# POTENTIAL DEVELOPMENT IN THE SARATOGA LAKE WATERSHED

## Introduction

The environmental well-being of a municipality is inherently tied to its zoning regulations. Zoning is determined on the local level, but environmental effects do not always fall within the bounds of a city limit. We have examined the zoning regulations, comprehensive plans and land-use categories within all the municipalities that are part of the Saratoga Lake Watershed. Using this information and Geographic Information Systems (GIS), we created a build-out analysis of the watershed which will assess, given current zoning regulations and land use patterns, where land development and population growth is likely to take place within the watershed. This, in turn, will have implications for water quality.

Between 1957 and 1997, the total area of urban land in the United States almost quadrupled, from 18.6 million acres to 74 million acres. In addition, the majority of this development took place during the 1990s, when the national rate of development doubled (Anderson et al., 2006). One of the central implications of this development has been the subsequent increase of impervious surfaces like rooftops, transport components, and paved lots, which comprise a key environmental indicator of urban watershed health (Crane et al., 2007). Stream degradation begins when the area percentage of impermeable surfaces surpasses 10-15%, and in most urban areas it is estimated that 40-80% of land surfaces are covered by impermeable surfaces (Brant et al., 2000; Sinex, 2003). High percentages of impermeable surfaces in turn suggest high amounts of pollutants in runoff including construction site sediments, nutrients from fertilizers, bacteria from animal waste, road deicing salts, and floating aquatic litter (Sinex, 2003). Heavy metals such as lead (Pb), zinc (Zn), copper (Cu), and cadmium (Cd) may also be present in runoff, further degrading water quality (Coldeway et al., 2007).

Increased development may have other implications for watershed health as well. Removing the natural vegetation in riparian zones along streams and water bodies can increase the local temperatures in that area from 6 to 15 degrees Celsius, which may subsequently change the regular climate conditions (Anderson et al., 2006; Sinex, 2003). Reducing riparian vegetation also degrades the riparian zone's effectiveness as a flood plain as well as a filter against nutrients and sediments. This is an especially important consideration when the alterations made to riparian zones during development can negatively impact the quality of a water source (Anderson et al., 2006).

The Great Lakes basin is an example of where increased development around major urban centers has impacted water quality. Suburban sprawl has lead to the construction of more housing, large commercial centers, and retail properties. Newly constructed parking areas and roads have increased the amount of impermeable surfaces in the area, contributing to increased runoff in the watershed (Blaney et al., 2004). Ultimately, the watershed has been exposed to an increased nutrient load, which may accelerate eutrophication, the process by which large accumulations of nutrients promote abundant algal growth in water bodies. As a result, the dissolved oxygen content of the water body is greatly diminished and gradually becomes unsuitable for most aquatic organisms. Although eutrophication occurs naturally, it may be significantly sped up by human activities. Creating impermeable surfaces (roads, pavement, etc.) decreases the amount of water that can infiltrate the ground, thus increasing the amount of runoff. Additionally, fertilizers and animal wastes from human-related activities add to the nutrient load present in runoff, eventually adding to the nutrient load of the water body. Runoff from developed areas may also carry other contaminants into the water body, diminishing its

value as a healthy drinking water source (Bowen et al., 2001). Thoughtful zoning in the Great Lakes basin and elsewhere may provide protection against increased runoff and nutrient loads.

In addition, when implemented carefully, zoning may protect against some environmental hazards. Increasing the amount of impermeable surfaces allows less water to infiltrate into the ground, increasing the likelihood of flood events (Harp et al., 2004). This concept was exemplified by the areas around New Orleans, Louisiana which experienced dramatic flooding during Hurricane Katrina in 2005. It has been contended that, had the area's coastal wetlands not been developed and more permeable land surfaces left intact, the magnitude of the flood event would have been greatly diminished (Daviss, 2005).

Despite its environmental benefits, zoning is not always perceived in a positive light. In a comparative study of zoning ordinances in the states of Michigan and New Jersey, R.A. Cunningham found that zoning in New Jersey was more frequently viewed as a planning tool that would benefit the general welfare, whereas in Michigan zoning was often perceived as a restrictive process (1965). These perceptions, in turn, impacted what zoning laws were enacted and how strongly they were enforced.

Similarly, the level at which zoning ordinances are fully enforced vary according to each municipality. Our study area, the Saratoga Lake watershed, is located in upstate New York and contains twelve municipalities: the towns of Ballston, Charlton, Corinth, Galway, Greenfield, Malta, Milton, Providence, Saratoga, Stillwater, and Wilton, and the city of Saratoga Springs. Whereas Saratoga Springs has detailed ordinances for 27 zoning districts, the town of Charlton has only four districts which operate under broader conditions. The town of Providence has no formal zoning regulations.

