Proposed Open Space Consumed 2025	Land Deficit 2025	Total Score	Category Score
Buckingham Twp	3598	0	0	3598	10.00
Upper Makefield Twp	3327	0	0	3327	10.00
Worcester Twp	2674	0	0	2674	10.00
Plumstead Twp	2542	0	0	2542	10.00
Solebury Twp	2517	0	0	2517	10.00
Franconia Twp	2283	0	0	2283	10.00
Richland Twp	1940	0	0	1940	5.36
Thornbury Twp	157	393	305	1858	5.36
East Bradford Twp	1156	337	0	1830	5.36
Birmingham Twp	232	413	230	1749	5.36
Montgomery Twp	0	173	461	1728	5.36
West Caln Twp	1682	0	0	1682	5.36
New London Twp	1631	0	0	1631	5.36
Doylestown Twp	0	710	0	1419	5.36
Limerick Twp	1363	0	0	1363	5.36
Upper Uwchlan Twp	1046	96	0	1239	5.36
Hilltown Twp	1112	0	0	1112	5.36
New Garden Twp	1110	0	0	1110	5.36
Towamencin Twp	469	316	0	1101	5.36
New Hanover Twp	1091	0	0	1091	5.36
East Rockhill Twp	1069	0	0	1069	5.36
East Marlborough Twp	922	0	0	922	2.68
West Brandywine Twp	919	0	0	919	2.68
Tinicum Twp	900	0	0	900	2.68

Municipality	Rural / Ag Consumed 2025	Proposed Open Space Consumed 2025	Land Deficit 2025	Total Score	Category Score
Nether Providence Twp	0	183	144	798	2.68
Upper Southampton Twp	1	393	0	788	2.68
Upper Salford Twp	766	0	0	766	2.68
Lower Frederick Twp	751	0	0	751	2.68
London Britain Twp	735	0	0	735	2.68
Kennett Twp	727	0	0	727	2.68
West Vincent Twp	711	0	0	711	2.68
Upper Frederick Twp	690	0	0	690	2.68
Edgemont Twp	0	336	0	672	2.68
Bethel Twp	0	308	0	616	2.68
Upper Pottsgrove Twp	613	0	0	613	2.68
Springfield Twp	611	0	0	611	2.68
Wrightstown Twp	606	0	0	606	2.68
East Nottingham Twp	603	0	0	603	2.68
Franklin Twp	574	0	0	574	2.68
Bedminster Twp	571	0	0	571	2.68
New Britain Boro	0	68	138	550	2.68
Chalfont Boro	0	240	0	480	1.25
Ridley Twp	125	65	73	474	1.25
Londonderry Twp	453	0	0	453	1.25
Warwick Twp	448	0	0	448	1.25
Conshohocken Boro	9	12	138	447	1.25
West Sadsbury Twp	382	0	0	382	1.25
Chadds Ford Twp	379	0	0	379	1.25
West Pikeland Twp	375	0	0	375	1.25
West Rockhill Twp	370	0	0	370	1.25
Milford Twp	342	0	0	342	1.25
Wallace Twp	333	0	0	333	1.25
Penn Twp	323	0	0	323	1.25
Salford Twp	306	0	0	306	1.25
Lower Pottsgrove Twp	303	0	0	303	1.25
Elk Twp	289	0	0	289	1.25
Douglass Twp	272	0	0	272	1.25
Morrisville Boro	0	135	0	271	1.25
Honey Brook Twp	270	0	0	270	1.25
West Grove Boro	5	0	83	254	1.25
Perkiomen Twp	97	65	0	226	1.25
West Nottingham Twp	225	0	0	225	1.25
Perkasie Boro	92	66	0	224	1.25
Langhorne Boro	0	31	53	220	1.25
Sharon Hill Boro	0	39	47	219	1.25
Telford Boro	0	0	65	195	0.36
East Nantmeal Twp	191	0	0	191	0.36

Municipality	Rural / Ag Consumed 2025	Proposed Open Space Consumed 2025	Land Deficit 2025	Total Score	Category Score
Souderton Boro	0	0	56	169	0.36
New Hope Boro	166	0	0	166	0.36
Charlestown Twp	165	0	0	165	0.36
South Coventry Twp	144	0	0	144	0.36
Chester Twp	0	65	0	129	0.36
Marlborough Twp	117	0	0	117	0.36
Warwick Twp	102	0	0	102	0.36
West Nantmeal Twp	99	0	0	99	0.36
Bridgeton Twp	98	0	0	98	0.36
West Marlborough Twp	98	0	0	98	0.36
Aldan Boro	-11	10	22	76	0.36
Yardley Boro	0	31	0	61	0.36
Newlin Twp	56	0	0	56	0.36
Green Lane Boro	8	19	0	47	0.36
Rutledge Boro	0	0	12	37	0.36
Parkside Boro	0	1	8	25	0.36
Silverdale Boro	19	0	0	19	0.36

There is not much forecasted growth, nor rural/agricultural land remaining in the inner suburban area around Philadelphia. Moving outward, the analysis indicates which municipalities' resources are most threatened by forecasted development. The severest mismatches occur in Central Bucks County and in Worcester and Franconia Townships in Montgomery County.

Of the municipalities shown on the map, there are three general situations. The first is the rural/agricultural township that, due to recent population and employment growth, faces losing many acres of rural/agricultural land. These are located on the suburban fringes of the region, with the most severe examples of mismatches illustrated by the Central Bucks communities of Buckingham, Upper Makefield, Solebury and Plumstead, and Franconia and Worcester Townships in Montgomery County. The second general situation is the quickly suburbanizing communities that are faced with a combination of disappearing open space and dwindling farm fields to accommodate growth. Examples are Towamencin, East Bradford, Edgemont, Bethel, and Doylestown Township (the last three had no land designated for rural/agricultural preservation on the 2025 plan, and thus only showed open space consumed). The third category of municipalities are those showing land deficits. These actually range from built-out places experiencing intensive redevelopment, like Conshohocken Borough (which is not technically experiencing a land deficit because it has increased density significantly) to rapidly suburbanizing communities such as Montgomery Township and Birmingham and Thornbury Townships in Chester County, which will also have to increase densities, presumably, to accommodate their forecasted growth.

The Horizons 2025 Plan shows DVRPC's vision for future land use in the region, i.e. what the regional planning commission and counties *want* to happen, whereas the DVRPC population and employment forecasts show what is *expected* to happen. Comparing the two through the Land Use Forecast Model (LUFM) demonstrates where there is a mismatch, or friction, between what is desired and what is expected. Although all municipalities' resources may indeed be under threat of inappropriate development in the future, the LUFM and Friction Map highlight those municipalities with resources probably under the *most* threat. According to current growth forecasts, over 80 municipalities, or 35% of the communities in the southeastern Pennsylvania region are likely to have significant amounts of agricultural and natural resource lands consumed out of need to accommodate growth. Therefore, the unprotected lands in these municipalities are under a greater threat from development.

B. EMPLOYMENT CENTER TRAVEL TIME ANALYSIS

Feedback from the residential developer indicated that proximity to employment centers was a prime driver of development pressure. A method to quantify locations' travel time to employment centers was therefore needed. Fortunately, DVRPC possessed three unique data sources that could be used to determine relative development threat to available land based on proximity to employment locations using actual travel times across the region. The three sources are:

1) 1990 Employment Centers in the Delaware Valley – This report, published in 1994, identified the existence of 124 employment centers in the 9-county region along with several emerging centers. The report mapped out the physical area of each center and showed number of employees by sector. (A Year 2000 Employment Centers report will not be available until 2004.)

2) 2000-2010 Employment Growth forecasts from the DVRPC Horizons 2025 Plan – DVRPC maintains employment forecasts by municipality to the year 2025. This project is using only the growth forecast for the next ten years, to 2010, as a contributor to the threat assessment.

3) 1997 Highway and Transit Travel Time Survey for the Delaware Valley Region - This recently published report (June 2002) provides a computer model that outputs actual travel times at different times of day from any point within the region. The project is based on a statistically significant sample of different roadway types (freeway, parkway, major arterial, minor arterial, or collector / local) that were also distinguished by location in either a CBD, CBD fringe, urban, suburban, or rural area, with actual travel times taken at the morning, midday and evening peak periods. The "average vehicle method", whereby a specially equipped vehicle travels the surveyed roads amid a traffic stream, was used to measure travel times on 1700 miles (12% of the entire network) of varying roadway in the nine-county region. Travel times for the remaining roads were designated through a simulation network model based on the samples taken. Once programmed into ArcView's GIS Network Analyst program, the information allows the user to draw a road-based path based on a chosen time length from any point in the region. For the purposes of this study, travel times were based on P.M. rush hour return trips from the designated employment center points.

METHOD

There were three major steps to creating the final product. The first was to combine certain employment centers together and to assign employee growth forecasts to those centers; the next was to use the Network Analyst to create three rings around each center point representing 10, 20, and 30 minute distances from each point; and the final step was to combine all of the rings so that the region is covered by small polygons created from the rings' intersections with each other. Each polygon has a total score, based on the number of overlaying rings in that space, with each ring differing in value based on its

classification as a 10, 20, or 30 minute zone and on the magnitude (employment growth) of each ring's respective employment center.

1. Creating Employment Centers with Growth Magnitudes

The original 1990 employment centers were mapped as polygons whose outlines were determined by actual land use and employment density data rather than political boundaries. Since employment growth forecasts are municipal-based, careful evaluation was needed to determine the desired set of points, not polygons, to use with the network analyst.

Employment growth, rather than the actual number of employees within an employment center, was used because the growth, or additional employees, are what is expected to drive the development pressure, not the existing employees. A thousand (1,000) new employees over the next ten years (2000 – 2010) was assumed to be the minimum threshold for impacting development pressure to be included in the analysis. In addition, the magnitude of employment growth over 1,000 new jobs was deemed directly related to the subsequent development pressure. Overlaying the employment center and employment growth maps along with a map of the region's road network provided the visual clues for establishing where the points should be placed. The employment center polygons were expected to be the areas where a municipality's employment growth would go, and the actual points (as opposed to polygons) needed to run the Network Analyst were based on the nearest major intersections. Knowledge of future plans for large new employment centers, such as the new Vanguard and Merrill Lynch corporate complexes within the region, were also included.

Appendix B lists each newly designated employment center along with the included municipalities and their respective growth forecasts. The accompanying notes point out additional information used in the evaluation as well as rationales for specific point selections. Centers 8 and 11 are not included in the final analysis because a minimal amount of influence on the southeastern Pennsylvania region was assumed. The data for center number 40 (Wilmington) does not come from DVRPC but was obtained from the Wilmington Area Planning Council (WILMAPCO) and is evaluated in much the same manner, although a portion of travel times had to be estimated as the original 1997 survey did not measure across the Delaware state line.

Two additional centers were suspected as possibly bearing influence, but communications with the planning commissions for those areas revealed that little employment growth is expected. Chatna Patel, senior transportation planner for the Joint Lehigh-Northampton Planning Commission, reported that they did not expect over 1,000 new jobs by 2010 in the southern Allentown and Bethlehem area that would affect housing development in northern Bucks and Montgomery Counties. She stated that the greatest amount of industry growth was to occur in warehousing which offers a relatively small amount of jobs to the area. Michael Golumbec, transportation modeler for Berks County Planning Commission, also reported no significant job growth in Berks County along the border with western Chester and Montgomery Counties. He stated that most growth would occur in retail businesses around Morgantown, but the growth would not

approach 1,000 new jobs. It would take a large single employer to bring that many jobs to the mostly rural and "bedroom" communities in eastern Berks County, and this was not expected to happen within the time period.

Thirty-eight employment centers were identified for the purposes of this evaluation. While it would certainly be possible to get more detailed and precise by not combining adjacent employments from the original report and by including centers with less than 1,000 new employees, it would not benefit the project in the later steps as the overall map would become too convoluted and time-consuming for the processing stages. See *Appendix B – Employment Centers and Associated Municipal Growth Forecasts*, for details.

