Growth Management Plan for Milford Township, PA: Suitability Analysis and Buildout Scenarios

Md Mahbubur Rabb Meenar, ASM Abdul Bari, Jesse Sherry

ABSTRACT

The paper describes the GIS techniques and methods used to help develop and design a growth management plan for Milford Township, Bucks County, Pennsylvania. It analyzes Milford Township's existing zoning and land use plan and discusses a future projection buildout scenario, following existing plans and regulations. Then alternative development scenarios, along with 3D visualizations, are developed and compared. The paper summarizes the pros and cons of all these development scenarios.

Key Words: Growth Management Plan, Buildout Scenario, GIS, ArcGIS, CommunityViz

INTRODUCTION

Growth management, one of the foremost issues in land-use planning, involves a number of features that provides a community's unique sense of place, ideally in a sustainable environment. Over the years the contemporary land development patterns of the USA have created an outward extension of new development into agricultural land, which results in a steady decline of older communities. Such urban sprawl consumes valuable open spaces and green fields and thus compromises our environment, biodiversity, health, and overall quality of life. Progressive communities across the nation have been taking initiatives to preserve their natural resources by managing growth or development trends. A growth management plan or smart growth, which is a collection of urban development strategies to reduce sprawl, focuses on growth in concentrated areas by considering the available economic or environmental recourses within communities. Growth management plans recognize the relationship between development patterns and quality of life and the connections between environmental protection, social equity, public health, and economic sustainability.

Based on an on-going project initiated by the Center for Sustainable Communities (CSC) of Temple University, PA, this paper does not propose a specific growth management plan for Milford Township, Bucks County, PA. An actual growth management plan for Milford Township can only be developed after significant public involvement, which has not yet occurred. Thus, this paper focuses on Geographic Information Systems (GIS) based analyses that have been performed by the CSC GIS Studio and used as decision making tools for developing such a plan for the municipality in future.

The software used for this project are Microsoft Excel, ESRI ArcGIS 8.3, ArcView 3.2, and CommunityViz, a program of The Orton Family Foundation.

BACKGROUND

Use of GIS in Growth Management Planning

Since the launch of GIS for conducting land resource management in 1971 by the Canadian Geographic Information System, GIS has been used to explore the growth management questions through the use of model and build-out scenarios. As stated in the Environmental Protection Agency (EPA) web site, smart growth analysis seeks to determine "how and where new development should be accommodated" (EPA, 2004). GIS application can be used to identify these problems as it can consider the population change, development impact, job growth and need, transportation alternatives, resource protection need and more.

Intelligent use of GIS in landuse planning can curb sprawled growth and promote smart growth instead. For example, in order to visualize the land use changes and growth pattern, the City of Portland, Oregon, created an urban growth boundary by making a GIS inventory of vacant land dated as far back as 1980. Using GIS tools to the fullest extent Portland has managed to shape the growth. During the period of 1970 – 1990 the population of Portland Metro grew by 50 percent but used up only 2 percent of the buildable land, whereas Los Angeles Metro grew 45 percent and used up 200 percent of the buildable land (Robinson, 1999).

As a decision making tool, GIS is being extensively used for developing growth management plans by different communities. Planners, local governments, or other interest groups can use GIS for creating alternative build-out scenarios for their community. Such analysis in the past could be cost prohibitive and time consuming. The Harvard University Graduate School of Design conducted a project entitled "Alternative Futures for Monroe

County, Pennsylvania” in 1994. Monroe County, located in the Pocono Mountains, estimated that the county population would be doubled by the year 2020. The county was facing interrelated issues, including social services, conservation, transportation system, wastewater treatment, and preserving the quality of life. Using GIS, the team mapped and analyzed the existing conditions of the county. Based on the analysis, they created six possible alternative future scenarios for the county and assessed the positive and negative impacts of these scenarios by using simplified rating charts. Although the project did not provide any definite answer for the future growth of Monroe County, it helped the decision makers to analyze their goals, needs, and values (Harvard University Graduate School of Design, 1994). San Antonio, Texas also used GIS as a tool for creating build-out scenarios for its Broadway Corridor project. The City used a GIS Based planning support tool named Smart Growth INDEX, distributed by U.S. Environmental Protection Agency (EPA), to evaluate and rate different scenarios with a set of indicators that measure a scenario’s performance in transportation, urban design, and environmental terms (ArcNews Online, 2002).