Another point of consideration is how much surface area of each municipality is represented within the watershed's boundaries. Only Saratoga Springs and Milton are located completely within the watershed; the other municipalities have ranging amounts of surface area located within its boundaries. Therefore, a municipality could potentially impact the watershed in a way that is disproportionate to its surface area representation, dependent upon its land use patterns and zoning ordinances.

Finally, it must be recognized that zoning ordinances and districts are prone to change. Recently, the town of Wilton proposed amendments that would change some areas zoned under the RB-1 classification to RB-2 districts, which would prohibit more intense types of development (Post, 2007). Perhaps more dramatically, the town of Greenfield recently voted to consolidate their existing zones into fewer, larger zones. Though changes to zoning are not entirely predictable, some changes may be projected in a municipality's comprehensive plan, which, among other things, offers recommendations for future development (Kinney, 2007).

## Methods

First, we gathered information from the towns of Ballston, Charlton, Corinth, Galway, Greenfield, Malta, Milton, Providence, Saratoga, Stillwater, and Wilton, and the city of Saratoga Springs. We were able to get zoning maps and use schedules for all municipalities except for Providence. Providence does not have formal zoning. We also collected the comprehensive plans for all of the municipalities that have them. Many of these documents were available online. To ensure that we were using the most recent information possible, we also contacted the appropriate office at the town or city hall of each municipality by phone and visited the offices in person for many of the municipalities.

The use schedules serve as a key for the zoning codes. The labels for the zones of each municipality are slightly different so we collapsed the zones into our own set of variables. We did this to standardize the zoning among the municipalities so that they could be easily compared. We also did this to lessen the number of different zones to make it easier to work with and clearer for our audience to understand. We used the use schedules that explain the meanings of the original zoning labels and collapsed the zones, combining zones that were similar and finding commonality among the different zones. We came up with 14 variables that cover the wide range of zoning types. Our residential zones are the collection of parcels that are meant primarily for housing in all future development. Our collapsed variables have three of these, separated into groups by density. Our residential zones are:

- R-L: Low Density Residential Zone. These are parcels that have a relatively high minimum lot size requirement of over 2 acres.
- R-M: Medium Density Residential Zone. These are the parcels that have a minimum lot size requirement of less than 2 acres and more than half an acre.
- R-H: High Density Residential Zone. These are parcels that have a minimum lot size requirement of less than .5 acres.

Our commercial zones are districts that are meant mainly for commercial development. Our collapsed variables have three of these zones:

- C-L: Low Density Commercial Zone. These are parcels that have a minimum lot size requirement of .5 acres or less. This includes commercial development that is comprised of small buildings.

- C-M: Medium Density Commercial Zone. These are parcels that have a minimum lot size requirement of over .5 acres and less than 2 acres. This includes commercial development of a medium size.
- C-H: High Density Commercial Zone. These are parcels that have a minimum lot size requirement of 2 acres or more. This includes the areas that have "big box" stores development, large parking lots and shopping malls.

Our industrial zones are districts that are intended by each municipality to be developed for industrial purposes. Our collapsed version of these zones are:

- I-L: Low Density Industrial Zone. These are parcels that have a minimum lot size requirement of less than 1 acre. This is zoned for industrial development that uses a relatively small amount of land.
- I-H: High Density Industrial Zone. These are parcels that have a minimum lot size requirement of an acre or more. This is zoned for industrial development that uses a considerable amount of land.

There were many other use types that we collapsed into these more basic perimeters.

- AG: Agricultural Zone: an agricultural zone is a district that is meant mainly for agricultural use.

- MU: Mixed Use Zone: a mixed use district has many different uses in one area. As an example, North Broadway is a mixed use area as it has businesses and housing in close

proximity to one another. Often in a mixed use district, businesses will be housed on the first floor of a building and the floors above will have apartments.

- CON: Conservation Zone: A conservation district is a protected area of land. The Wilton Wildlife Preserve is one example within the watershed.

- PUD: Planned Unit Development: This type of district have development plans in progress. PUD's often develop as condos or some type of resort development.

- GOV: Government owned land: An example of this type of development in the state correctional facility in Wilton.

- HAM: Hamlet: A Hamlet is a small area within a town that is a rural neighborhood center that usually is pedestrian-friendly and has a few shops.

