CAPE COD COMMISSION

Cape Wide Buildout Analysis to Support Regional Wastewater Planning

Final Report

Submitted to the MA Department of Environmental Protection

July 31, 2012

The Cape Cod Commission is developing a Regional Wastewater Management Plan (RWMP) to recommend the best combination of approaches to restore the quality of the region's coastal waters in a way that contains costs to the extent feasible. The goal of the RWMP is the development and implementation of a policy that integrates water quality restoration with affordability, appropriate infrastructure, and growth management. To inform this wastewater planning effort, the Cape Cod Commission has established a Cape-wide data set for both existing land use and water use, a consistent Cape-wide buildout that quantifies future land uses, and a density analysis of both existing development and potential for future development.

Part of this planning effort includes the creation of a wastewater planning application (Watershed MVP) that combines GIS mapping, land use, water use, buildout projections and cost to compare various scenarios on a town, watershed, or Cape-wide scale. The application has been developed internally in a desktop environment and currently allows staff members to choose areas, make assumptions about treatment technologies in those areas, and identify the land use characteristics, wastewater flows, nitrogen loads, and estimated costs for a given selection area. When complete a web version of this tool with similar functionality will serve as an informational resource to provide regional estimates for wastewater planning purposes, as well as a tool for public engagement in wastewater discussions.

The funds provided by the State of Massachusetts for this project enabled the collection of the data sets and funded the subsequent analysis that supported both the development of the Cape Cod RWMP and the Watershed MVP. Each of the data sets and analyses identified above are described in further detail below.

Data Sets

Cape-wide Land Use

The Commonwealth of Massachusetts' Office of Geographic Information Services (MassGIS) provided the Cape Cod Commission with the parcel boundaries and assessing data (ranging from 2010-2012) for 14 of the 15 Cape towns. Up to date assessing data is important for wastewater planning because it allows one to establish an existing build from which to measure potential future changes in development, helping to identify areas where wastewater treatment may be most needed in the future or areas where growth should be directed based on existing wastewater infrastructure. In addition, assessing data informs analyses that seek to minimize costs by limiting the distances between existing development from which wastewater will be collected. Wastewater collection costs comprise up to 70% of the costs of providing wastewater infrastructure. Such an analysis calculates the ratios of road lengths to parcels for discrete ¼ x ¼ mile areas for the purpose of prioritizing wastewater collection in low-ratio (high density) areas. Estimated wastewater flows may then be identified sequentially for collection, from high to low density, thereby minimizing collection costs.

The parcel data used in this project was created by MassGIS using their Standard for Digital Parcels and Related Datasets. Inconsistencies in the way in which the assessor's data is formatted and gathered initially raised concerns about the ability to create consistent Cape-wide data coverage; however, MassGIS received a grant to address this state-wide problem and are

creating standardized assessing data and parcel linework for the Commonwealth over the course of 3 years. They agreed to prioritize 14 of the 15 Cape Cod towns in order to support our efforts. In turn, the Cape Cod Commission agreed to standardize the remaining Cape Cod town (Wellfleet) in house, using the same level 3 parcel standard developed by MassGIS. The standardized data for the 14 towns was provided by MassGIS to the Cape Cod Commission as it was completed and all data was received by June 2012. This project could not have been completed within the timeframes specified without the efforts of MassGIS in delivering this data.

Even with the significant support from MassGIS, considerable effort was made to improve the dataset before the build out analysis could be run successfully. Individual towns collect assessing information differently. Although MassGIS conducted quality assurance and quality control on the data at a state wide level, inconsistences arose when analyzing the data at the County level. Major data improvements included the following:

- Although the Department of Revenue has a state class code standard that is updated periodically, many towns modify these standards to address their individual needs. For example, the Department of Revenue's list of state class codes has approximately 265 entries, some of which do not exist in Barnstable County. Commission staff documented every incarnation of state class code as collected by the assessors and the list exceeds 700. To effectively perform regional analysis Commission staff standardized the local interpretation of the state class codes into a single list.
- Building area is an important field for non-residential build out analysis as it establishes the amount of non-residential development on site. Building area is not directly relevant to residential buildout as the number of dwelling units is the primary field used. In the instances where residential building area and commercial floor area were collected in the same field, Commission staff manually separated the data into residential and non-residential fields by state class code.
- As noted above, the number of dwelling units is a field essential to buildout, however, this information is collected inconsistently across the Commonwealth. Commission staff evaluated the data to determine if it were possible to use assessors' information to calculate dwelling units in a consistent manner. In the event that there are multiple units on a parcel, multiple assessing cards can be attached to a particular parcel. Commission staff manually counted every multiple card scenario and corrected the information found in the dwelling units field.