GIS can be used as a tool to help preserve farmlands. When land is being considered for preservation, GIS can be utilized in identifying and inventorying zoning, urban growth boundaries, and agricultural districts (Daniels et al, 1997). In order to encourage smart growth, Lancaster County, Pennsylvania, is using GIS to identify high quality agricultural land, to rank possible future preservation sites, and to keep track of the information over the years.

Identifying and protecting natural and historic resources is another aspect of growth management plan and GIS can be extremely helpful tool to provide such service. The Georgia Institute of Technology’s Center for Geographical Information Systems (CGIS) has created the Greenspace Acquisition Support System that aids in preserving green space in Metro Atlanta, using GIS. The system “demonstrates the importance of using GIS for greenspace identification, prioritization, and acquisition” (Giarrusso, 2003). This system identified parcels larger than five acres that are important for water quality, urban forest preservation, and the formation of contiguous greenspace systems.

Milford Township: Current Conditions

The starting point for this project was to determine the current conditions in

Milford Township and to develop the quantitative measurements that would serve as the baselines for projections.

Milford Township, a municipality in the Quakertown area of southeastern Pennsylvania, became an attractive place for European setters in the 17th and early 18th century due to its rich farmland and pristine water resources. Today the township offers a number of culturally and historically significant sites as well as scenic resources like rolling hills, woodlands, farmlands, and stream corridors. However, the township is facing development pressure due to its proximity to the Lehigh Valley, Philadelphia, and New Jersey. The township population grew from 7,300 in 1990 to 8,810 in the year 2000, an increase of 19.7%, along with 636 new dwelling units (U.S. Census Bureau, 2004). Facing the demand to convert open space into more intensive land uses, the township leaders realized that unmanaged development would lead to a loss of what residents treasured most in this township: open space and a strong agricultural orientation. Since 1970s the township has adopted several creative landuse planning strategies and now it has embarked on a growth management plan to guide its development for the next 20 years.

In 2000 Milford Township had 3,161 total housing units and 78.2% were one unit single family detached houses, compared to 64.1% of such types of houses for the whole Bucks County. The median household income grew by 42.8% from 1990 to 2000, which had increased the capability of purchasing or constructing new houses. In 2002, nearly 35% of the township population was in the 35 to 54 age group whose preferences have tended to be single family detached housing units. Based on these statistics it is evident that the construction of single family detached houses is preferred in the township and likely to continue to be so and, for that reason, only this type of buildings has been considered for the build-out scenarios.

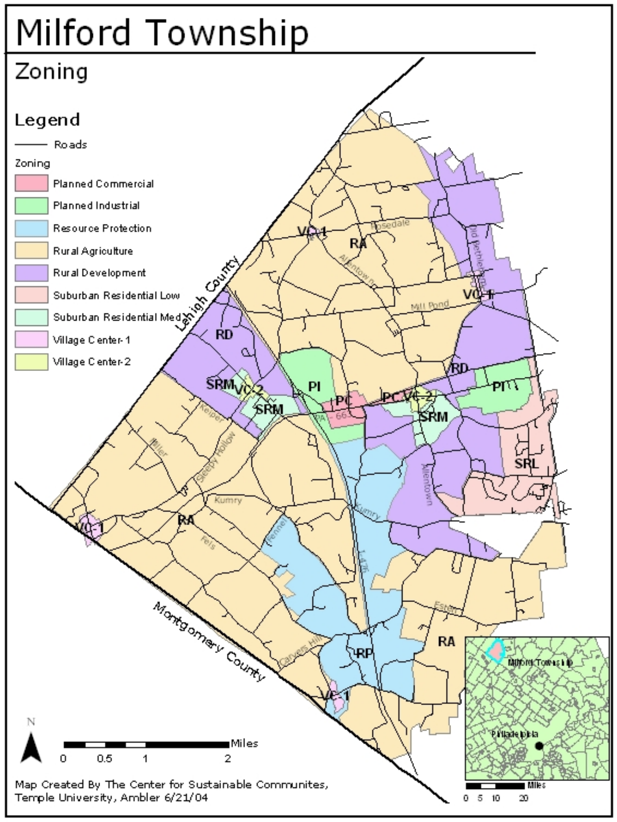

Fig: Map of Milford Township showing existing zoning

METHODOLOGY

Developing GIS Data Resources

1) Base Layers

The CSC has collected, compiled, edited, and created databases and maps for all the base layers. Some of these data sources are Milford Township, Delaware Valley Regional Planning Commission (DVRPC), Natural Land Trust (NLT), ESRI, Federal Emergency Management Agency (FEMA), and Temple University Department of Community and Regional Planning (CRP). Based on the DVRPC Aerial Images, CSC has digitized all the building points located in Milford Township.