We also used land use maps overlapped with the collapsed zones on GIS to compare the current land use with how the land is zoned for development in the future. The land use maps don't necessarily represent legal ownership boundaries. Instead, they show the environmental attributes of the land. The variable categories for the land use maps are Water, Developed, Agriculture, Forests/Shrublands, and Wetlands.

The comprehensive plans show us how a municipality intends to develop the community. It is a statement of somewhat idealistic goals and objectives that explore what will be best for the municipality as a whole. The statements made in comprehensive plans are recommendations,

not legislation, and should be viewed as such. By looking at maps in comparison with comprehensive plans, we can determine if a municipality is properly poised for the growth or preservation that they have proposed. A comprehensive plan might also provide clues to how each town will develop that are not indicated through zoning. For example, if a town says in its comprehensive plan that it wants to build an industrial park, the town's officials might not have zoned for this yet because the comprehensive plan is merely what they are striving towards for the future.

After gathering information from zoning maps, use schedules, comprehensive plans, and land data, the next part of our process involved using Geographic Information Systems. By using GIS, we can overlay multiple maps and observe several variables at one time. Our first task to this end was to compose a map in ESRI ArcMap 9.1 of the tax parcels for all twelve municipalities using 2005 data available on the Skidmore College GIS server. Then, we overlaid the parcel map with an outline of the Saratoga Lake watershed, also available on the GIS server. In order for the maps to project correctly, both the map's data frame and the watershed outline layer must have their projections defined as "NAD 1983 UTM Zone 18N," while the parcel layers' projections should be defined as "NAD 1983 State Plane New York East FIPS 3101 (Feet)."

In order to utilize only parcels located within the watershed boundary, we used the "Clip" tool, found under the heading "Extract" in the "Analysis" toolbox. By inputting a municipality and clipping it using the watershed outline, ArcMap can create a layer of tax parcels that exist inside the watershed.

To add zoning data, we added the text field "Zoning" to the attribute table of each municipality. Although, the 2005 tax parcel data contained some zoning information, we found

the data to be incomplete and largely erroneous. We consequently relied on information gathered from the municipalities themselves to select parcels and fill in the "Zoning" field manually. We then added another text field, which we labeled "Collapsed," and filled in the collapsed version of each zoning district.

After we had placed all of the parcels under a common zoning classification system, we merged the municipality layers, using the "Merge" tool in the "Data Management" toolbox under the heading "General", to create one comprehensive shape file for the entire watershed. Then we used the "Dissolve" tool, also found in the "Data Management" toolbox under the heading "Generalization," to eliminate the boundaries between individual parcels and to create a single feature for each collapsed zoning district specified in the attribute table.

For an overlay layer, we utilized a 2001 land use file from the USGS that had been clipped to the boundaries of the watershed and were available on the Skidmore College GIS Server. The projection for this layer is "NAD 1983 Albers." In the Symbology table, we condensed the land use classifications into five categories based upon their usage: Water, Developed, Agriculture, Forests/Shrublands, and Wetlands.

Upon completing these tasks, we began creating a series of comparison maps that demonstrated the build-out potential for development within the watershed. Our first comparison map investigated the potential for development in areas zoned as moderate or high density residential. Using the selection tool, we created a new feature showing only moderate and high density residential areas. We overlaid this map with the USGS land use file. Again, we utilized the "Clip" tool, clipping the land use layer by our moderate and high residential feature, to create a layer of land uses constrained to these two zoning districts. By further manipulating the symbology of the resulting land use layer to show only undeveloped areas, we were able to

effectively display areas vulnerable to development within these zoning districts. Using similar methods we created a second map identifying the potential development of lands being used for agricultural purposes in all zoning districts. Our third map showed lands vulnerable to development within areas zoned for "Planned Use Development" as well as areas specifically identified for development within municipalities' comprehensive plans. Our final map combined all the layers from our previous maps of lands vulnerable to development, in order to portray total potential build-out within the watershed. We also created a 50 foot buffer zone around any streams and water bodies within the watershed using the "Buffer Tool" within the "Analysis" toolbox under the heading "Proximity," since these areas are protected against development.

We compared these maps in order to locate areas suitable for development, from a legal standpoint and a geographic one as well. In conjunction with the recommendations set forth in the individual comprehensive plans, we made predictions of areas most prone to development in the near future. In addition, we used land acreage information found in the GIS Extract data files to calculate the percent increase of development in the watershed, were total build-out to take place.

Results and Analysis

In Table 1. we have listed all twelve municipalities in the watershed, the abbreviations for the zoning that exists in each municipality, the full names of those zoning districts, and the collapsed variable that we adapted from the original districts. These collapsed variables are used in our subsequent maps.