2. Creating Time-Based Contour Rings

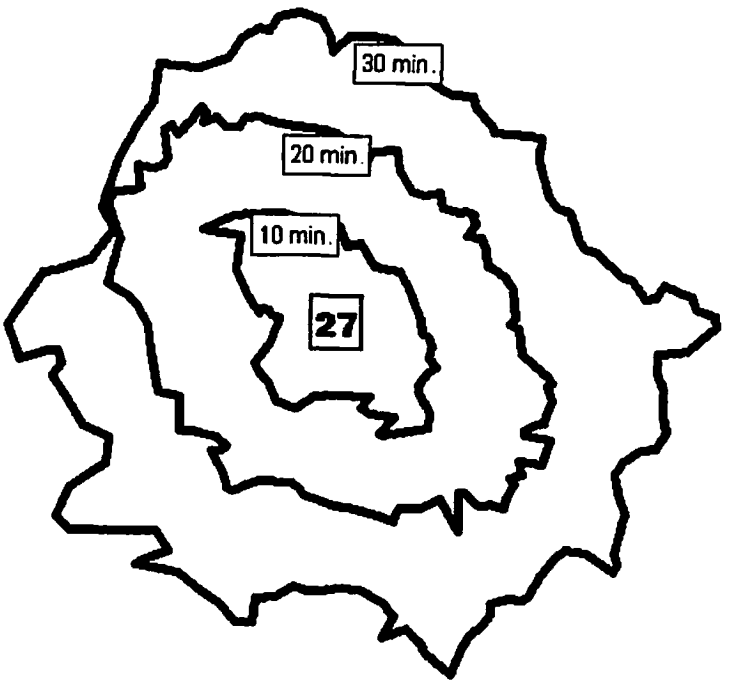
Each employment center point is used separately to create its own rings of travel time. The rings are not actually circles, but appear more like contour lines due to the use of the survey data and the network analyst. In GIS, the Network Analyst highlights all roads within a specified distance of the main point. After these are highlighted, a polygon is digitized that reaches out in every direction based on exactly how far one could travel along that direction or path within the specified time limit. The end result looks more like a spider web than a circle for any given travel time, because greater distances can be reached on some roads as opposed to others. Each set of three rings are also accompanied by an attribute table. The table identifies the rings as having a magnitude equivalent to the assigned employment growth figures, and each ring is also given a score of 5, 3, or 1 for being in a 10, 20, or 30 minute proximity, respectively. The table can then determine a score for all of the land in each ring equivalent to the formula of magnitude times proximity scores.

3. Combining all of the Proximity Rings

The final step requires the geoprocessing capabilities of GIS to combine the travel time rings from all 38 employment centers. The intersection of 114 rings resulted in over 8900 separate polygons across the region. Utilizing the final scores from each ring, the table is set up to add scores that overlapped each other. In other words, each polygon can check itself by registering a value for each of the existing rings. If that polygon is not in a specific ring, then it will receive a score of 0 for that field. When a ring comes up that does overlap the polygon, then the calculations are performed and the score becomes a part of the total score for that polygon. The end result used here separates final scores into ten quantiles with equal distribution so that the top ten percent of all polygons receive a score of 10, the next ten percent receives a score of 9, and so forth until the bottom ten percent, or least threatened polygons, receive a score of 1. The map applies a graduated chromatic color scheme to represent the greater and lesser threats throughout the region. The end results could be categorized and displayed in numerous ways if so desired.

Figure 1

Travel Time Contour Rings for Emp. Center 27



RESULTS

The final map (see *Threat Related to Employment Center Travel Times* map) reveals the highest scores and most threat to be along the major roadways in the region. The Pennsylvania Turnpike, Interstate 476, and US202 and US30, all show "severe" areas of threat in their nearby vicinities. This is expected with the methodology focusing on roadways as functions of travel time. It is useful to note where the combinations of growing employment in different geographical centers can lead to "hotspots" that are valuable residential locations due to their proximity to more than one center.

Areas on the fringe that may only be affected by a few centers are assigned less relative threat than more central locations. Other components in the TA composite have more influence on those fringe areas that are attracting development. The travel time component is important for recognizing that where there is open space in centralized locations, it is under an extreme amount of threat due to its high value. This component is integrated into the composite map by use of Spatial Analyst. The small polygons automatically retain their diversity within the context of municipal-based scores.

C. BUILDING ACTIVITY - PROPOSED HOUSING UNITS RELATIVE TO MUNICIPAL LAND SIZE AND PERCENT DEVELOPABLE LAND

The Friction and Employment Center Travel Time maps are created largely from forecasts of future conditions. While those components somewhat account for the past by incorporating trend data, the Threat Assessment group sought another component that would directly reflect recent development activity, as well as incorporate some of the factors from the Montgomery County Planning Commission's Future Growth Index (MCPC FGI). Originally, maps of relative threat based on Building Permit Activity between 1990 and 2000 were created. These maps showed absolute and percent change of building permits issued over the last decade. The Census tracks building permits on an annual basis, and estimates that 98% of permits authorized are constructed. The time lag between permits issued and construction is typically short, within 1 to 2 years, so that a decade of building permit data will be fairly close to the number of new homes actually built over that decade.

Upon presentation of the building permit data, a debate ensued over whether these maps depicted future threat as well as possible since they did not account for municipal size or remaining available land, which was considered especially significant in cases where tremendous building activity took place over the 1990's, to the point where little undeveloped land in the municipality remained. Both municipal size and available land were expressed as important in that the number of new houses built in any municipality is largely dependent on these two factors, so relative threat can only be accurately determined when they are taken into account.

The revised method of incorporating housing trend data substitutes *building permits issued* with *proposed residential units*, and included a formula that factored in municipal size and remaining available land. (All three factors were also used, albeit differently, in the MCPC FGI). Proposed units were used because they better reflect the level of development interest in a municipality, and typically have a longer lag time, of 3 to 15 years, making them a better indicator of future threat. The time frame was also changed to cover 1994-2001, because only this time frame was available consistently across the 4 suburban counties.

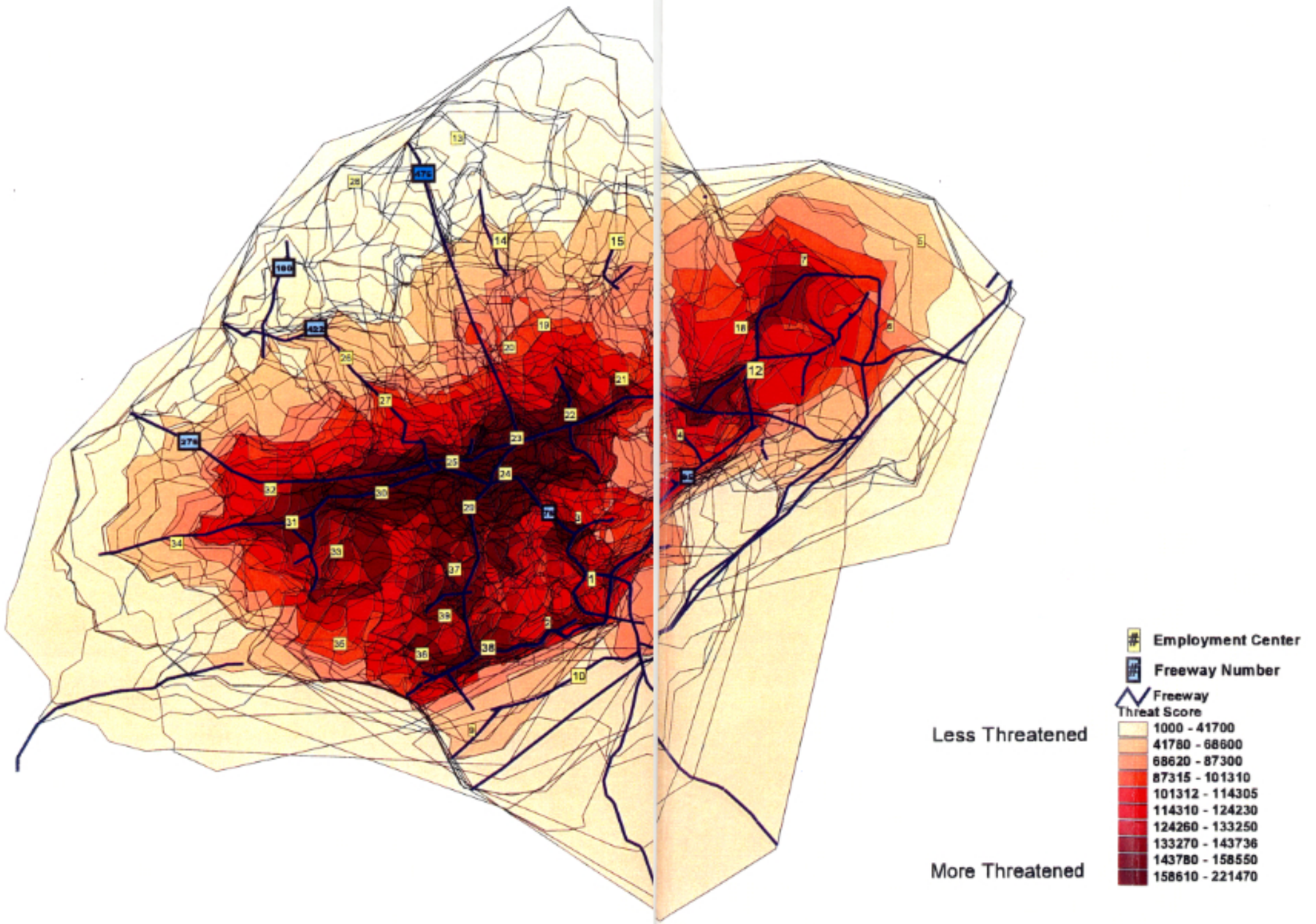
METHOD

The formula that establishes a municipality's residential building activity score is:

$$\frac{\text{1994-2001 Proposed Units}}{\text{Total Area}} \times \frac{\text{Developable Land}}{\text{Total Area}}$$

Proposed units are obtained from county planning commission publications of annual subdivision, land development, and zoning activity pursuant to Act 247 of the Pennsylvania State Legislature. Total area is simply the acreage of a municipality. Developable land is determined by subtracting the combined file of 2000 Parkland, Preserved Farmland and Privately Protected Open Space (DVRPC's 2025 Land Use

Threat Related to Employmen Center Travel Times



RESULTS

A review of the map *Proposed Housing Units Relative to Municipal Size and Percent Developable Land* shows what one familiar with development pressure in Southeastern Pennsylvania would largely expect: There is low pressure in the inner ring suburbs and boroughs surrounding the City of Philadelphia, and the highest pressure are found in the exurban municipalities with the most building activity. Without the second half of the equation (% available land), more small in size, but largely built-out communities experiencing some building activity would have ranked higher. Moving further away from Philadelphia, there is greater variation both in large and small municipalities.

Table 6 demonstrates how the formula works for four neighboring townships in Bucks County that all had similarly high amounts of proposed units: Northampton, Warminster, Warrington, and Warwick Townships all have had over 2,000 residential proposals made since 1994. Warrington and Warwick are in the most severe threat category while Northampton and Warminster are only in the middle category. The two severely threatened municipalities are so designated because they **a)** have a large number of proposals while being of a medium size and **b)** more than 50% of their total area is developable land. Warminster is only slightly under those numbers in terms of proposals and total area. However, most of its land is already built-out with only 13% still considered developable, which lowers its relative threat ranking. Northampton has even more proposals than Warwick but they are spread over an area greater than twice the size. Additionally, only 35% of Northampton is still developable. All of these factors combine to make the conclusion that Warwick and Warrington are more threatened by development activity than are Northampton and Warminster. These kinds of comparisons can be made across the region, but the formula is rigid enough so that no municipalities with over 1500 proposals are found in the two "least threatened" categories.

***Table 5* - Data for Four Bucks County Municipalities**

Municipality	1994-2001 Residential Units Proposed	Total Land	Available Land	Final Score
Northampton township	2705	16,730	5544	0.054
Warminster township	2316	6,534	810	0.044
Warrington township	3942	8,811	4761	0.242
Warwick township	2589	7,042	4251	0.222

Also note that under this method, some boroughs still rank quite high on the degree of threat score. However, unlike other attempts to incorporate building activity data, the boroughs are distributed throughout the entire range of scores. Where boroughs are similar in size and in number of proposed units, this method differentiates based on remaining developable lands which could still be threatened, thereby elevating, or being mindful of, the purpose of the study.