This information was used to generate maps that showed the existing residential density (dwelling units/acre) and the existing non-residential square footage (square feet/acre) for the region (Figures 1 and 3, respectively). In each of these images, areas of residential density and development intensity are highlighted by darker colors. The images also show watersheds with Total Maximum Daily Loads (TMDL) established by the Massachusetts Estuaries Project (MEP). These images can be used to identify areas of higher density that are in shared watersheds and/or multiple jurisdictions. Figure 2 is a more detailed look at the existing residential density in a watershed with a TMDL that crosses town boundaries. Figure 4 is a detailed look at the existing non-residential square footage in the same watershed.

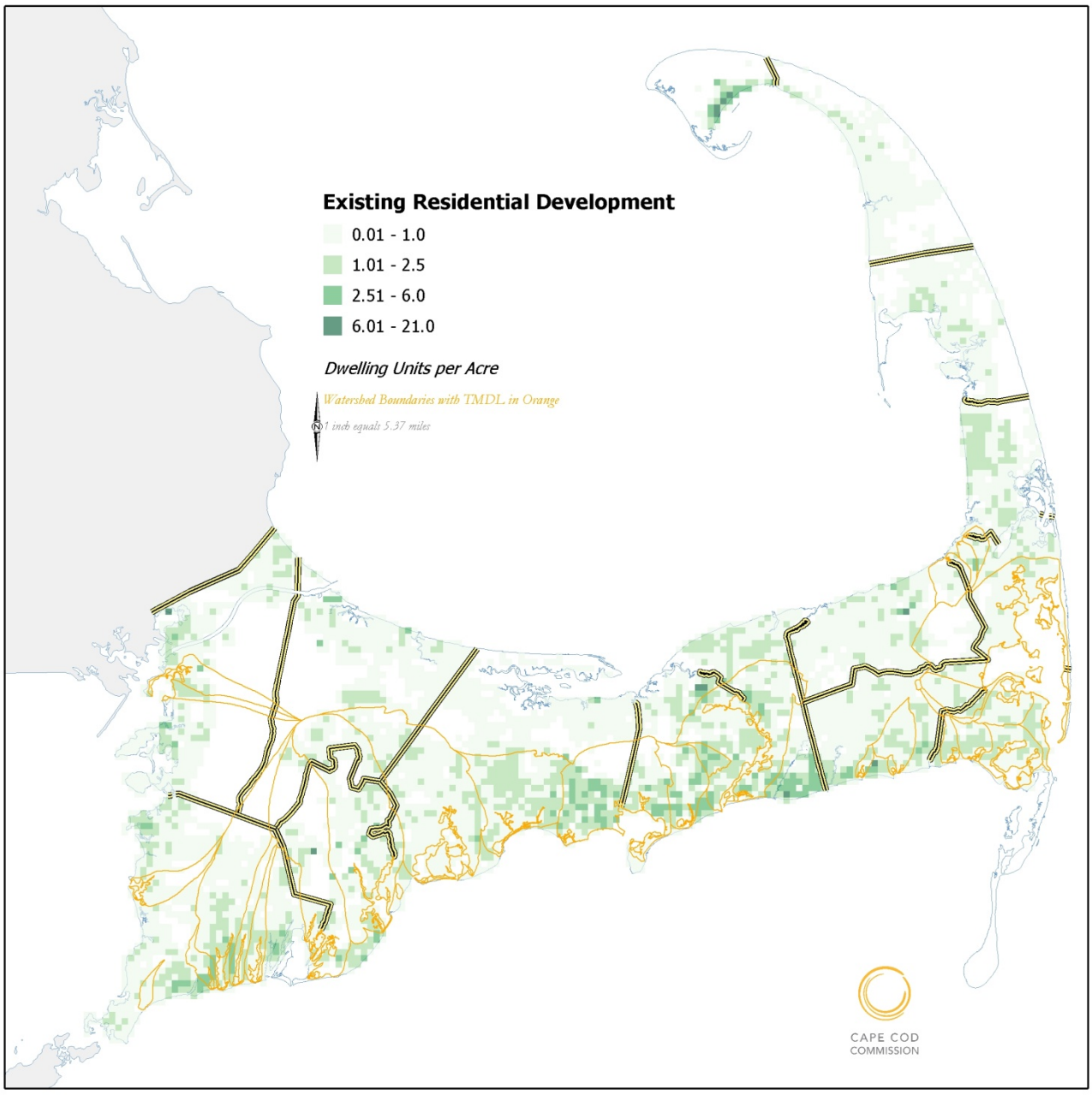

Figure 1: Existing Cape-wide residential development (dwelling units/acre).