In the watershed, there are:

1 agricultural zone
1 high density commercial zone
13 low density commercial zones

3 medium density commercial zones
5 conservation zones
5 government use zones
8 hamlet zones
2 heavy industrial zones
5 light industrial zones
15 mixed use zones
6 planned unit development zones
16 high density residential zones
10 low density residential zones
16 medium density residential zones.

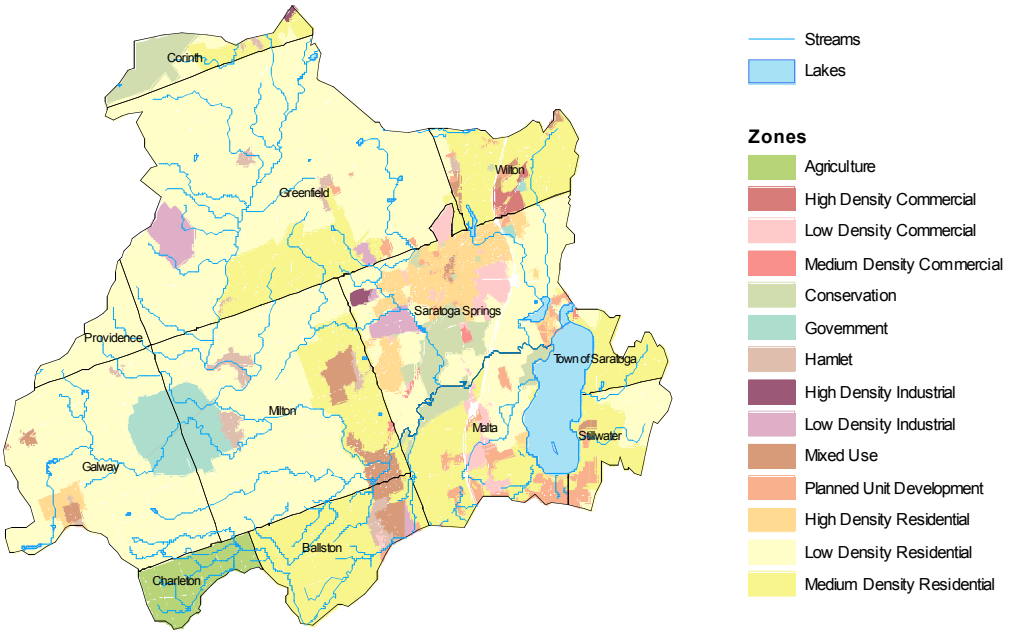


**Figure 1**. Map of the zoning districts within the Saratoga Lake Watershed, utilizing a collapsed series of zoning variables.

As displayed in Figure 1, the Saratoga Lake watershed is dominated by residential zoning. Most high density residential areas were located in the eastern part of the watershed, primarily within Saratoga Springs region, although we also found high density residential zoning surrounding the village of Galway, located within the town of Galway. The largest single zoning

district was low density residential, which characterizes Greenfield, Galway, and Milton. Providence, which had no formal zoning regulations, was also placed into this category based on the characterization of the municipality in its comprehensive plan.

The only zone formally zoned as Agricultural is located in Charlton. Other municipalities had similar zoning designations, but were more frequently referred to as Agricultural Residential or Rural Residential, and were characterized by smaller lot sizes more suitable for residential uses.

There is also significant governmental zoning in both Galway and Milton. This area is comprised largely of the US Reservation Kenneth A. Kesselring Site, run by the Department of Energy. Other government zones included the state correctional facility in Wilton and municipal purpose zones in Saratoga Springs.

Areas zoned as Conservation included parklands and other protected areas and were found primarily in Saratoga Springs, Malta, and Corinth. The Adirondack State Park is represented in the northern section of the watershed in Corinth. However, it should be noted that other conserved lands exist in the watershed, though they may lack formal zoning. Additionally, the amounts of environmental protection afforded areas zoned as Conservation varies dramatically according to municipality. In Malta, for example, development in conservation areas is prohibited, due to the "environmental sensitivity of this zone" (Mallozzi, 2005). In Corinth, conservation areas are given a more hands-on approach; according to the municipality's land use laws, "the need to protect, manage, and enhance forest, agricultural, recreational and open space resources is of paramount importance because of overriding natural resource and public considerations" (Town of Corinth, 2004). In Saratoga Springs, parkland can serve a

variety of functions, including forest management, nurseries, public spa facilities, public recreation facilities, and public assembly facilities (City of Saratoga Springs, 2005).