D. VULNERABILITY INDEX

Another component that the Threat Assessment measures is a municipality's preparedness for appropriate growth, or, conversely, its vulnerability to appropriately managing growth. Although "vulnerability" to manage growth is not the equivalent of development threat in that a municipality ill-prepared to handle development may not even be under development pressure, a vulnerability index was incorporated into the Threat Assessment for several reasons. First is that, unlike other parts of Pennsylvania, all of southeastern Pennsylvania is considered under development pressure. Second is that, through a collaboration between the Pennsylvania Department of Conservation and Natural Resources, the Natural Lands Trust, and the Governor's Center for Local Government Services, there is a statewide community planning initiative called Growing Greener: Conservation by Design. This initiative uses educational material and technical assistance to help communities better employ local plans and ordinances to achieve their conservation and open space objectives. Stronger local plans and ordinances are therefore recognized and supported by conservation funding agencies and land trusts as being an important and integral part of natural resource protection. The third reason that a vulnerability index was included was that the bulk of the work to create such an analysis was already recently completed by DVRPC through a separate project.

The Vulnerability Index component identifies twelve common conservation tools available to local officials and creates an index that credits municipalities that have formally implemented any of them. The tools are weighted themselves as some are considered more valuable than others. The basic premise is that land found in municipalities which are more proactive in conservation efforts should be considered less threatened than municipalities which have put little effort into conservation tools.

METHOD

DVRPC conducted an assessment of municipal use of natural resource protection tools for all localities within the region in 2001 (conservation planning tools adopted since then are not reflected in this analysis). Surveys were mailed to all localities followed by DVRPC research into non-responsive communities until the use of all twelve (12) planning tools for each municipality in the region was determined. The 12 tools investigated are:

Wetlands Management Ordinance – Designed to protect environmentally sensitive wetland areas. Wetlands Ordinances typically prohibit any disturbance of delineated wetlands for residential, commercial or industrial development.

Stream Corridor Protection Ordinance – Ensures that vegetated riparian buffers are maintained by requiring development to be set back from stream banks, floodplains and wetland areas, and by limiting the use and intensity of activities within the corridor. Buffer widths typically range from 25 to 300 feet, depending on community goals.

Steep Slope Ordinance – Regulates development on areas of steep slope. The definition of steep varies from one municipality to another, with 8% typically the minimum gradient classified as steep.

Open Space Design Ordinance – Also includes Cluster Development Ordinances and Performance Zoning. Open Space Design Ordinances enable developers to locate permitted dwelling units on one portion of a tract (sometimes increasing density) in order to preserve open space on another portion of the tract. This analysis only included municipalities that required at least 50% of a given tract as open space.

"Net-Out" of Resources – Refers to the technique of deducting environmentally constrained lands from development density calculations. Netting-out is intended to protect and preserve such constrained areas by reducing or eliminating the credit given for these lands toward the amount of development permitted on a given site.

Transfer of Development Rights (TDR) Ordinance – Allows municipalities to preserve rural and natural features while protecting property rights and allowing some growth. A TDR program takes development that would normally occur in rural areas (called "sending areas") and transfers it to other parts of a municipality where growth is more acceptable (receiving areas).

Agricultural Zoning (10+ acres) – A technique that allows municipalities to protect their rural and agricultural areas by establishing large minimum lot sizes. A minimum lot size of 10 acres was required to be counted in this analysis.

Environmental Impact Statement (EIS) – Intended to highlight the impacts of a development proposal on air, water, soil and aquatic and terrestrial life. Standards vary as to which types of development proposals require an EIS.

Environmental Resource Inventory (ERI) – A compilation of text and mapped information about the natural resource characteristics and environmental features of a municipality. An ERI identifies critical natural resources and provides a policy basis for the development of resource protection ordinances.

Open Space Plan – A comprehensive document that serves as a guide for open space protection and preservation in a municipality. An open space plan examines a community's needs and goals, analyzes preserved and unpreserved open spaces, and lays out a set of priorities and strategies for preservation.

Floodplain Management Ordinance – Regulates development activities in the 100-year floodplain. Typically, all new forms of residential, commercial and industrial construction in the floodplain are limited.

Locally Funded Open Space Program (Tax or Bond) – A new funding source, in the form of an increase in the property tax, income tax, or real estate transfer tax, or in the form of a bond, dedicated for open space preservation.

These twelve tools are also weighted into three categories according to impact on conservation, and then they were normalized into a ten-point scale to be consistent with the other components. The value assigned to each tool is listed in *Table 6.* A municipality that implemented every one of the twelve tools would receive a cumulative score of ten. The lower the cumulative score that a municipality receives, the greater the vulnerability, or threat. A score of zero implies that the municipality is not using any of these tools and would be under the most threat in the context of this component alone. See Appendix D – Vulnerability Index Score by Municipality, for a matrix of all municipalities and their scores. If a municipality has a conservation tool, then the value of that tool is entered into a row and all registered scores are added together for a cumulative score.

Table 6

Weighted Values of Conservation Tools	
Wetlands Management Ordinance	1.31
Stream Corridor Protection (Riparian Buffers)	1.31
Locally Funded Open Space Program (Tax or Bond)	0.87
Steep Slope Ordinance	0.87
Open Space Design Ordinance	0.87
"Net-Out" of Resources	0.87
Transfer of Development Rights (TDR) Ordinance	0.87
Agricultural Zoning (10+ Acres)	0.87
Environmental Impact Statement (EIS)	0.87
Environmental Resource Inventory (ERI)	0.43
Open Space Plan	0.43
Floodplain Management Ordinance	0.43
Total Maximum Score:	10.0

In conducting the spatial analyst, the scores were reversed to remain consistent with the other components. In other words, for display purposes, as shown above, the high scores mean lower threat, because a community is using many conservation tools. However, in the spatial analyst, when the five components are combined, high scores translate as high threat. To compensate, the cumulative scores of conservation tools are subtracted from ten to create the final component score in order to remain consistent with the other analyses.

RESULTS

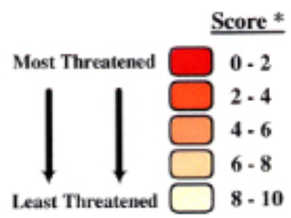
The following map – *Vulnerability Index of Southeastern Pennsylvania: A Measure of a Municipality's Preparedness for Growth*, graphically shows the results. On the whole, Delaware County municipalities stand out as the most severely threatened. Only one of it's communities, Radnor Township, does not fall into the top two categories of threat. Eastern Delaware County communities are already largely built-out, minimizing their ability to be truly threatened by future development pressure, but western, suburban fringe Delaware County communities appear unprepared to manage growth, according to the index. On the other hand, Bucks County municipalities, as a group, appear most prepared to manage their growth. Yet, a handful of Bucks County communities do, in fact, appear highly vulnerable according to the index.

Interestingly, some parts of the region vary widely with neighboring municipalities being at opposite ends of the scoring range. For example, in Chester County, East Coventry is designated as most threatened, while adjacent South Coventry and East Vincent enjoy least threatened status. In sum, most municipalities in the region appear to use less than half the tools surveyed, leaving ample room for strengthening conservation tools and ordinances as a technique to help preserve natural resources.

In any case, while this component does measure the formal existence of certain conservation tools, the index does not account for the quality of the tool in question, nor the political will of those responsible for enforcing them. Those two components would be extremely time-consuming, as well as subjective, to determine. Without somehow incorporating quality and political will, some members of the advisory committee felt that the vulnerability index could be misleading. Other members acknowledged this limitation, but felt it was still a useful measure because 1) it was at least reasonably predictive as to a municipality's intentions regarding conservation; 2) it was better for communities to have the tools listed, even if they were mediocre, than to not have them at all; and 3) even if political will could be ascertained, it potentially changes with each change in administration, and would therefore be a less stable indicator than the existence of the conservation tools. A compromise was therefore reached, by including the analysis, but lowering the respective weight of the index to 10% of the final composite.

Vulnerability Index of Southeastern Pennsylvania

A Measure of a Municipality's Preparedness for Growth



Weighted Values of Conservation Tools

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Environmental Impact Statement (EIS)	0.87
Environmental Resource Inventory (ERI)	0.43
Open Space Plan	0.43
Floodplain Management Ordinance	0.43
Total Maximum RAW Score:	10.00

* Scores are determined by assigning the listed value above for each tool that exists within a municipality. A score of 10 would be considered "Least Vulnerable", while a score of 0 would signify "Most Vulnerable".

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SEPTEMBER 2002

E. SEWER SERVICE AREAS

The presence of sewer systems has been considered one of the most important infrastructure facilities in attracting growth and development. The MCPC FGI gave public sewer service the highest weight category. In the five-county Southeastern Pennsylvania region, sewer service is provided at the local level by at least 82 public or municipal authorities, and over 200 non-public sewage treatment plants. As part of a grant from the Environmental Protection Agency's *Making Smart Growth Work: Community Innovations and Responses to Barriers* program, 10,000 Friends of Pennsylvania was awarded funding and engaged DVRPC to conduct a sewer infrastructure inventory and analysis of Southeastern Pennsylvania. A GIS layered map of existing and proposed sewer service areas was created as part of the study.

METHOD

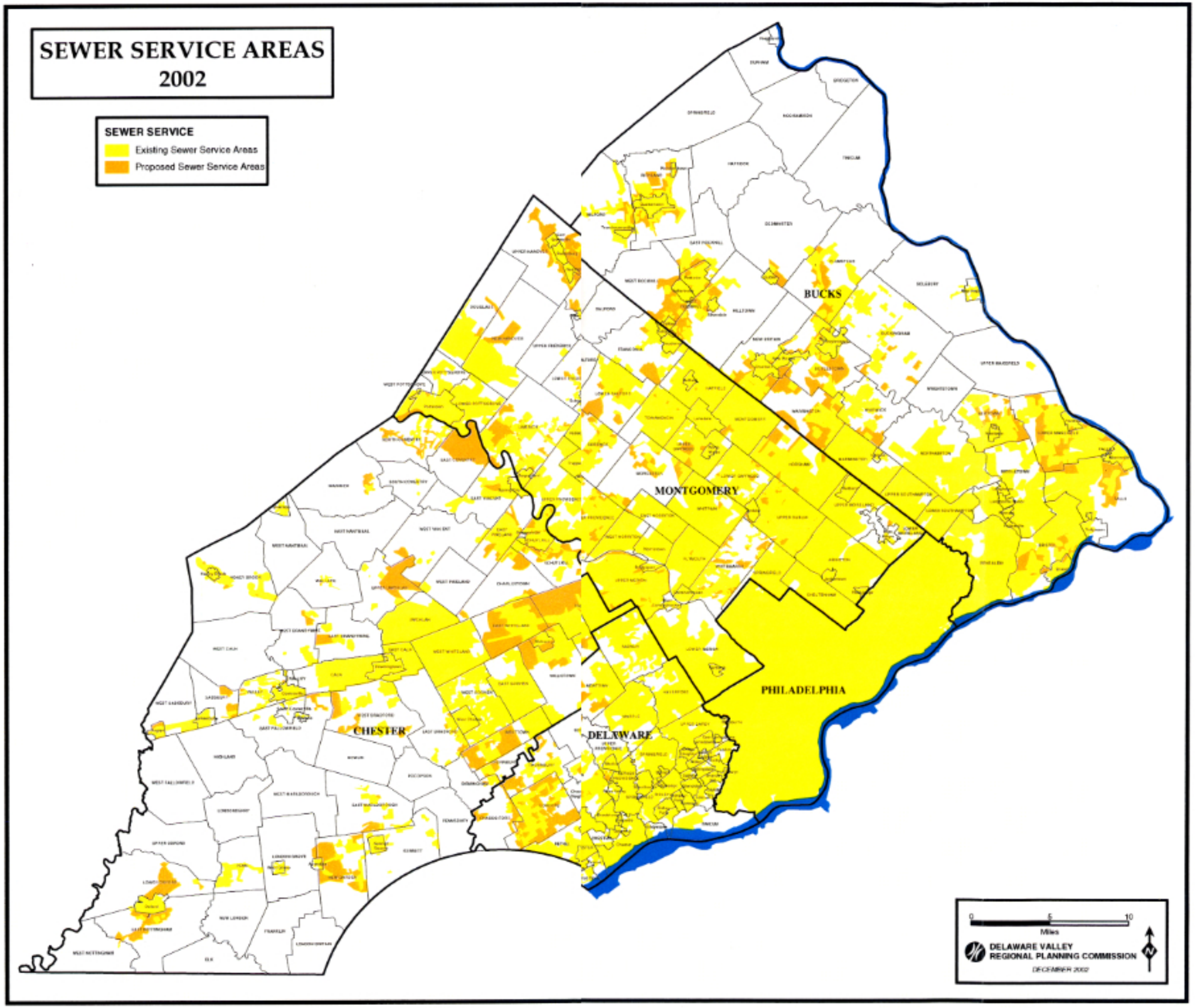
Gathering information on existing and proposed sewer service areas has been difficult for planners, developers, engineers, and policy analysts. Up-to-date summary information on sewer infrastructure at the regional level was last compiled in 1992, also by DVRPC. The 2002 effort to update a regional map was exhaustive and involved research at the county, municipal and authority levels to produce an up-to-date map showing areas of existing or proposed public sewer service.