2) Constraint Layers

The following GIS layers, either created by CSC or collected from different sources, have been selected as constraint layers for any future residential development of Milford Township.

Physical Constraint layers

• **Unbuildable Parcels** – this layer was created by CSC in multiple steps using data collected from the municipality and other sources. First, all of the township parcels that are already built out were removed from consideration. This was done by selecting the parcels within each zoning category that are less than twice the minimum lot size. These parcels cannot be subdivided and so are considered as built-out. Those parcels that are in two zoning categories were assigned to the zoning category with the highest density. The municipality land records database, which was in Excel file format, was then used to determine which of these unbuildable parcels were currently vacant. These parcels were assumed to be available for buildout. In the following step, parcels which contained churches, schools, cemeteries, as well as the township building were also excluded from the buildable land layer. These parcels were found by intersecting a point file containing that feature with the parcel file. The final task was to deduct all the buildable parcels from the original municipality parcel layer to find out the unbuildable parcels.

• **Agricultural Preservation Overlay District** – a new zoning layer with restricted or no residential development, proposed by the Temple University CRP Studio in spring 2004.

• **Protected Spaces** – the layer, collected from NLT, contains lands protected by Homeowners Associations, Milford Township, and the Quakertown School District.

• **Airport Buffer Zones** – the zones one, two and three surrounding the Quakertown Airport, a general aviation airport and an important player in local economy, do not permit residential development. These zones were drawn using data from the Bucks County Airport Authority and were amended to match the map document produced by Kimball Associates, which is the official document delineating these areas. Here are the details of three zones: o Zone 1 – the area extends 200ft on each side of the actual runway. o Zone 2 – the area extends 2500ft from the end of Area 1 (at both ends of the runway) and consists of the area under the approach surface. Using the Chart on page 9 of the Pennsylvania Airport Land Use Compatibility Guidelines the outer width of this region was found to be 1250 ft. and the inner width was found to be 250 ft. o Zone 3 – the area extends 1050 ft from each side of the runway and 3000ft from the end of the runway and includes the land under the approach zone for this length.

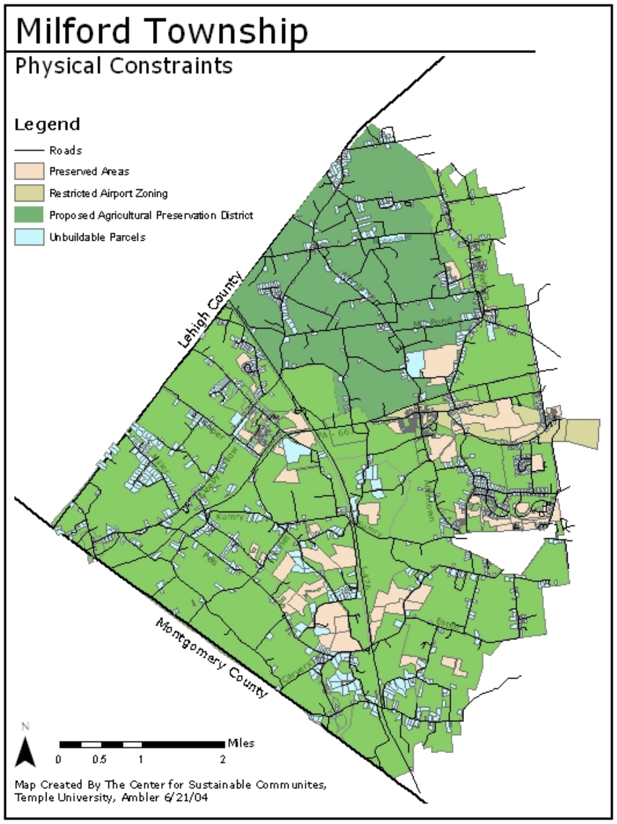

Fig: Map of physical constraint layers

<u>Environmental Constraint layers</u>

• **Floodplains** – the 100 year floodplains as designated by FEMA.