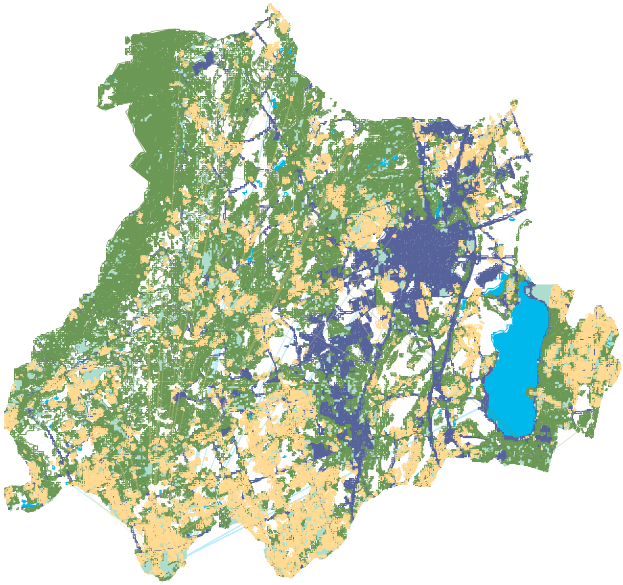

**Figure 2**. Map showing the 2001 USGS Land Use Classifications in the Saratoga Lake watershed.

As displayed in Figure 2, developed land is most prominent in western Wilton, central Saratoga Springs, eastern Milton. These areas correspond to Wilton's high density commercial district, the inner district of Saratoga Springs, the airport in Milton, and the village of Ballston Spa within the town boundaries of Milton and Ballston. There are also lines of development throughout the watershed corresponding to major roadways, most notably I-87. Although we looked at developed land as a single entity, the USGS recognizes four variations of developed land, depending on the percent total cover of impervious surfaces: open space, low density, medium density, and high density. The percent total cover by impervious surfaces in developed

areas range from less than 20% to 100% (See Appendix N). However, since stream degradation may begin to occur at as low as 10% total impervious cover, all lands classified as developed may negatively impact the quality of the watershed (Sinex, 2003).

All areas designated under the Forest and Shrubland categories by the USGS have a surface coverage greater than 20% by vegetation. Forests/Shrublands have the most cover proportionately in the northern and western parts of the watershed, and are well represented in the watershed in the municipalities of Providence, Greenfield, and Corinth. In addition, the eastern and southern sides of Saratoga Lake are bordered to an extent by forested land. This may indicate some preservation of the integrity of riparian zones in these areas, although similar coverage is not present elsewhere around the lake.

Agriculture occurs largely in the southern part of the watershed and decreases towards the northern parts of the watershed. Agricultural activities may include crop cultivation, grazing, pasture/hay management. Although agriculture does not present a dramatic threat to watershed quality in terms of percent coverage by impervious surfaces, intensive agricultural practices may prove detrimental. Runoff from agricultural areas may contain pesticides, herbicides, fertilizers, and animal waste, which accelerate the eutrophication process in water bodies and degrade drinking water quality (Bowen et al., 2001).

The 2001 USGS land use data reflects an exorbitantly large area covered under the classification of woody wetlands. The 1992 definition of woody wetlands pertains to areas periodically saturated or covered by water where forest or shrubland vegetation accounts for 25-100% of the total land cover. The 2001 definition varies slightly, pertaining to areas periodically saturated or covered by water where forest or shrubland vegetation accounts for 20-100% of the total land cover. Although the difference in definitions appears, and may be, insignificant, the

2001 land use map shows dramatically more wetland areas than the 1992 land use map. The Freshwater Wetlands Act affords wetlands of a certain size and ecological importance protection from development. The New York State Department of Conservation makes this distinction for wetlands 12.4 acres or larger, although smaller wetlands may also be protected if they serve a vital ecological function. In addition, protected wetlands are surrounded by a 100 foot buffer where development is prohibited (NYSDEC).

We chose not to include wetlands in our build-out analysis for several reasons. First, the revisions to the definition of woody wetlands in the 1992 and 2001 USGS land use data and the subsequent vast increase in wetland areas on the 2001 map made it questionable which wetland areas were afforded protection from development. This is especially true for areas we knew to be developed that fell within the USGS 2001 wetland designation. In addition, while the NYDEC protects wetlands of 12.4 acres or more, where these wetlands occurred in respect to the USGS data was unclear.