The scoring for the sewer map still remains within the ten-point scale of other components, but uses only 3 categories that were assigned scores based on assumed influences. Areas identified as proposed sewer areas were given the highest score of seven; existing sewer service areas received a score of two; and areas that have no service or rely on on-lot systems were scored with zero points. As with the Employment Center Travel Time component, areas of sewer service are polygons disassociated from municipal boundaries. These polygons actually follow along lot lines and natural markers. The integration of the sewer service areas into the composite creates "hot spots" over the municipal-based data of the other components.

RESULTS

The *Sewer Service Areas 2002* map shows all of Philadelphia, and most first generation suburbs (inner ring suburbs and boroughs throughout the region) served by public sewer systems. Proposed sewer service areas are adjacent to existing sewer service areas, and are distributed throughout the region in areas expected to experience growth, or, in some cases, in areas already developed but suffering from malfunction septic systems. Not withstanding the reported new emphasis on spray and drip irrigation systems (community systems) in Chester County, the existing and proposed sewer service areas are expected to absorb the most intensive future growth. Other growth will rely on septic systems or other on-site technology, and, although cumulatively very significant, will by nature be lower density.

SEWER SERVICE AREAS
2002



VI. COMPOSITE THREAT MAP

REVIEW

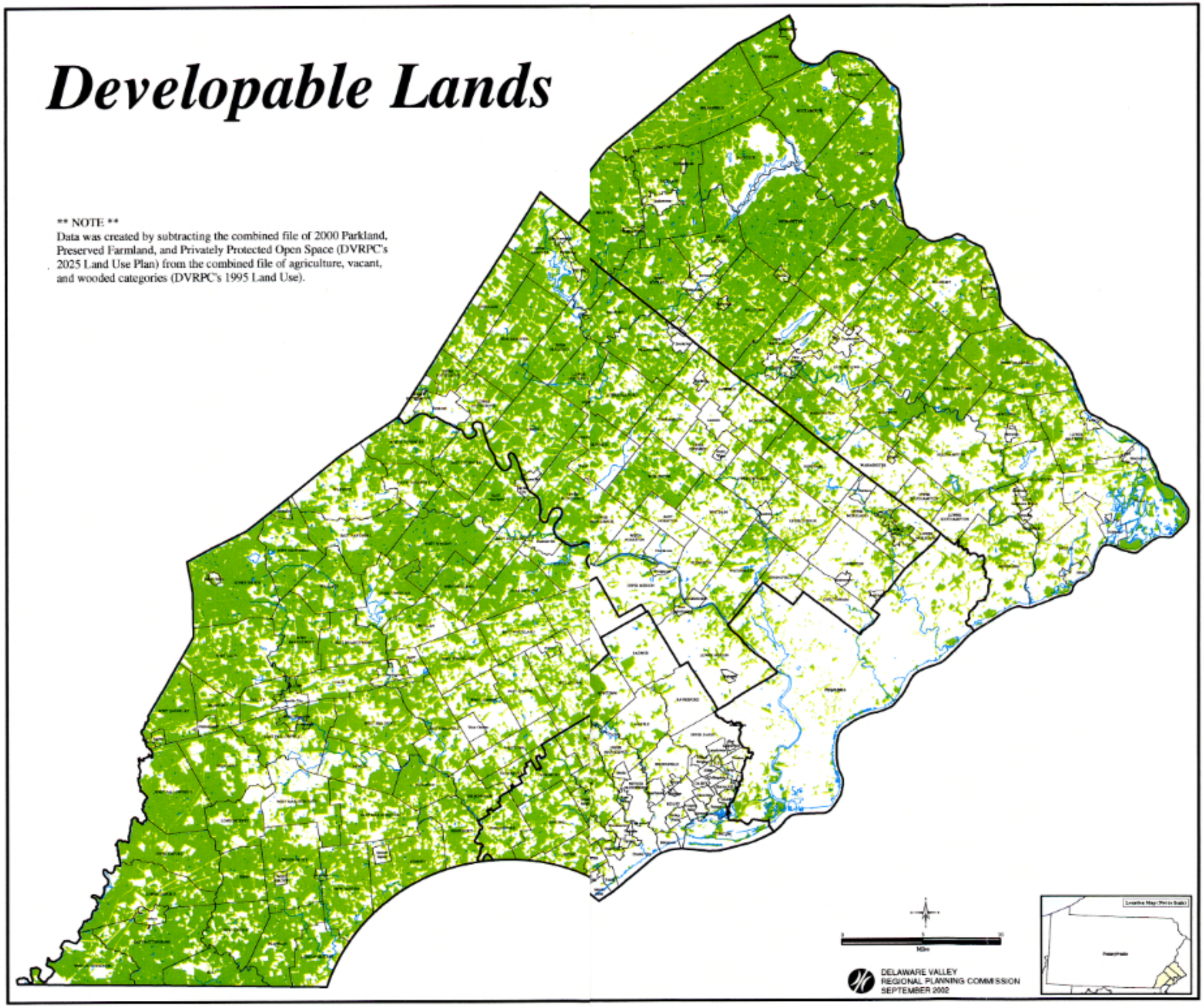
As described in **Section IV - Overall Project Approach**, the five components: Trend Friction Map, Employment Center Travel Times, Proposed Housing Units Relative to Size and Available Land, Vulnerability Index, and Sewer Service Areas, were each assigned weights and then combined using Spatial Analyst to produce a final composite map of relative threat. A second composite map was created by overlaying the original composite with DVRPC's Developable Lands map, which blocks out already developed and otherwise undevelopable lands. The first map is solid colors of relative threat, and the second is more spotty, but still very discernable, in terms of areas of relative threat.

RESULTS

The maps show hotspots of threat in Central Bucks communities, namely Plumstead, Solebury, Buckingham and Upper Makefield townships, portions of Franconia and Worcester and Limerick townships in Montgomery County, sections of Upper Uwchlan, East Whiteland, Thornbury and New Garden townships in Chester County, and parts of Bethel, Concord, and Newtown townships in Delaware County. The heavy weight of the Trend Friction and Building Activity map can be seen here. The next tier of threat appear most influenced by the travel time analysis as it follows highway corridors, most notably Route 202, 422, 30, 322, 476 and 276. The least threatened areas, not counting the City of Philadelphia, are on the extreme fringes of the region in Upper Bucks, Upper Western Montgomery County, and Western and Southern Chester County.

Developable Lands

** NOTE **
Data was created by subtracting the combined file of 2000 Parkland, Preserved Farmland, and Privately Protected Open Space (DVRPC's 2025 Land Use Plan) from the combined file of agriculture, vacant, and wooded categories (DVRPC's 1995 Land Use).



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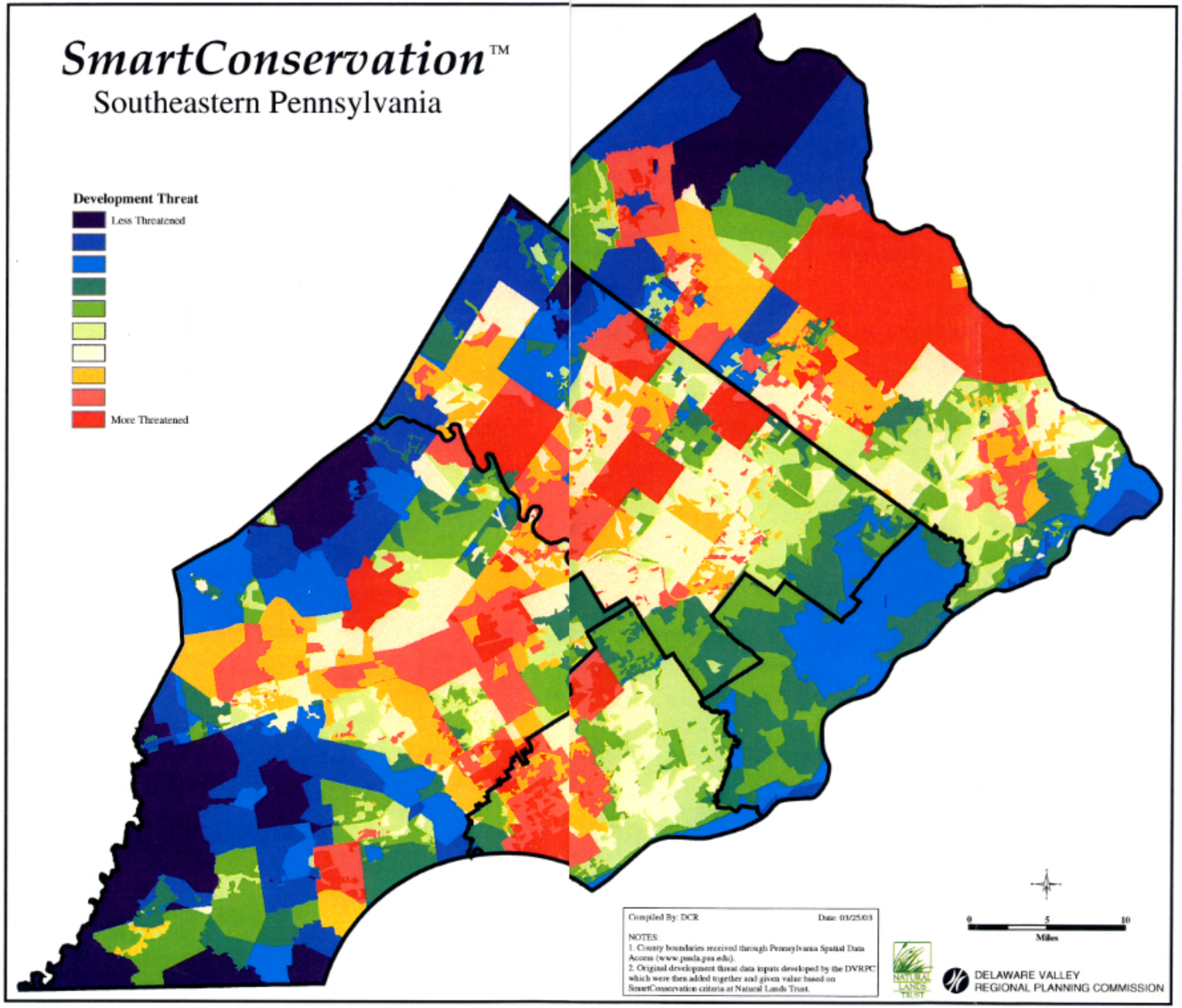
SmartConservation™

Southeastern Pennsylvania



Appendix A

Land Use Forecast Model Technical Documentation[1]

Introduction

Purpose

To convert municipally forecasted population and employment growth to acres of land consumed and to compare the acres consumed to the future growth area, as designated on the land use plan. This version of the model was developed to improve efficiency when the model is updated with new forecasts and/or land use plan data.