• **Riparian Buffers** – a 75ft buffer of the stream layer created by FEMA.

• **Wetlands** – a layer of the wetlands supplied by DVRPC.

• **Steep Slopes** – the layer obtained from the municipality contains areas with steep grades that difficult for development as well as erosion prone.

• **Wellhead Protection Zones** – three types of zones, developed by the Temple University CRP Studio in spring 2004, were used as constraint layers: o Zone 1 - the layer contains existing and proposed wellhead protection zones (a 400 ft buffer of all public wells) with restricted residential development. o Zone 2 and 3 – this layer delineates the area of recharge for the public wells in the township. This is the area from which the well draws its water and is also the area where contaminants in the soil are very likely to leach into the well water. These zones allow limited residential development.

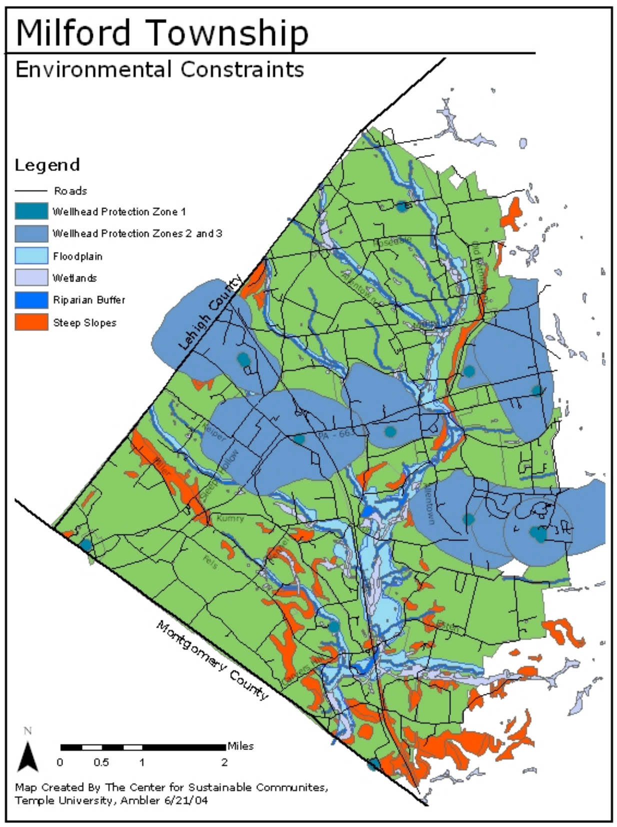

Fig: Map of environmental constraint layers

Suitability study

It was necessary to determine what land could actually be developed in Milford Township, as the current zoning did not take into account barriers to development, such as unsuitable soils and floodplains.

Using ArcGIS Spatial Analyst Extension, raster files were created with a cell size of 100 ft from the following constraint layers: unbuildable parcels, protected spaces, resource protection zone (from Zoning map), wellhead protection zones, riparian buffer, floodplains, airport buffer zones, steep slopes, wetlands, and agricultural preservation overlay district. For each of these files, the areas suitable for development were assigned a value of 1 and those areas unsuitable for development were assigned a value of 0. Each of these layers was assigned a specific weight, considering 5 as the most unsuitable layer, and then combined using the Raster Calculator. The equation was like this:

[unbuildable parcels] X 5 + [protected spaces] X 5 + [resource protection zone] X 5 + [wellhead protection zone 1] X 5 + [wellhead protection zone 2 and 3] X 4 + [riparian buffer] X 4 + [floodplains] X 5 + [airport buffer zones] X 5 + [steep slopes] X 3 + [wetlands] X 5 + [agricultural preservation overlay district] X 3

The suitability map shows that areas with darker color are the most suitable for development and areas with lighter color are the least suitable.