In the following figures, we will show important zoning and land use comparisons for development. These maps show areas that are especially prone to development. In Figure 3, we will look at areas that are zoned for medium to high density residential development but that presently exist as undeveloped forest or shrubland. In Figure 4, we will look at all of the lands that are currently being used for agriculture. In Figure 5, our map shows all the areas that are zoned for a planned unit development as well as the areas that are discussed in a municipality's comprehensive plan as being in line for a specific development project. Figure 6 will show a combined build-out potential that shows the accumulation of all the areas shown in Figures 3-5.

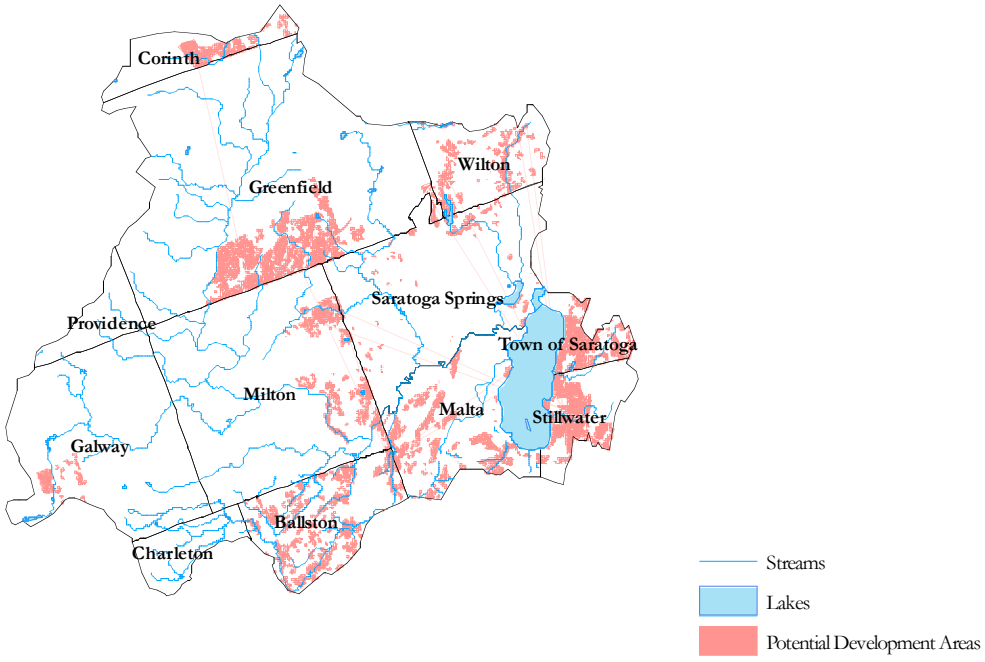


**Figure 3**. Map showing where lands classified as forested/shrubland areas overlap with areas currently zoned for moderate to high density residential density.

For this map we narrowed our focused to the areas of moderate to high density residential development and the areas that are currently forests or shrubland. The areas where the residential development and the existing forested land are overlapping are represented in the coral color. These are potential areas for development.

We observed that the majority of the existing zoning for moderate and high density residential development exists in the eastern portion of the watershed. This might be due to a variety of factors such as proximity to I-87, existing popularity and perceptions of the area, and recreational interest in Saratoga Lake itself. We noticed a strong potential for development in the areas that surround Saratoga Lake. This shows that much of the land that surrounds the lake that isn't already developed is currently zoned for potential development. This could have implications for the direct quality of Saratoga Lake and the watershed as a whole.

The lack of medium to high density residential zoning in the western side of the watershed leads to less potential for heavy residential development to usurp forested land in that area. Much of the area is zoned for low density residential development which is likely to have a different impact on forested land. Low density residential parcels are likely to stay somewhat forested while people build dwelling units on only a small portion of the land.

It is important to mention that land that is labeled as "wetlands" by the USGS is often land that has a lot in common with the forests and shrublands that we looked at. The difference is that wetlands, as USGS defines them, are wet some of the time. They could potentially be included in our analysis of forest and shrubland land use. Because we excluded them, this makes our analysis of potential moderate to high density residential development fairly conservative. If the lands that are labeled as wetlands by the USGS were developed, this would have implications for the amount of forested land in the watershed.

**Figure 4**. Map showing all lands used for agricultural purpose and open to development, regardless of zoning.

Figure 4. shows the current agricultural land use in the Saratoga Lake watershed. We have found that the agricultural land is spread throughout the entire watershed, concentrated most heavily to the east of Saratoga Lake, and to the southwest of the watershed. Of all municipalities, Saratoga Springs appears to have the least overall agricultural influence, which makes sense considering that Saratoga Springs is fairly urbanized in comparison to the other municipalities in the watershed.