Background

The first version of the land use forecast model was created in 1996 for use with the 2020 land use plan. With some revisions, the spreadsheet model was again used for the 2025 regional land use plan. This most recent version can be readily updated as new data becomes available.

Methodology

The model converts forecasted municipal population and employment growth to acres of land consumed by that growth and then compares the acres consumed to the future growth area by municipality, as designated in the 2025 Plan. Municipalities with insufficient capacity to accommodate forecasted growth in designated growth areas are noted as having a mismatch.

Data Sets

- Aerial photographs of the region taken in 1995 that have been digitized and geocoded.
- 2025 forecasts of population and employment by municipality
- 2025 land use map
- Density category analyses

Forecast Models

Baseline Model

This model converts forecasts of municipal population and employment growth to acres of land consumed by that growth, and then compares the acres consumed to the future growth area by municipality, as designated in the 2025 Plan. Where there is sufficient future growth area identified to accommodate forecasted growth, the municipality shows a surplus in future growth area. If there is insufficient future growth area, land designated as rural/agriculture is consumed next. Then, if there is insufficient rural/agricultural land to absorb the growth, proposed open space is consumed. If residual growth cannot be accommodated by the future growth area, rural/agricultural area, or proposed open space, the municipality is noted as having a land deficit, in other words, insufficient land to accommodate forecast growth. Since growth is intended to occur in the designated growth areas of the plan, municipalities with significant mismatches are studied further. Mismatches are noted as significant when the percentage of total land deficit (land consumed that does not fit into Future Growth Area) is greater than 5 percent of all the developed land (all land developed up to 2025) in the municipality. The baseline model showed 84 municipalities with significant mismatches between forecasted growth and designated growth area on the 2025 plan.

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[1] The Land Use Forecast Model includes two adjusted density models in addition to the baseline model. The documentation referring to the non-baseline models has been omitted in this appendix.

Residential land consumption

For each of the region's municipalities, acreage that will be consumed by residential development was estimated based on forecasted population. Municipal population forecasts were first translated into forecasted households; (synonymous with occupied housing units).

Acres consumed by residential development: derived by multiplying the number of additional units required in each MCD by a land consumption factor.

Residential land consumption factor: represents the average acres consumed per residential unit, calculated based on known 1990 land use consumption data. When an MCD's population increased enough that it was reclassified into a higher "density category", the increased factor for that category was employed. Municipalities were originally classified into density categories during the 2020 forecast process. These density categories (see Table 1) describe the general character and stage of development of a municipality.

Assumption

- Average acreage consumed per unit remains the same in each MCD in future years unless the local population density increases enough that the locality is re-classified as a different "density category". In this case the consumption factor is changed to the average for the next highest density category. See Table 1 for factors by density category.

Vacant units: Since an MCD's housing stock includes both vacant and occupied units, the methodology accounts for future vacant units by holding the 1990 vacancy rate constant.

Assumption

- The model accounts for future vacant units by holding the 1990 vacancy rate constant.

Non-residential land consumption

For each of the region's municipalities, acreage to be consumed by non-residential development was estimated by assigning an appropriate employment density category to the jurisdiction and multiplying the forecasted employment growth by the median employment factor for that density category. The non-residential, or employment factors used are based on median factors for each density category rather than on the unique 1990 net average employees per non-residential acre in a municipality. Median factors are preferable to actual factors because some of the actual factors appeared to be anomalies and because future employment in municipalities is more likely to follow the pattern of similar MCDs than it is to equal 1990 figures. If employment increases sufficiently, the MCD moves up to the next employment density category, and the median factor for the next category is applied.

Employment factor: based on the median factor for all MCDs within a density category. As density in municipality type increases, so does the employment factor.

Assumptions

- If employment decreases within a decade, it is assumed that no additional land is developed; loss of developed acreage, however, is not provided for.
- Additional employees in future decades will fill spaces vacated by employees lost in previous years before additional land will be developed (this only applies if the municipality loses employees in one decade and gains employees in a future decade; this occurs primarily in developed boroughs).

Table 1: Baseline Land Use Consumption Factors

Density Category	Population Density (persons/mile^2)	Residential Net Factor (acre/unit)	Employment Net Factor (acre/employee)
Center City, Philadelphia	+15,000	.02	.002
Urban borough or city	7,500-14,999	.08	.03
Mature borough or city	4,000-7,499	.13	.05
Suburban borough or city	< 4,000	.29	.09
Urban township	+ 4,000	.11	.06
Mature township	2,500-3,999	.27	.09
Suburban township	750-2,499	.42	.20
Suburban fringe township	250-749	.83	.45
Rural township	< 250	1.11	.45

During the 2020 plan process, further adjustments were made to factors for individual municipalities to reflect county planning staff's knowledge and expectations about specific future densities or infill patterns. In addition, in certain municipalities with shortfalls in designated future growth area, future growth area was expanded using rural/agricultural land.

Glossary

Background growth: Growth that takes place without altering the character of the landscape because it takes place without major infrastructure requirements and is in the form of infill or small subdivisions.

Density category: Reflects the pattern of development and is used to assign residential and non-residential factors to forecast land consumption.

Employment factor: Based on median employees per acre of non-residential land in 1990 for all MCDs within a given density category. When municipality's employment changes enough for it to switch density categories, the median factor for the next category is applied.

Future growth area: Areas designated as appropriate for future growth based on existing or planned infrastructure, consistent with county plans and the New Jersey SDRP.

Mismatch: Area designated for future growth in the land use plan is insufficient to accommodate forecasted growth.

Future growth area surplus: Acres of designated future growth area remaining after forecasted growth is absorbed.

Residential factor: Represents the average acres consumed per residential unit, per municipality, calculated based on known 1990 land use consumption data. As a municipality's population changes enough for it to switch density categories, the median land use factor for the next category is applied.

Appendix B- **Employment Centers and Associated Municipal Growth Forecasts**

Emp Center	Name	Emp. Growth	Total Growth	Notes
1	Center City	11,650	13,850	
	W. Philadelphia	2200		
2	SW Philadelphia	3550	4100	
	South Philadelphia	550		
3	Roxborough/Manayunk	1150	1600	
	Germantown/Ches. Hill	450		
4	Far NE Philadelphia	2050	3860	
	Bensalem	1410		
	L. Southampton	400		
5	W. Windsor	5500	7350	
	Princeton Twp.	1750		
	Princeton Borough	100		
6	Hamilton Twp.	2750	2750	Trenton above loses 1050
7	Hopewell Twp.	3050	13175	MERRIL LYNCH (10,125 new jobs)
8	Evesham	3150	10650	Area not included due to minimal influence on new homes in Pennsylvania suburbs. Most employees would figure to buy homes in the nearby and more affordable New Jersey municipalities.
	Mt. Laurel	5200		
	Moorestown	2300		
9	Logan	1400	1400	
10	W. Deptford	1750	1750	Centers exist far apart. Unsure exactly where most growth would occur. Rt. 45 area seems to decline in boroughs nearby. Riverfront and 295 seem more likely corridors for growth.
11	Voorhees	6620	7330	Area not included for reasons cited in area 8.
	Gibbsboro	710		
12	Middletown	6690	6690	Point selected on Rt. 1 corridor just below 95 intersection
13	Richland	1430	1560	Area at 309-313 exchange. Minor growth in Quakertown.
	Quakertown	130		
14	W. Rockhill	340	1130	Point chosen along 309. Not entirely sure of where majority of Hilltown growth will take place.
	Hilltown	790		
15	Doylestown Twp.	1350	2140	Chose point along 611 N above the boro to represent Plumstead which has been expanding sewer service in its southern half.
	Doylestown Boro	80		
	Plumstead	710		
16	U. Southampton	2020	2020	
17	Warwick	1090	1090	Southern area along 332 is only employment center recognized
18	Newtown Twp.	910	970	Employment center extending out of the borough along 332.
	Newtown Boro	60		
19	Montgomery	3850	6450	Point chosen along 309-202 exchange
	Hatfield	2600		
20	Towamencin	1600	2700	Chose midpoint of 4-6 and 4-7 centers with lack of better information
	U. Gwynedd	1100		
21	Horsham	1950	2940	Point along 611 to represent Warminster influence
	Warminster	990		

22 U. Dublin	1400	1900	Point along 309 above turnpike as midpoint of two employment centers
L. Gwynedd	500		
23 Plymouth	3650	3650	276 & NE Ext. intersection - Plymouth Meeting
24 Conshohocken	1800	2050	
W. Conshohocken	250		
25 U. Merion	2800	2800	King of Prussia centerpoint (202 & 76)
26 Limerick	1700	1700	Emerging center along 422
27 U. Providence	2100	2100	Emerging center along 422
28 U. Hanover	1000	1000	Sewer expansion along 29 while boroughs to South show no growth
29 Radnor	2350	2350	476 & 30 exchange
30 E. Whiteland	3000	6900	Midpoint along 202 corridor incorporating 202, 30, and 76 centers
Tredyffrin	2950		
Malvern	950		
31 W. Whiteland	3300	3300	Rt. 30 & 100 exchange
32 U. Uwchlan	1300	9650	Vanguard headquarters (6500 jobs estimated)
Uwchlan	1850		
33 E. Goshen	1700	3200	Rt. 3, 202, 100 exchanges with point put just inside E. Goshen
W. Goshen	1450		
W. Chester	50		
34 Caln	650	1200	Along Rt. 30, East of Coatesville to allow for spread out Caln numbers
Coatesville	350		
S. Coatesville	200		
35 Chadds Ford	2740	4420	Rt. 202 and 1 exchange (A new office building just opened on SE corner to supply 1000 new jobs)
Concord	1160		
Thornbury	520		
36 Aston	1020	2210	North of 95 and 322
Chester Twp.	760		
U. Chichester	430		
37 Marple	1620	2760	Midpoint of 2 emp. centers along 476 and rt. 3
Newtown	1140		
38 Ridley	2110	2110	Emp. center along rt. 13
39 Middletown	770	2250	Municipality midpoint favored toward larger growth of 2 southern MCDs
N. Providence	740		
Media	430		
U. Providence	310		
40 Wilmington	10042	10042	Data collected from WILMAPCO