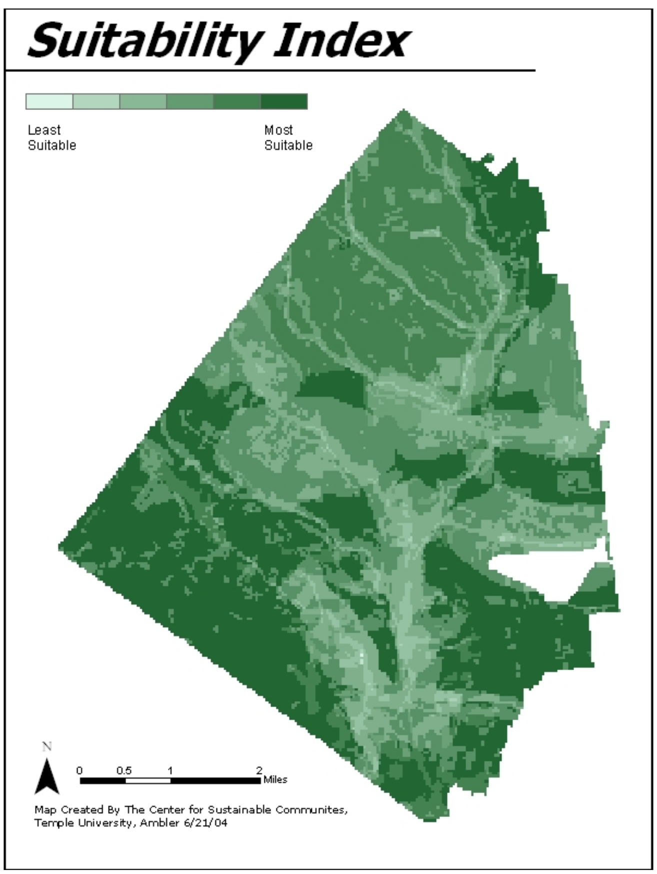

Fig: Map of Suitability *Index*

Developing Alternative Buildout Scenarios

Using CommunityViz software, CSC GIS Studio has developed four different Buildout Scenarios for Milford Township. CommunityViz Buildout Wizard enables users to query existing or proposed zoning maps and then visualizes what the community would look like if it were to grow to the boundaries. The buildout capacity is based on land-use designation, density specifications, land-use efficiency, and building-placement constraints (Geoplace.com web site, 2004). The Wizard provides output of estimated point locations of future buildings, not the exact locations.

The following values were used in each of the Buildout scenarios. Minimum offset means center-to-center distance of two neighboring buildings. These values have been taken from the township Zoning Ordinance. Efficiencies are given as a percentage, between 0 and 100, where a 100 value means complete efficiency (i.e. no land is lost to development), and a 0 value will mean no buildings will be estimated for that land use. A composite efficiency of development takes into account how much land has to be set off for roads, parking, and open space. In this project, 30% of total developable land has been set aside for parks, roads, and other community services. Thus a composite efficiency of 70% (100% - 30%) has been considered for each type of zoning.

Zoning	Dwelling Units/Acre	Minimum Lot Size (sqft)	Efficiency	Minimum Offset (ft)	Floor Space (sqft)
Resource Protection	0.21	217800	70%	325	3000
Rural Agriculture	0.5	87120	70%	200	3000
Rural Development	0.9	43560	70%	120	3000
Suburban Residential Low	2.75	20000	70%	100	3000
Suburban Residential Medium	3.8	15000	70%	100	3000
Village Center 1	2.3	20000	70%	80	3000
Village Center 2	3.2	15000	70%	70	3000

A) Buildout 1: Unconstrained Buildout

This Buildout considers the Unbuildable Parcel layer as the only constraint layer, given the current zoning. The output of this Buildout is 4710 new buildings.