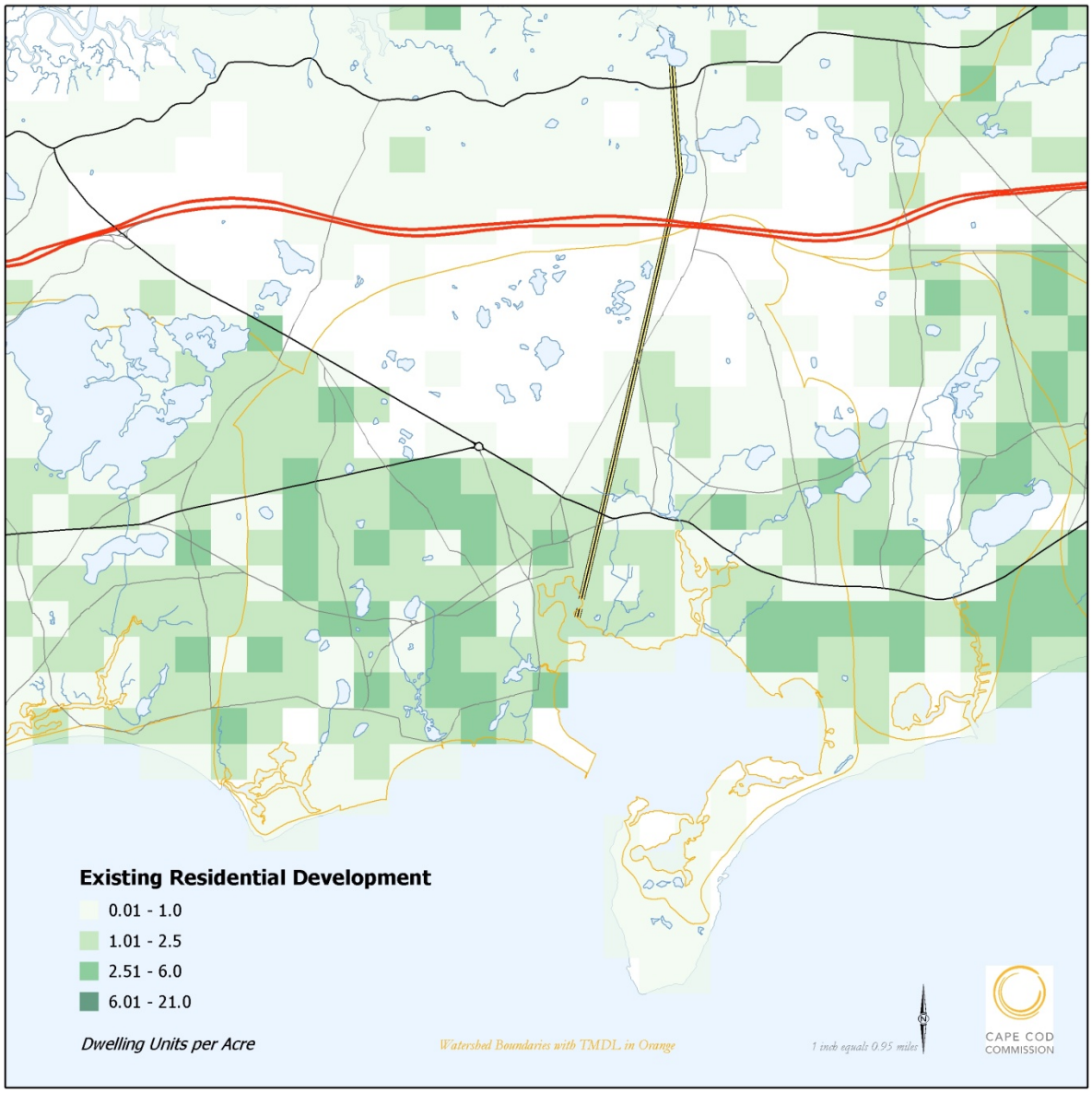

Figure 2: A closer look at existing residential development in the Lewis Bay Watershed, which has a TMDL associated with it and is shared by Barnstable and Yarmouth.