Appendix C

PROPOSED HOUSING RELATED TO AVAILABLE LAND AND MUNICIPAL SIZE RANKED

Muncipality	County	1994-2001 Residential Units Proposed	Total Land	Available Land	94-2001 (Prop/Total Land) * (Avail Land/Total Land)	Category Score
New Hope borough	Bucks	946	901	415	0.483	10
Bethel township	Delaware	2581	3455	1829	0.396	10
Oxford borough	Chester	907	1,257	617	0.354	10
Pennsburg borough	Montgomery	361	505	175	0.247	10
Warrington township	Bucks	3942	8,811	4761	0.242	10
Warwick township	Bucks	2589	7,042	4251	0.222	10
Elverson borough	Chester	256	638	351	0.221	10
Concord township	Delaware	3474	8715	4793	0.219	10
Coatesville city	Chester	884	1,177	314	0.201	10
Ivyland borough	Bucks	179	223	51	0.183	10
Honey Brook borough	Chester	195	307	82	0.169	10
Penn township	Chester	1214	6,097	4998	0.163	10
Upper Pottsgrove township	Montgomery	759	3182	2107	0.158	10
Upper Providence township	Montgomery	2676	11616	7249	0.144	10
West Whiteland township	Chester	2680	8,253	3572	0.141	10
Thornbury township	Chester	625	2,530	1299	0.127	10
Caln township	Chester	1295	5,690	2972	0.119	10
Buckingham township	Bucks	3865	21,093	13665	0.119	10
Richland township	Bucks	1937	13,153	10377	0.116	10
East Nottingham township	Chester	1761	12,778	10556	0.114	10
Trappe borough	Montgomery	412	1325	470	0.110	10
Valley township	Chester	634	3,814	2380	0.104	10
Limerick township	Montgomery	2271	14600	9610	0.102	10
Newtown township	Delaware	1490	6440	2770	0.100	10
Thornbury township	Delaware	1015	5925	3426	0.099	8
New Garden township	Chester	1463	10,176	6995	0.099	8
Skippack township	Montgomery	1611	8937	4800	0.097	8
East Whiteland township	Chester	1585	7,031	2920	0.094	8
Franklin township	Chester	978	8,344	6504	0.091	8
Lower Providence township	Montgomery	2853	9896	3122	0.091	8
East Caln township	Chester	522	2,374	982	0.091	8
East Goshen township	Chester	1696	6,515	2237	0.089	8
Dublin borough	Bucks	85	381	152	0.089	8
Perkasie borough	Bucks	694	1,631	339	0.088	8
Middletown township	Delaware	1838	8618	3534	0.087	8
East Brandywine township	Chester	1064	7,161	4215	0.087	8
West Bradford township	Chester	1594	11,927	7759	0.087	8
Sadsbury township	Chester	524	3,987	2633	0.087	8
East Coventry township	Chester	908	6,938	4426	0.083	8
Perkiomen township	Montgomery	519	3168	1609	0.083	8
Lower Salford township	Montgomery	1423	9272	4750	0.079	8
Upper Chichester township	Delaware	1006	4279	1421	0.078	8
Upper Uwchlan township	Chester	1150	7,637	3957	0.078	8
Middletown township	Bucks	3309	12,319	3548	0.077	8
Parkesburg borough	Chester	190	809	265	0.077	8
Bedminster township	Bucks	1873	20,059	16354	0.076	8
East Rockhill township	Bucks	971	8,303	5367	0.076	8
East Vincent township	Chester	942	8,736	5966	0.074	8
Lower Pottsgrove township	Montgomery	836	5151	2322	0.073	8
New Hanover township	Montgomery	1393	13866	9948	0.072	8
South Coatesville borough	Chester	149	1,146	632	0.072	8
Plumstead township	Bucks	1648	17,439	13153	0.071	8
Westtown township	Chester	925	5,590	2352	0.070	8
West Conshohocken borough	Montgomery	126	573	181	0.069	8
West Caln township	Chester	1421	14,061	9447	0.068	8
Schuylkill township	Chester	813	5,748	2658	0.065	8
Hilltown township	Bucks	1560	17,354	12608	0.065	8
West Brandywine township	Chester	824	8,563	5763	0.065	8
Upper Makefield township	Bucks	1249	13,617	9588	0.065	8

Muncipality	County	1994-2001 Residential Units Proposed	Total Land	Available Land	94-2001 (Prop/Total Land) * (Avail Land/Total Land)	Category Score
Chalfont borough	Bucks	255	1,073	287	0.064	8
Phoenixville borough	Chester	485	2,340	715	0.063	8
Downingtown borough	Chester	307	1,407	403	0.062	8
London Grove township	Chester	1002	11,096	7611	0.062	8
Solebury township	Bucks	1827	17,323	10027	0.061	8
Charlestown township	Chester	685	8,001	5614	0.060	8
Milford township	Bucks	1319	17,958	14645	0.060	8
Lower Oxford township	Chester	975	11,747	8410	0.059	4.25
Red Hill borough	Montgomery	75	431	138	0.056	4.25
Uwchlan township	Chester	892	6,668	2752	0.055	4.25
Northampton township	Bucks	2705	16,730	5544	0.054	4.25
Lower Makefield township	Bucks	1665	11,489	4224	0.053	4.25
West Vincent township	Chester	695	11,382	9594	0.051	4.25
East Pikeland township	Chester	510	5,697	3199	0.050	4.25
Malvern borough	Chester	112	804	289	0.050	4.25
Atglen borough	Chester	43	532	327	0.050	4.25
Newtown township	Bucks	794	7,631	3632	0.050	4.25
Honey Brook township	Chester	941	16,246	13736	0.049	4.25
East Fallowfield township	Chester	968	10,079	5127	0.049	4.25
Conshohocken borough	Montgomery	593	654	35	0.049	4.25
Aston township	Delaware	497	3737	1368	0.049	4.25
West Norriton township	Montgomery	1122	3924	657	0.048	4.25
Franconia township	Montgomery	695	8857	5346	0.047	4.25
Montgomery township	Montgomery	872	6812	2412	0.045	4.25
South Coventry township	Chester	391	4,875	2716	0.045	4.25
Yardley borough	Bucks	254	595	62	0.045	4.25
Warminster township	Bucks	2316	6,534	810	0.044	4.25
Kennett township	Chester	633	9,922	6725	0.043	4.25
Londonderry township	Chester	530	7,347	4333	0.043	4.25
Willistown township	Chester	1071	11,710	5429	0.042	4.25
Wrightstown township	Bucks	367	6,471	4834	0.042	4.25
Pocopson township	Chester	312	5,447	4019	0.042	4.25
Chester Heights borough	Delaware	96	1421	860	0.041	4.25
Worcester township	Montgomery	685	10380	6427	0.041	4.25
New London township	Chester	423	7,660	5331	0.038	4.25
Horsham township	Montgomery	1157	11088	4041	0.038	4.25
Schwenksville borough	Montgomery	40	252	60	0.038	4.25
Hulmeville borough	Bucks	29	251	76	0.035	4.25
Birmingham township	Chester	247	3,983	2223	0.035	4.25
West Goshen township	Chester	849	7,719	2268	0.032	4.25
Douglass township	Montgomery	522	9877	5830	0.031	4.25
East Marlborough township	Chester	589	9,929	5173	0.031	4.25
Doylestown township	Bucks	965	10,020	3154	0.030	4.25
West Pikeland township	Chester	278	6,357	4367	0.030	4.25
Spring City borough	Chester	77	523	107	0.030	4.25
Upper Hanover township	Montgomery	714	13539	7332	0.029	4.25
Lower Gwynedd township	Montgomery	489	5937	2028	0.028	4.25
Whitpain township	Montgomery	834	8227	2252	0.028	4.25
East Bradford township	Chester	486	9,676	5200	0.027	4.25
Langhorne borough	Bucks	59	317	45	0.027	4.25
London Britain township	Chester	284	6,432	3827	0.026	4.25
Hatfield township	Montgomery	492	6415	2192	0.026	4.25
Whitemarsh township	Montgomery	647	9420	3427	0.025	4.25
West Sadsbury township	Chester	188	6,759	5681	0.023	1.75
Lower Moreland township	Montgomery	452	4673	1096	0.023	1.75
Upper Gwynedd township	Montgomery	594	5213	1025	0.022	1.75
Falls township	Bucks	1161	16,225	5057	0.022	1.75
Wallace township	Chester	251	7,571	5078	0.022	1.75
West Rockhill township	Bucks	313	10,502	7756	0.022	1.75
Sellersville borough	Bucks	91	766	139	0.022	1.75
Bridgeton township	Bucks	117	4,226	3207	0.021	1.75
Towamencin township	Montgomery	413	6200	1947	0.021	1.75

Muncipality	County	1994-2001 Residential Units Proposed	Total Land	Available Land	94-2001 (Prop/Total Land) * (Avail Land/Total Land)	Category Score
North Coventry township	Chester	275	8,602	5596	0.021	1.75
Edgmont township	Delaware	387	6218	1963	0.020	1.75
New Britain township	Bucks	341	9,768	5360	0.019	1.75
Avondale borough	Chester	12	312	152	0.019	1.75
Elk township	Chester	156	6,621	5231	0.019	1.75
Upper Merion township	Montgomery	1210	11088	1824	0.018	1.75
Springfield township	Delaware	689	4056	428	0.018	1.75
Upper Salford township	Montgomery	147	5803	4050	0.018	1.75
West Nantmeal township	Chester	213	8,644	6021	0.017	1.75
Upper Southampton township	Bucks	339	4,235	890	0.017	1.75
Norristown borough	Montgomery	503	2337	182	0.017	1.75
Pennsbury township	Chester	178	6,551	3938	0.016	1.75
Royersford borough	Montgomery	73	509	57	0.016	1.75
East Greenville borough	Montgomery	33	319	47	0.015	1.75
Telford borough (part) *	Bucks	39	334	43	0.015	1.75
Doylestown borough	Bucks	287	1,382	98	0.015	1.75
Upper Oxford township	Chester	185	10,758	9026	0.014	1.75
Chester township	Delaware	34	894	332	0.014	1.75
Tinicum township	Bucks	334	18,985	14814	0.014	1.75
Upper Frederick township	Montgomery	124	6449	4579	0.014	1.75
Highland township	Chester	238	11,010	6808	0.013	1.75
Plymouth township	Montgomery	443	5444	864	0.013	1.75
Telford borough (part) *	Montgomery	42	318	31	0.013	1.75
Bristol borough	Bucks	112	1,117	143	0.013	1.75
Ambler borough	Montgomery	78	537	45	0.012	1.75
Marple township	Delaware	352	6731	1552	0.012	1.75
Newlin township	Chester	183	7,700	3822	0.012	1.75
Kennett Square borough	Chester	61	694	93	0.012	1.75
Upper Providence township	Delaware	223	3750	734	0.012	1.75
Bensalem township	Bucks	583	12,793	3211	0.011	1.75
East Norriton township	Montgomery	263	3881	653	0.011	1.75
Springfield township	Bucks	252	19,607	16727	0.011	1.75
Easttown township	Chester	305	5,287	977	0.011	1.75
Darby township	Delaware	92	910	94	0.010	1.75
Langhorne Manor borough	Bucks	12	413	147	0.010	1.75
Lower Southampton township	Bucks	265	4,309	715	0.010	1.75
West Fallowfield township	Chester	139	11,652	9363	0.010	1.75
East Nantmeal township	Chester	147	10,459	6965	0.009	0.5
Nockamixon township	Bucks	172	14,359	11056	0.009	0.5
Salford township	Montgomery	73	6106	4233	0.008	0.5
Bridgeport borough	Montgomery	33	447	45	0.007	0.5
West Pottsgrove township	Montgomery	30	1541	582	0.007	0.5
Upper Dublin township	Montgomery	283	8497	1860	0.007	0.5
West Nottingham township	Chester	89	8,996	6023	0.007	0.5
Nether Providence township	Delaware	237	3025	254	0.007	0.5
Ridley Park borough	Delaware	50	676	60	0.007	0.5
Sharon Hill borough	Delaware	43	495	37	0.007	0.5
Warwick township	Chester	193	12,342	5080	0.006	0.5
Lower Frederick township	Montgomery	45	5190	3824	0.006	0.5
Riegelsville borough	Bucks	5	589	431	0.006	0.5
Chester city	Delaware	896	3874	101	0.006	0.5
Richlandtown borough	Bucks	4	177	46	0.006	0.5
Pottstown borough	Montgomery	146	3151	393	0.006	0.5
Haycock township	Bucks	144	13,476	7197	0.006	0.5
Silverdale borough	Bucks	4	300	123	0.005	0.5
Norwood borough	Delaware	34	520	43	0.005	0.5
Abington township	Montgomery	424	9935	1200	0.005	0.5
Upper Moreland township	Montgomery	161	5085	807	0.005	0.5
Radnor township	Delaware	338	8836	1154	0.005	0.5
Modena borough	Chester	2	218	111	0.005	0.5
Chadds Ford township	Delaware	49	5581	2957	0.005	0.5
Marlborough township	Montgomery	50	8148	6071	0.005	0.5