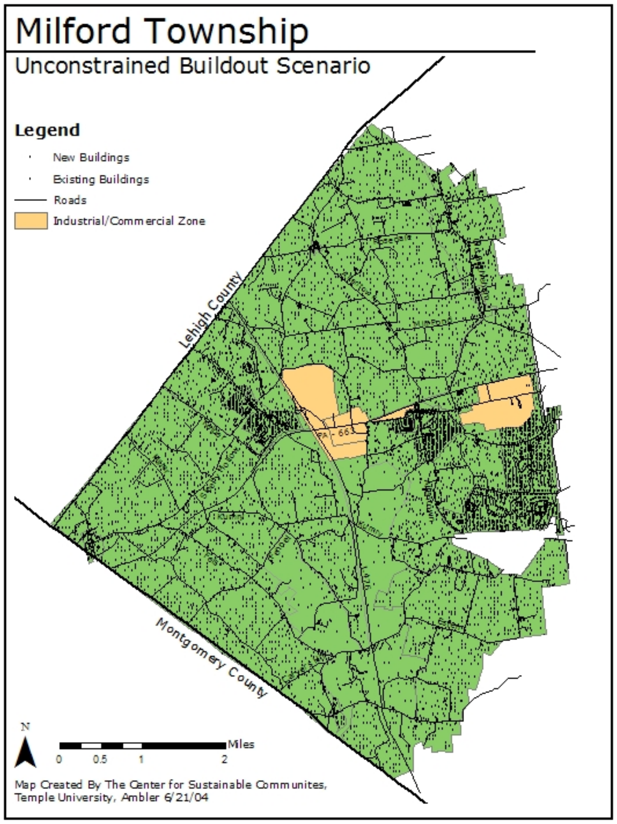

Fig: Unconstrained Buildout Scenario

B) Buildout 2: Constrained Buildout

This Buildout considers the following constraint layers: Unbuildable Parcels, Protected Spaces, Floodplains, Steep slopes, Wetlands, Riparian buffers, Airport Buffer Zones, and Wellhead Protection Zones. Areas falling within these layers are treated as unbuildable. The output of this Buildout is 1585 new buildings.

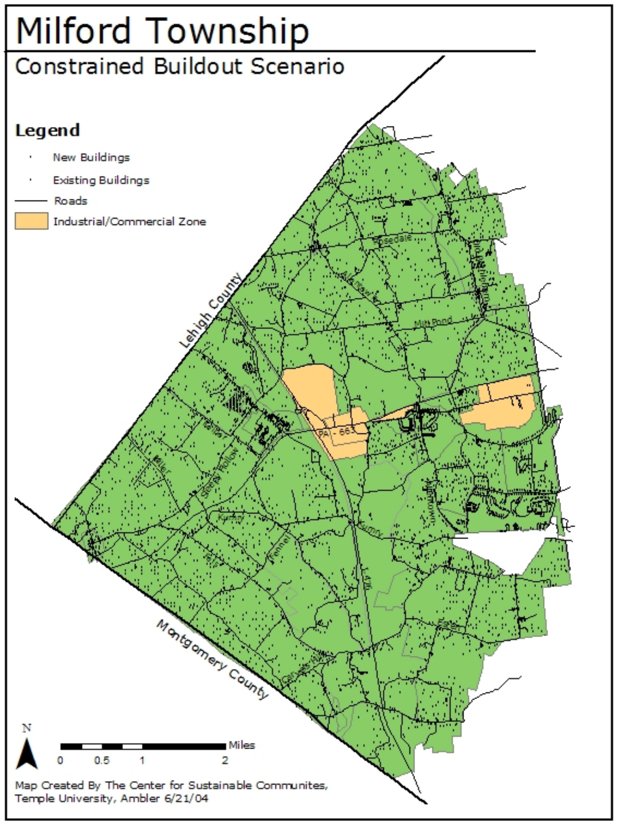

Fig: Constrained Buildout Scenario

C) Buildout 3: Alternative Development Scenario 1

By looking at areas that are currently zoned for high density residential, having major roads and sewer lines, several areas were chosen as optimal for dense development. These areas include the area to the north of Trumbauersville Borough, the area north of Route 663 on the east side of the township, and the area surrounding Milford Square. These areas were changed for the analysis, to the zoning category Suburban Residential Low and then a Buildout analysis was performed. It was found that these areas could easily absorb most of the projected increase in the township's residential construction/population. This Buildout alternative was subject to the same constraints as Buildout 2. This analysis also involved the protection of the entire Agricultural Preservation Overlay District. The output of this Buildout is 2171 new buildings.