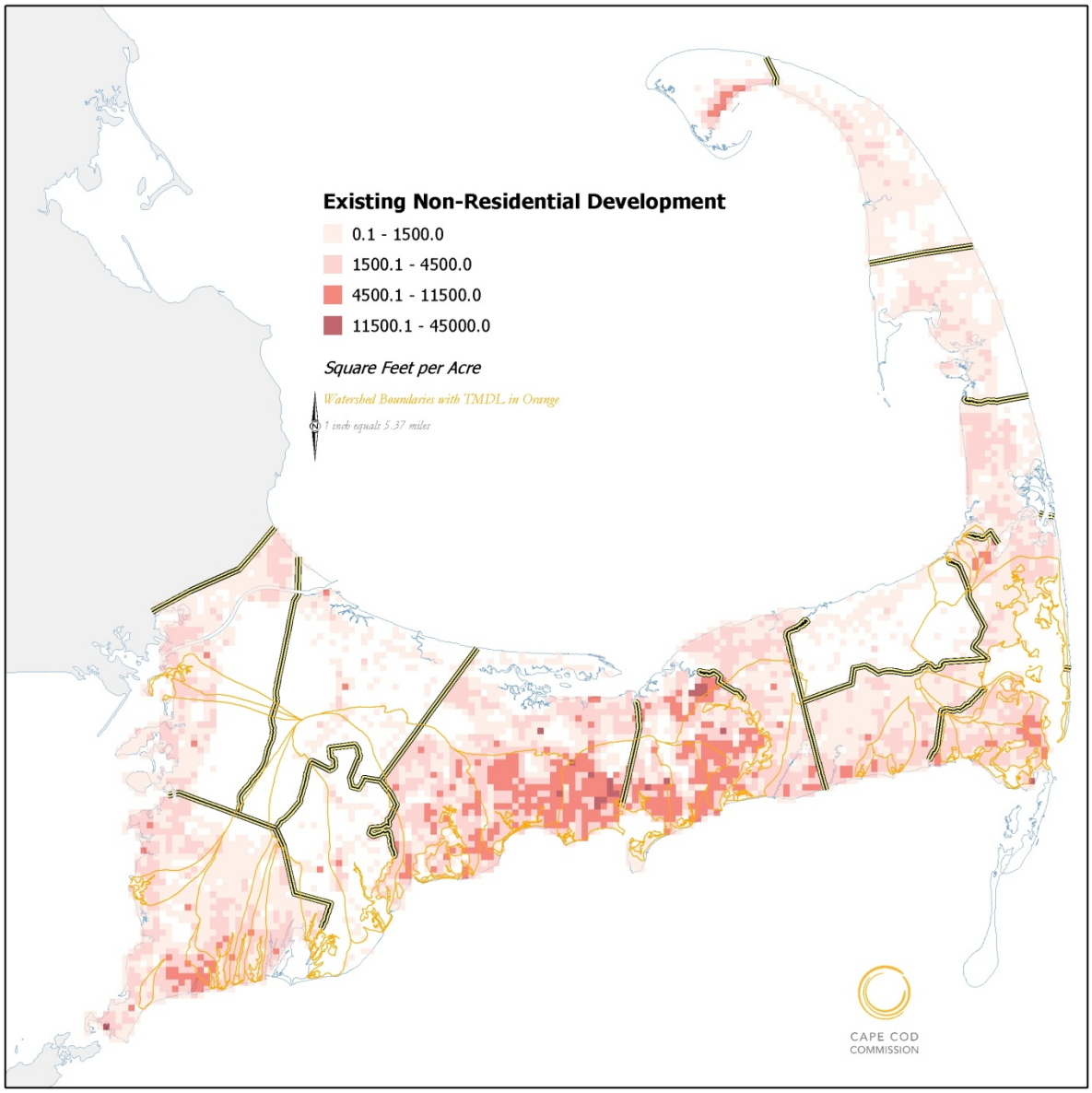

Figure 3: Existing Cape-wide non-residential development (square feet/acre).