We decided not to show the zones underneath as a separate layer because it complicates the map. However, it is important to note that the only area that is strictly zoned for agriculture is the portion of Charlton that falls within the watershed. All of Charlton on this map is zoned as agricultural. In various municipalities, there is zoning for "rural residential" or "agricultural

residential" use. These zones serve as a mixed use agricultural and residential land option. We represented most of these in our low density residential collapsed zone.

Ultimately, the zoning of the currently agricultural land diminishes in importance as it becomes apparent that agricultural land is at risk of becoming re-developed for other uses. Agricultural lands are under a lot of development pressure. Many of the comprehensive plans point to the problem that farmers are finding it more profitable to sell off their land to a developer rather than to continue farming it.

**Figure 5**. Map showing the location of Planned Unit Development (PUD) areas as well as areas recommended for development by municipalities' comprehensive plans

As seen in Figure 5, Planned Unit Developments (PUDs) are most prominent in the southeastern part of the watershed and are located in the municipalities of Greenfield, Wilton, Ballston, Saratoga Springs, Malta, and Stillwater. The term Planned Unit Development

generally pertains to a development of subdivision comprised of a group of compatible land uses, although municipalities may have their own definitions. The definition of PUDs in Greenfield's town code depict PUDs as "the establishment of areas in which one use or diverse uses may be created together, containing both individual building sites and common properties, in a compatible and unified development." In Wilton, the purpose of PUDs appears to be more greatly related to providing developers with more freedom "in which certain economies of scale or creative architectural or planning concepts may be used," while preventing unrestrained sprawl. Minimum lots sizes for PUDs vary depending on the type of development proposed, and all PUDs are subject to review by a municipality's zoning board.

The most prominent example of a PUD within the watershed is the proposed Luther Forest Technology campus, which will be situated in both Malta and Stillwater. The campus is 1,350 acres large and designed for the purpose of nanotechnology manufacturing, research and development. Another PUD in Stillwater is the proposed site of the Brown's Beach Hotel, Resort, and Marina, a 25 million dollar resort and conference center located on Saratoga Lake along New York State Route 9P.

PUDs concentrate development within fixed boundaries, which may arguably be beneficial for the health of the watershed. By concentrating development areas, impervious surfaces are also concentrated, and fewer roads need to be constructed to connect patches of development. Theoretically, there will be more permeable surface left untouched if developed areas are concentrated.

Unfortunately, the flaw in this argument is that concentrating development in one area does not necessarily ensure the prevention of development in other areas.

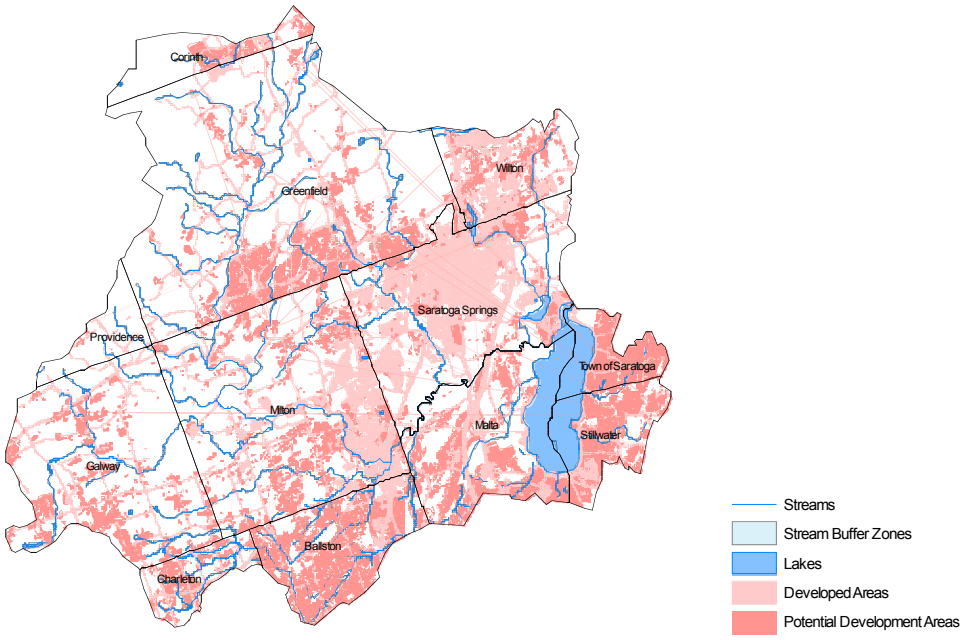


**Figure 6.** Map showing the build-out potential from all of the previous maps.

The map above shows both what is already developed (in light coral) and what could be developed based on our analysis, shown in dark coral. Together they show how much land would be developed if the municipalities in the watershed maximized their build-out potential. The dark coral is an accumulation of what we have shown in the past few maps. It is comprised of moderate to high density residential potential in forested areas, the potential for change in all currently agricultural lands, and the zoning and discussion for planned use developments in many areas in the watershed.