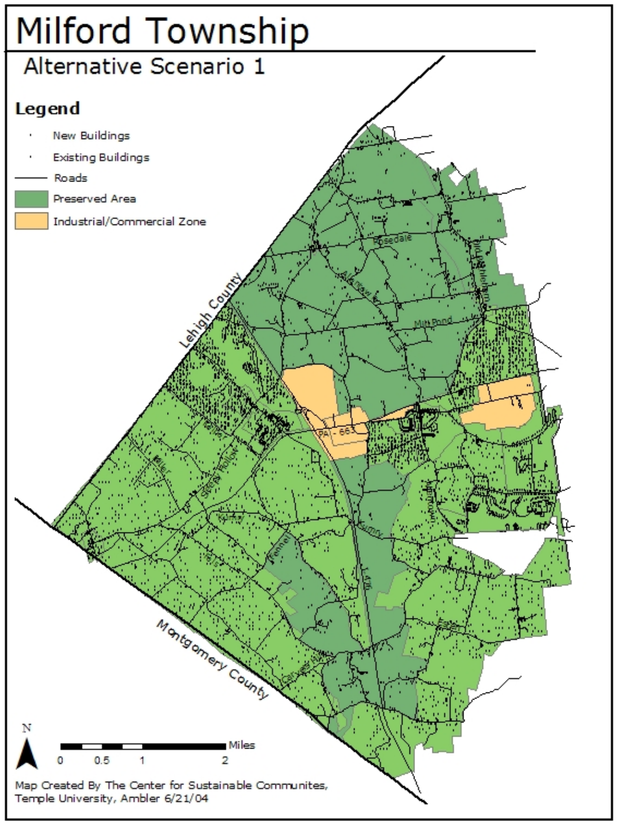

Fig: Alternative Scenario 1

D) Buildout 4: Alternative Development Scenario 2

In this alternative CSC projected that the southern half of the Agricultural Preservation Overlay District and the Rural Agriculture land north of Route 663 on the western side of the township would be converted to one acre (Rural Development) zoning in order to spread the density more evenly throughout the township. The output of this Buildout is 1896 new buildings.

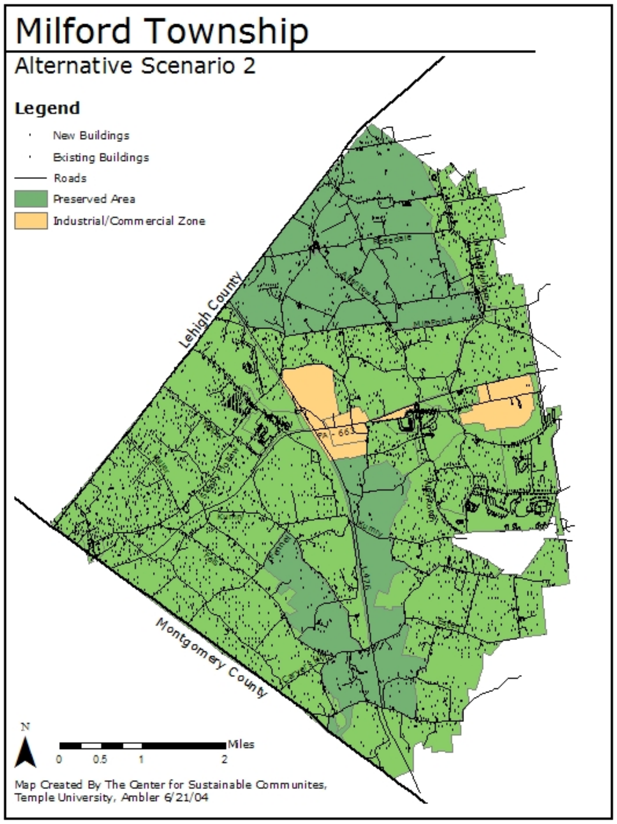

Fig: Alternative Scenario 2

After running the Buildout scenarios, CSC has developed three dimensional simulations for Alternative 1 and 2 scenarios by using Site Builder 3D component of CommunityViz.

Results and Discussions

The difference between the outputs of Buildouts 1 and 2 clearly shows the fact that most of the areas of the township are affected by a number of environmental and physical constraints. This result can also be observed from the suitability study. Considering all the constraint layers, Buildout 2 is showing only one third of the total output of Buildout 1.

Buildouts 3 and 4 are suggesting two different types of alternate future development scenarios for the township. Alternative 1 (Buildout 3) maximizes open space and agricultural land by increasing residential density in some zones, even after accommodating 275 more buildings than Alternative 2 (Buildout 4). Alternative 2 minimizes increase of residential density, and thus reduces open space and agricultural land. Three dimensional simulations of

Alternative 1 and 2 also provide a visual comparison of density and open space of these two scenarios.