Muncipality	County	1994-2001 Residential Units Proposed	Total Land	Available Land	94-2001 (Prop/Total Land) * (Avail Land/Total Land)	Category Score
Durham township	Bucks	31	5,867	5069	0.005	0.5
Tredyffrin township	Chester	247	12,692	2832	0.004	0.5
Green Lane borough	Montgomery	3	217	66	0.004	0.5
Bristol township	Bucks	234	10,445	1866	0.004	0.5
Morrisville borough	Bucks	55	1,170	88	0.004	0.5
Trumbauersville borough	Bucks	2	277	124	0.003	0.5
West Grove borough	Chester	6	402	79	0.003	0.5
Springfield township	Montgomery	67	4348	820	0.003	0.5
Collegeville borough	Montgomery	19	1030	148	0.003	0.5
West Chester borough	Chester	147	1,172	24	0.003	0.5
Trainer borough	Delaware	16	880	126	0.003	0.5
Bryn Athyn borough	Montgomery	6	1230	645	0.003	0.5
Morton borough	Delaware	15	236	8	0.002	0.5
Souderton borough	Montgomery	133	721	8	0.002	0.5
Ridley township	Delaware	118	3386	203	0.002	0.5
Brookhaven borough	Delaware	15	1095	164	0.002	0.5
Upland borough	Delaware	9	432	42	0.002	0.5
Swarthmore borough	Delaware	18	899	79	0.002	0.5
New Britain borough	Bucks	7	755	141	0.002	0.5
Lower Merion township	Montgomery	223	15286	1816	0.002	0.5
Clifton Heights borough	Delaware	9	406	31	0.002	0.5
Cheltenham township	Montgomery	108	5791	487	0.002	0.5
West Marlborough township	Chester	46	10,855	3973	0.002	0.5
Hatboro borough	Montgomery	23	925	47	0.001	0.5
Darby borough	Delaware	9	525	37	0.001	0.5
Penndel borough	Bucks	8	276	11	0.001	0.5
Quakertown borough	Bucks	13	1,284	146	0.001	0.5
Folcroft borough	Delaware	10	892	86	0.001	0.5
Media borough	Delaware	26	487	10	0.001	0.5
Hatfield borough	Montgomery	3	395	53	0.001	0.5
Upper Darby township	Delaware	80	4992	311	0.001	0.5
Tullytown borough	Bucks	12	1,206	112	0.001	0.5
Haverford township	Delaware	74	6388	490	0.001	0.5
Glenolden borough	Delaware	8	625	43	0.001	0.5
Rockledge borough	Montgomery	3	219	12	0.001	0.5
Lansdale borough	Montgomery	23	1884	110	0.001	0.5
Lower Chichester township	Delaware	2	706	171	0.001	0.5
Rose Valley borough	Delaware	2	464	73	0.001	0.5
Lansdowne borough	Delaware	5	769	51	0.000	0.5
Newtown borough	Bucks	12	348	4	0.000	0.5
Tinicum township	Delaware	9	5719	688	0.000	0.5
Prospect Park borough	Delaware	21	477	2	0.000	0.5
Jenkintown borough	Montgomery	12	367	1	0.000	0.5
Marcus Hook borough	Delaware	5	1005	19	0.000	0.5
Collingdale borough	Delaware	1	566	29	0.000	0.5
Aldan borough	Delaware	1	394	14	0.000	0.5
Narberth borough	Montgomery	1	298	6	0.000	0.5
Colwyn borough	Delaware	0	164	5	0.000	0.5
East Lansdowne borough	Delaware	0	125	0	0.000	0.5
Eddystone borough	Delaware	0	972	75	0.000	0.5
Millbourne borough	Delaware	0	43	7	0.000	0.5
Parkside borough	Delaware	0	128	1	0.000	0.5
Rutledge borough	Delaware	0	94	0	0.000	0.5
Yeadon borough	Delaware	0	1030	163	0.000	0.5
North Wales borough	Montgomery	14	368	0	0.000	0.5

Appendix D Vulnerability Index Scores, by Municipality

Municipality	County	ERI	Open Space Plan	Floodplain	Stream Corridor	Wetlands	Steep Slope	TDR	OS Design Ordinance	Net-Out	Agricultural Zoning	EIS	Local OS Funding	Total Score	Spatial Analyst Score
Bedminster	Bucks	0.43	0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87			0.87	8.26	1.74
Bensalem	Bucks		0.43	0.43		1.31	0.87							3.04	6.96
Bridgeton	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87				5.21	4.79
Bristol Borough	Bucks		0.43	0.43								0.87		1.73	8.27
Bristol Township	Bucks		0.43	0.43		1.31	0.87			0.87				3.91	6.09
Buckingham	Bucks		0.43	0.43		1.31	0.87	0.87	0.87	0.87		0.87	0.87	7.39	2.61
Chalfont	Bucks	0.43	0.43	0.43	1.31									2.6	7.4
Doylestown Borough	Bucks		0.43	0.43										0.86	9.14
Doylestown Township	Bucks		0.43	0.43			0.87	0.87		0.87				3.47	6.53
Dublin Borough	Bucks		0.43											0.43	9.57
Durham	Bucks	0.43	0.43	0.43	1.31	1.31	0.87			0.87		0.87		6.52	3.48
East Rockhill	Bucks		0.43	0.43		1.31	0.87		0.87	0.87			0.87	5.65	4.35
Falls	Bucks		0.43	0.43	1.31	1.31	0.87			0.87	0.87			6.09	3.91
Haycock	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87				5.21	4.79
Hilltown	Bucks	0.43	0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87	0.87	8.26	1.74
Hulmeville	Bucks	0.43	0.43	0.43		1.31	0.87			0.87				4.34	5.66
Ivyland	Bucks		0.43		1.31									1.74	8.26
Langhorne Borough	Bucks	0.43	0.43	0.43	1.31	1.31	0.87					0.87		5.65	4.35
Langhorne Manor	Bucks	0.43	0.43	0.43		1.31	0.87			0.87				4.34	5.66
Lower Makefield	Bucks	0.43	0.43	0.43		1.31	0.87			0.87			0.87	5.21	4.79
Lower Southampton	Bucks		0.43	0.43			0.87			0.87				2.6	7.4
Middletown	Bucks		0.43	0.43		1.31	0.87							3.04	6.96
Milford	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87			0.87	6.08	3.92
Morrisville	Bucks	0.43	0.43	0.43		1.31	0.87		0.87					4.34	5.66
New Britain Borough	Bucks	0.43	0.43	0.43		1.31				0.87		0.87		4.34	5.66
New Britain Township	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87			0.87	6.08	3.92
New Hope	Bucks	0.43	0.43	0.43		1.31	0.87			0.87		0.87		5.21	4.79
Newtown Borough	Bucks	0.43	0.43	0.43		1.31	0.87							3.47	6.53
Newtown Township	Bucks	0.43	0.43	0.43		1.31	0.87		0.87					4.34	5.66
Nockamixon	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87				5.21	4.79
Northampton	Bucks	0.43	0.43	0.43		1.31	0.87		0.87					4.34	5.66
Penndel Borough	Bucks	0.43	0.43	0.43		1.31	0.87							3.47	6.53
Perkasie	Bucks		0.43	0.43		1.31	0.87							3.04	6.96
Plumstead	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87			0.87	6.08	3.92
Quakertown	Bucks		0.43											0.43	9.57
Richland Township	Bucks		0.43	0.43		1.31			0.87	0.87				3.91	6.09
Richlandtown	Bucks	0.43	0.43	0.43	1.31		0.87							3.47	6.53
Riegelsville	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87		0.87		6.08	3.92
Sellersville	Bucks		0.43	0.43	1.31	1.31	0.87							4.35	5.65
Silverdale Borough	Bucks		0.43	0.43										0.86	9.14
Solebury	Bucks	0.43	0.43	0.43			0.87		0.87	0.87	0.87	0.87	0.87	6.51	3.49
Springfield	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87			0.87	6.08	3.92
Telford	Bucks	0.43												0.43	9.57
Tinicum	Bucks	0.43	0.43	0.43		1.31	0.87		0.87	0.87				5.21	4.79
Trumbauersville	Bucks		0.43									0.87		1.3	8.7
Tullytown	Bucks		0.43	0.43								0.87		1.73	8.27
Upper Makefield	Bucks	0.43	0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87	0.87	8.26	1.74
Upper Southampton	Bucks	0.43	0.43	0.43		1.31	0.87		0.87					4.34	5.66
Warminster	Bucks	0.43	0.43	0.43		1.31	0.87							3.47	6.53
Warrington	Bucks	0.43	0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87		0.87		8.26	1.74
Warwick	Bucks		0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87		6.98	3.04
West Rockhill	Bucks		0.43	0.43		1.31	0.87		0.87	0.87			0.87	5.65	4.35
Wrightstown	Bucks	0.43	0.43	0.43			0.87		0.87	0.87				3.9	6.1
Yardley	Bucks		0.43	0.43	1.31	1.31	0.87			0.87				5.22	4.78
Atglen	Chester	0.43		0.43										0.86	9.14
Avondale	Chester	0.43	0.43	0.43		1.31	0.87							3.47	6.53
Birmingham	Chester		0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87				6.98	3.04
Caln	Chester	0.43	0.43	0.43	1.31		0.87		0.87			0.87		5.21	4.79
Charlestown	Chester	0.43	0.43	0.43			0.87					0.87		3.03	6.97
City of Coatesville	Chester	0.43	0.43	0.43			0.87					0.87		3.03	6.97

Appendix D Vulnerability Index Scores, by Municipality

Municipality	County	ERI	Open Space Plan	Floodplain	Stream Corridor	Wetlands	Steep Slope	TDR	OS Design Ordinance	Net-Out	Agricultural Zoning	EIS	Local OS Funding	Total Score	Spatial Analyst Score
Downingtown	Chester	0.43	0.43	0.43	1.31	1.31	0.87							4.78	5.22
East Bradford	Chester		0.43	0.43			0.87		0.87	0.87		0.87	0.87	5.21	4.79
East Brandywine	Chester		0.43	0.43		1.31	0.87			0.87				3.91	6.09
East Caln	Chester	0.43	0.43	0.43			0.87					0.87		3.03	6.97
East Coventry	Chester	0.43	0.43	0.43										1.29	8.71
East Fallowfield	Chester	0.43		0.43			0.87		0.87	0.87	0.87	0.87		5.21	4.79
East Goshen	Chester	0.43	0.43	0.43			0.87		0.87					3.03	6.97
East Marlborough	Chester	0.43	0.43	0.43					0.87				0.87	3.03	6.97
East Nantmeal	Chester	0.43	0.43	0.43			0.87	0.87	0.87		0.87	0.87		5.64	4.36
East Nottingham	Chester	0.43		0.43			0.87							1.73	8.27
East Pikeland	Chester	0.43	0.43	0.43		1.31	0.87	0.87		0.87	0.87	0.87		6.95	3.05
East Vincent	Chester	0.43	0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87	0.87	0.87		9.13	0.87
East Whiteland	Chester		0.43	0.43	1.31	1.31						0.87		4.35	5.65
Easttown	Chester	0.43	0.43	0.43	1.31				0.87	0.87				4.34	5.66
Elk	Chester		0.43	0.43			0.87					0.87		2.6	7.4
Elverson	Chester	0.43	0.43	0.43			0.87							2.16	7.84
Franklin	Chester	0.43	0.43	0.43	1.31	1.31	0.87		0.87	0.87				6.52	3.48
Highland	Chester	0.43		0.43		1.31	0.87							3.04	6.96
Honey Brook Boro	Chester		0.43											0.43	9.57
Honey Brook Twp	Chester		0.43	0.43			0.87		0.87	0.87				3.47	6.53
Kennett Square Boro	Chester		0.43	0.43										0.86	9.14
Kennett Township	Chester	0.43	0.43	0.43	1.31	1.31	0.87		0.87					5.65	4.35
London Britain	Chester	0.43	0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87	0.87	8.26	1.74
London Grove Twp	Chester	0.43	0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87	0.87	0.87		9.13	0.87
Londonderry	Chester	0.43	0.43	0.43		1.31	0.87							3.47	6.53
Lower Oxford	Chester	0.43	0.43	0.43			0.87							2.16	7.84
Malvern	Chester	0.43	0.43	0.43		1.31	0.87							3.47	6.53
Modena	Chester			0.43			0.87							1.3	8.7
New Garden	Chester		0.43	0.43								0.87		1.73	8.27
New London	Chester	0.43	0.43	0.43			0.87							2.16	7.84
Newlin	Chester		0.43	0.43			0.87		0.87	0.87				3.47	6.53
North Coventry	Chester	0.43	0.43	0.43	1.31	1.31	0.87		0.87			0.87		6.52	3.48
Oxford	Chester			0.43					0.87					1.3	8.7
Parkesburg	Chester	0.43	0.43	0.43			0.87							2.16	7.84
Penn	Chester	0.43	0.43	0.43			0.87			0.87				3.03	6.97
Pennsbury	Chester	0.43	0.43	0.43			0.87		0.87	0.87		0.87		4.77	5.23
Phoenixville	Chester	0.43	0.43	0.43		1.31	0.87			0.87		0.87		5.21	4.79
Pocopson	Chester	0.43	0.43	0.43		1.31	0.87		0.87	0.87				5.21	4.79
Sadsbury	Chester		0.43	0.43	1.31		0.87		0.87	0.87				4.78	5.22
Schuylkill	Chester	0.43	0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87		7.39	2.61
South Coatesville	Chester	0.43	0.43	0.43			0.87							2.16	7.84
South Coventry	Chester	0.43	0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87	0.87			8.26	1.74
Spring City	Chester		0.43	0.43		1.31	0.87							3.04	6.96
Thornbury	Chester	0.43	0.43	0.43		1.31	0.87		0.87	0.87				5.21	4.79
Tredyffrin	Chester	0.43	0.43	0.43		1.31	0.87		0.87	0.87		0.87	0.87	6.95	3.05
Upper Oxford	Chester	0.43	0.43	0.43			0.87		0.87					3.03	6.97
Upper Uwchlan	Chester		0.43	0.43			0.87		0.87					2.6	7.4
Uwchlan	Chester		0.43	0.43	1.31	1.31	0.87					0.87		5.22	4.78
Valley	Chester	0.43	0.43	0.43			0.87							2.16	7.84
Wallace	Chester	0.43	0.43	0.43		1.31	0.87		0.87	0.87		0.87		6.08	3.92
Warwick	Chester	0.43	0.43	0.43	1.31	1.31	0.87			0.87		0.87		6.52	3.48
West Bradford	Chester		0.43	0.43			0.87	0.87	0.87	0.87		0.87		5.21	4.79
West Brandywine	Chester		0.43	0.43	1.31		0.87		0.87	0.87				4.78	5.22
West Caln	Chester		0.43	0.43		1.31	0.87							3.04	6.96
West Chester Borough	Chester	0.43	0.43	0.43		1.31			0.87					3.47	6.53
West Fallowfield	Chester	0.43	0.43	0.43		1.31	0.87		0.87		0.87	0.87		6.08	3.92
West Goshen	Chester		0.43	0.43		1.31	0.87		0.87	0.87		0.87		5.65	4.35
West Grove	Chester	0.43	0.43				0.87							1.73	8.27
West Marlborough	Chester	0.43		0.43			0.87				0.87	0.87		3.47	6.53
West Nantmeal	Chester		0.43	0.43		1.31	0.87			0.87				3.91	6.09