The areas that are shown in white are not immune to development, rather they seem to show less potential for development based on our research. There are many combinations of

land-use and zoning that we did not address and therefore, there may be potential for development which our analysis does not cover.

We have noticed that most of the build-out potential happens in clusters rather than being scattered in smaller pockets throughout the watershed. This suggests that development brings about more development. This seems logical as people are going to want to develop where there is already existing infrastructure such as existing sewer and water hook-ups as well as easy access to I-87 and other major roadways. Development does not seem to happen as much in isolation as it does in partnership with other existing development.

We see the most build-out potential in Ballston, the southern parts of Greenfield, in the town of Saratoga and Stillwater. These are all areas that are close to the existing developed center in the watershed, Saratoga Springs. We also notice that the town of Saratoga and Stillwater border the lake, so the potential for development there has even stronger implications for the water quality of Saratoga Lake.

## Conclusion

We have determined that there is a significant amount of build-out potential in the Saratoga Lake watershed. Our estimate shows that 56% of the watershed as a whole has the potential to be built out. Much of this build-out potential exists primarily near already existing developed areas and also, near Saratoga Lake. Development that is in close proximity to the lake will have a more direct impact on water quality.

Our research can serve as baseline information for future studies. In the summer of 2007, Professor Robert Jones and Hannah Phillips, a Skidmore student, will examine the potential for development around the Hudson River. The findings of this study may have implications for

Saratoga County's proposed Hudson River drinking water plan, and may potentially serve as a comparative piece to our study. We also hope that our research will be useful in the future for anyone wishing to compare development to 2007 levels. We offer our research as a tool in understanding the complexity of the current drinking water debate.

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References Cited

Anderson, G., L. Richards, and M. K. Santore. 2006. Protecting water resources with higher density developments. Accessed 13 February 2007 at http://www.epa.gov/smartgrowth/pdf/protect_water_higher_density.pdf.

Blaney, J.P., Brooks, I.B., Gourd, R., Gray, H., Olson, A.I., and D.L. Schornack. 2004. Twelth biennial report on Great Lakes water quality. Accessed 21 February 2007 at http://www.ijc.org/php/publications/html/12br/english/report/index.html.

Bowen, J.L. and I. Valiela. 2001. The ecological effects of urbanization of coastal watersheds: historical increases in nitrogen loads and eutrophication of Qaquoit Bay estuaries. Canadian journal of fisheries and aquatic sciences. 58(8): 1498-1500.

Brant, T. and G.J. Kauffman. 2000. The role of impervious cover as a watershed-based zoning tool to protect water quality in the Christina river basin of Delaware, Pennsylvania, and Maryland. Water Management 2000 Conference. 1-11.

Brazer, E., I. Cohen, and K. Wallace. 2002. A build-out analysis: Coventry, Rhode Island. Brown University Center for Environmental Studies.

Coldewey, W.G., C. Dierkes, and P. Göbel. 2007. Storm water runoff concentration matrix for urban areas. Journal of contaminant hydrology. 91(2007): 26-42.

Crane, M., J. Su, and G. Xian. 2007. An analysis of urban development and its environmental impact on the Tampa Bay watershed. Journal of environmental management. 10: 1-12.

Cunningham, R. A. 1965. Zoning law in Michigan and New Jersey: a comparative study. Michigan law review. 63: 1171-1202.

Daviss, B. 2005. Rebuilding the city's natural defenses. New Scientist. 187(2516): 9.

Harp, T.N., Maclennan, C., Norquist, J.O., and W.C. Perdue. 2004. Smart growth for community development. Journal of law, medicine, and ethics. 32(4): 27-31.

Kinney, J. 2007. Greenfield town to vote on zoning. The Saratogian.

NYSDEC. Freshwater wetlands program. Accessed 17 April 2007 at http://www.dec.state.ny.us/website/dfwmr/habitat/fwwprog.htm.

Post, P. 2007. Wilton residents raise concerns on zoning proposals. The Saratogian.

Sinex, S.A. 2003. Urban watersheds. Environmental Science Institute. 1-14.