Some other comparisons between Alternative 1 and 2 according to different indicators are listed below:

Indicators	Alternative 1	Alternative 2
Total new buildings	2,171	1,896
Total projected population	6,231	5,442
Total Water Consumption (gallons/day)	696,891	608,616
Total Sewer Consumption	557,947	487,272

Variables:
Population: 2.87 people per household in Milford area (U.S. Census 2000)
Water consumption: 321 gallons per single family detached unit per day (Burchell, 2002)
Sewer Consumption: 257 gallons per single family detached unit per day (Burchell, 2002)

CONCLUSION AND FUTURE WORKS

This project has proposed and compared two alternative future development scenarios for Milford Township, to be considered as options for developing the township's Growth Management Plan. The municipality officials as well as residents can now consider and compare these options and offer their opinions. The 3-D representations of the two alternatives and the estimates of changes in land consumption and population accommodation developed through GIS analyses will be very important in helping Milford Township's residents in helping them select their preferred alternative to growth management. This process will both quantify differences between approaches and give qualitative impressions of how the two development approaches might look. This is an extremely valuable tool because experience has shown that the visual presentation of higher development densities influences public acceptability. Quantitative comparisons, especially land use consumption and fiscal impacts, also are compelling. The scope of this project, as presented in this paper, was limited for various reasons. In the future, if given the chance, CSC will try to accomplish the following tasks in order to better serve the community:

1) Compare fiscal implications between Alternative scenario 1 and 2,

2) Compare estimated changes in total land consumption and total preserved land between Alternative scenario 1 and 2,

3) Present alternatives and analyses to Milford Citizens,

4) Seek community choice of growth management approach, and

5) Develop goals, implementation policies, and indicators to assess progress.

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Loveless, Shirley, Ph.D., Associate Professor, Department of Community and Regional Planning; Research Fellow, Center for Sustainable Communities, Temple University

Nalbandian, Richard, M.R.P., M.S., Associate Professor, Department of Community and Regional Planning; Research Fellow, Center for Sustainable Communities, Temple University

Vey, Jeffrey, Manager, Milford Township

References

ArcNews Online. 2002. Developing the "Broadway Corridor": San Antonio, Texas, Uses GIS Tool for Collaborative Planning. http://www.esri.com/news/arcnews/winter0102articles/ sanantonio-tx.html, accessed on June 22, 2004.

Burchell, Robert, et al. 2002. TCRP Report: Cost of Sprawl – 2000, 219, Washington D.C.: National Academy Press

Daniels, Tom, Parrish, Jay, and Henk, Jordan. 1997. GIS and Farmland Protection: The Case of Lancaster County, Pennsylvania, School of Architecture and Environmental Design, Arizona State University, http://www.asu.edu/caed/proceedings97/daniels.html, accessed on June 22, 2004.

Environmental Protection Agency, http://www.epa.gov/livability/about_sg.htm, accessed on June 22, 2004.

Geoplace.com web site, http://www.geoplace.com/gw/2002/0210/0210qt.asp, accessed on June 22, 2004.

Giarrusso, Tony. 2003. Combating Urban Sprawl in Georgia. Center for GIS, Georgia Institute of Technology, http://www.esri.com/news/arcuser/1003/sprawl1of2.html, accessed on June 22, 2004.

Harvard University Graduate School of Design. 1994. Alternative Futures for Monroe County, Pennsylvania, http://www.gsd.harvard.edu/research/projects/la/monroe/, accessed on June 22, 2004.

Robinson, Brian. 1999. Curbing Urban Sprawl, http://www.fcw.com/civic/articles/1999/CIVIC_050399_44.asp, accessed on June 22, 2004.

The Airport Technology and Planning Group, Inc. 1996. Pennsylvania Airport Land Use Compatibility Guidelines, Commonwealth of Pennsylvania Department of Transportation Bureau of Aviation.

U.S. Census Bureau, 2004, http://www.census.gov/, accessed on June 22, 2004

Author Information

Md Mahbubur Rabb Meenar
Senior GIS Design Specialist
Center for Sustainable Communities
Temple University
580 Meetinghouse Rd Ambler, PA 19002
Phone: 215-283-1562
Fax: 215-283-1344
E-mail: meenar@temple.edu

ASM Abdul Bari
Senior GIS Design Specialist
Center for Sustainable Communities
Temple University
580 Meetinghouse Rd Ambler, PA 19002
Phone: 215-283-1688
Fax: 215-283-1344
E-mail: asmbari@temple.edu

Jesse Sherry
Research Assistant
Center for Sustainable Communities
Temple University
580 Meetinghouse Rd Ambler, PA 19002
Phone: 215-283-1520
Fax: 215-283-1344
E-mail: Jsherry@temple.edu