Appendix D Vulnerability Index Scores, by Municipality

Municipality	County	ERI	Open Space Plan	Floodplain	Stream Corridor	Wetlands	Steep Slope	TDR	OS Design Ordinance	Net-Out	Agricultural Zoning	EIS	Local OS Funding	Total Score	Spatial Analyst Score
West Nottingham	Chester	0.43	0.43	0.43			0.87							2.16	7.84
West Pikeland	Chester	0.43	0.43	0.43			0.87		0.87	0.87				3.9	6.1
West Sadsbury	Chester		0.43											0.43	9.57
West Vincent	Chester	0.43	0.43	0.43	1.31	1.31	0.87	0.87	0.87	0.87				7.39	2.61
West Whiteland	Chester	0.43	0.43	0.43		1.31	0.87			0.87		0.87		5.21	4.79
Westtown	Chester		0.43	0.43	1.31		0.87		0.87	0.87	0.87			5.65	4.35
Willistown	Chester	0.43	0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87	0.87	6.26	1.74
Aldan	Delaware			0.43			0.87							1.3	8.7
Aston	Delaware			0.43			0.87					0.87		2.17	7.83
Bethel	Delaware								0.87					0.87	9.13
Brookhaven	Delaware			0.43					0.87					1.3	8.7
Chadds Ford	Delaware													0	10
Chester City	Delaware			0.43										0.43	9.57
Chester Heights Boro	Delaware			0.43			0.87							1.3	8.7
Chester Township	Delaware			0.43										0.43	9.57
Clifton Heights Boro	Delaware											0.87		0.87	9.13
Collingdale	Delaware			0.43										0.43	9.57
Colwyn	Delaware											0.87		0.87	9.13
Concord	Delaware		0.43											0.43	9.57
Darby	Delaware													0	10
Darby Borough	Delaware													0	10
East Lansdowne	Delaware													0	10
Eddystone	Delaware													0	10
Edgemont	Delaware		0.43	0.43			0.87					0.87		2.6	7.4
Folcroft	Delaware			0.43		1.31								1.74	8.26
Glenolden	Delaware			0.43										0.43	9.57
Haverford	Delaware			0.43										0.43	9.57
Landsdowne	Delaware	0.43												0.43	9.57
Lower Chichester	Delaware													0	10
Marcus Hook	Delaware													0	10
Marple	Delaware			0.43			0.87			0.87				2.17	7.83
Media	Delaware		0.43	0.43		1.31								2.17	7.83
Middletown	Delaware			0.43			0.87			0.87		0.87		3.04	6.96
Milbourne	Delaware			0.43										0.43	9.57
Morton	Delaware			0.43								0.87		1.3	8.7
Nether Providence	Delaware		0.43	0.43			0.87		0.87			0.87		3.47	6.53
Newtown	Delaware		0.43	0.43		1.31	0.87			0.87				3.91	6.09
Norwood	Delaware		0.43	0.43										0.86	9.14
Parkside	Delaware													0	10
Prospect Park	Delaware			0.43										0.43	9.57
Radnor	Delaware			0.43	1.31	1.31	0.87			0.87			0.87	5.66	4.34
Ridley	Delaware			0.43			0.87							1.3	8.7
Ridley Park	Delaware													0	10
Rose Valley	Delaware													0	10
Rutledge	Delaware			0.43										0.43	9.57
Sharon Hill	Delaware			0.43								0.87		1.3	8.7
Springfield	Delaware			0.43								0.87		1.3	8.7
Swarthmore	Delaware			0.43										0.43	9.57
Thornbury	Delaware			0.43			0.87							1.3	8.7
Tinicum	Delaware			0.43										0.43	9.57
Trainer	Delaware			0.43										0.43	9.57
Upland	Delaware			0.43										0.43	9.57
Upper Chichester	Delaware			0.43			0.87					0.87		2.17	7.83
Upper Darby	Delaware			0.43										0.43	9.57
Upper Providence	Delaware			0.43		1.31	0.87					0.87		3.48	6.52
Yeadon	Delaware													0	10
Abington	Montgomery	0.43	0.43	0.43			0.87		0.87					3.03	6.97
Ambler	Montgomery		0.43	0.43										0.86	9.14
Bridgeport	Montgomery	0.43	0.43	0.43										1.29	8.71
Bryn Athyn	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84

Appendix D Vulnerability Index Scores, by Municipality

Municipality	County	ERI	Open Space Plan	Floodplain	Stream Corridor	Wetlands	Steep Slope	TDR	OS Design Ordinance	Net-Out	Agricultural Zoning	EIS	Local OS Funding	Total Score	Spatial Analyst Score
Cheltenham	Montgomery	0.43	0.43	0.43		1.31	0.87					0.87		4.34	5.66
Collegeville	Montgomery		0.43	0.43	1.31		0.87			0.87				3.91	6.09
Conshohocken	Montgomery	0.43	0.43	0.43										1.29	8.71
Douglass	Montgomery	0.43	0.43	0.43		1.31	0.87			0.87				4.34	5.66
East Greenville	Montgomery		0.43	0.43								0.87		1.73	8.27
East Norriton	Montgomery	0.43	0.43	0.43										1.29	8.71
Franconia	Montgomery		0.43	0.43		1.31	0.87		0.87	0.87			0.87	5.65	4.35
Green Lane	Montgomery		0.43	0.43			0.87							1.73	8.27
Hatboro	Montgomery	0.43	0.43	0.43										1.29	8.71
Hatfield	Montgomery		0.43	0.43						0.87				1.73	8.27
Hatfield Borough	Montgomery		0.43	0.43		1.31								2.17	7.83
Horsham	Montgomery	0.43	0.43	0.43	1.31	1.31	0.87			0.87		0.87		6.52	3.48
Jenkintown	Montgomery	0.43	0.43	0.43										1.29	8.71
Landsdale	Montgomery		0.43	0.43		1.31								2.17	7.83
Limerick	Montgomery	0.43	0.43	0.43										1.29	8.71
Lower Frederick	Montgomery		0.43	0.43			0.87			0.87				2.6	7.4
Lower Gwynedd	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84
Lower Merion	Montgomery	0.43	0.43	0.43			0.87		0.87	0.87				3.9	6.1
Lower Moreland	Montgomery		0.43	0.43			0.87							1.73	8.27
Lower Pottsgrove	Montgomery		0.43	0.43			0.87							1.73	8.27
Lower Providence	Montgomery		0.43	0.43										0.86	9.14
Lower Salford	Montgomery	0.43	0.43	0.43					0.87					2.16	7.84
Marlborough	Montgomery		0.43	0.43		1.31	0.87							3.04	6.96
Montgomery	Montgomery		0.43	0.43										0.86	9.14
Narberth	Montgomery		0.43	0.43										0.86	9.14
New Hanover	Montgomery		0.43	0.43	1.31	1.31	0.87			0.87		0.87		6.09	3.91
Norristown	Montgomery		0.43	0.43		1.31								2.17	7.83
North Wales	Montgomery	0.43	0.43	0.43										1.29	8.71
Pennsburg	Montgomery	0.43	0.43	0.43	1.31		0.87							3.47	6.53
Perkiomen	Montgomery	0.43	0.43	0.43	1.31									2.6	7.4
Plymouth	Montgomery		0.43	0.43			0.87			0.87				2.6	7.4
Pottstown	Montgomery		0.43	0.43								0.87		1.73	8.27
Red Hill	Montgomery	0.43	0.43	0.43		1.31								2.6	7.4
Rockledge	Montgomery	0.43	0.43	0.43										1.29	8.71
Royersford	Montgomery	0.43	0.43	0.43										1.29	8.71
Salford	Montgomery		0.43	0.43			0.87							1.73	8.27
Schwenksville	Montgomery	0.43	0.43	0.43										1.29	8.71
Skippack	Montgomery	0.43	0.43	0.43					0.87				0.87	3.03	6.97
Souderton	Montgomery		0.43	0.43										0.86	9.14
Springfield	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84
Telford	Montgomery	0.43	0.43	0.43										1.29	8.71
Towamencin	Montgomery		0.43	0.43	1.31		0.87							3.04	6.96
Trappe	Montgomery		0.43	0.43			0.87							1.73	8.27
Upper Dublin	Montgomery	0.43	0.43	0.43			0.87			0.87				3.03	6.97
Upper Frederick	Montgomery	0.43	0.43	0.43			0.87		0.87					3.03	6.97
Upper Gwynedd	Montgomery		0.43	0.43							0.87	0.87		2.6	7.4
Upper Hanover	Montgomery	0.43	0.43	0.43	1.31		0.87			0.87		0.87		5.21	4.79
Upper Merion	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84
Upper Moreland	Montgomery	0.43	0.43	0.43										1.29	8.71
Upper Pottsgrove	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84
Upper Providence	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84
Upper Salford	Montgomery	0.43	0.43	0.43	1.31	1.31	0.87		0.87					5.65	4.35
West Conshohocken	Montgomery	0.43	0.43	0.43			0.87							2.16	7.84
West Norriton	Montgomery		0.43	0.43										0.86	9.14
West Pottsgrove	Montgomery	0.43	0.43	0.43										1.29	8.71
Whitemarsh	Montgomery		0.43	0.43			0.87							1.73	8.27
Whitpain	Montgomery		0.43	0.43					0.87				0.87	2.6	7.4
Worcester	Montgomery		0.43	0.43	1.31	1.31	0.87		0.87	0.87		0.87		6.96	3.04
Philadelphia	Philadelphia			0.43	1.31		0.87		0.87			0.87		4.35	5.65