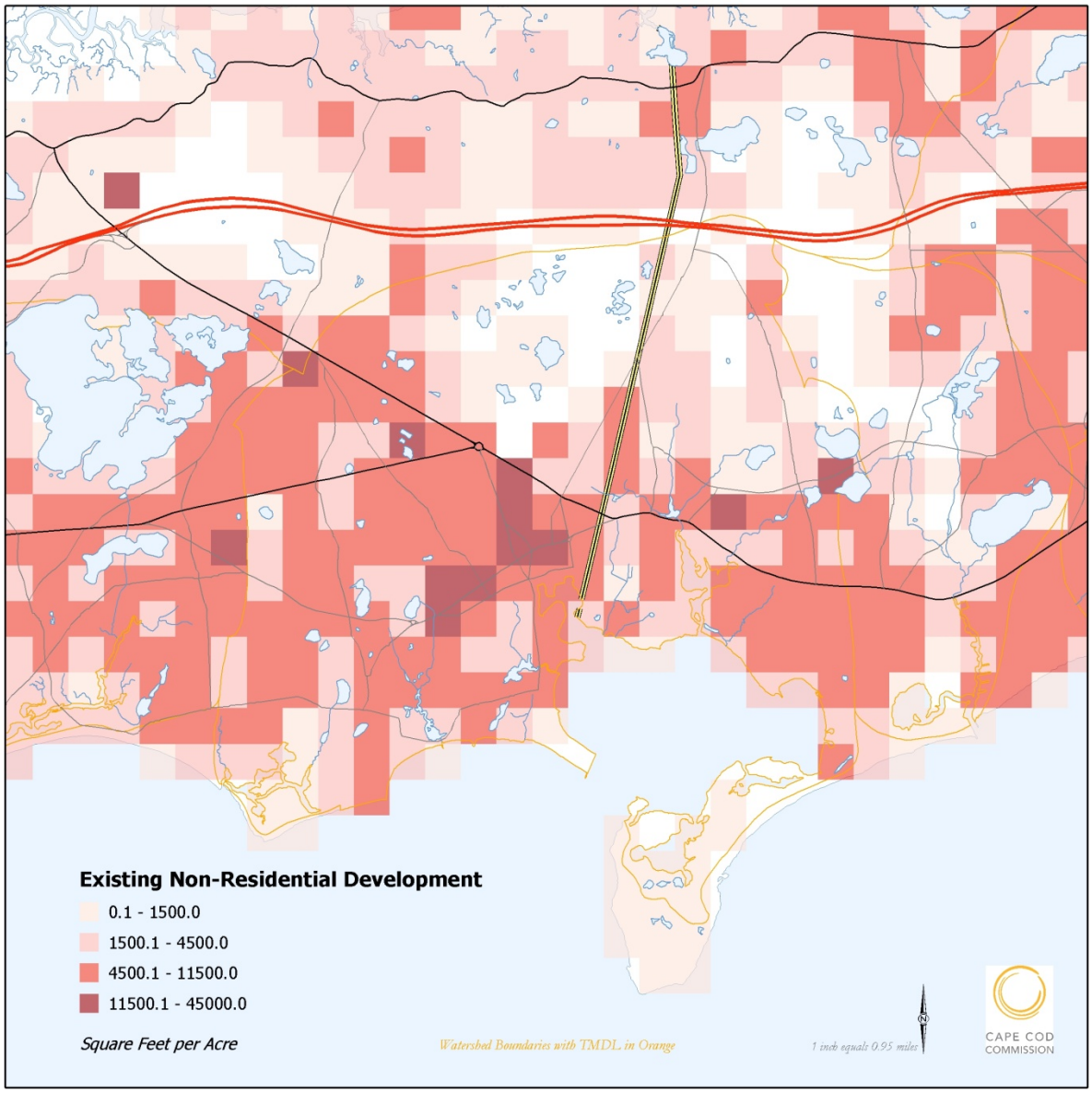

Figure 4: A closer look at existing non-residential development in the Lewis Bay Watershed, which has a TMDL associated with it and is shared by Barnstable and Yarmouth.

Cape-Wide Water Use

Water use data is important for wastewater planning because water usage, expressed in "flow" or "gallons per day (gpd)," serves as a surrogate for wastewater generation. In order to identify the existing parcel level water use data the Cape Cod Commission contacted each of the region's water purveyors with a request for their most up-to-date data. Specifically, the Commission requested a spreadsheet with the following information for the 3 most recent years of available data:

- Account Number
- Address for the account
- Type (Residential, Commercial, Municipal)
- Water Use by Year or reading event (let us know units)
- Map and Parcel Number, if available

Water use data was obtained from all of the water districts and departments, with the exception of the North Sagamore Water District and the Provincetown Water District. Table 1 identifies the Cape Cod Water Districts and the range of data received from each.

Table 1: Range of Water Use Data by District/Department

District/Department	Range of Data
Barnstable Fire District	October 2006-September 2008
West Barnstable	No Town Water
Bourne Water District	2002-2004, 2010
Brewster Water District	2011
Buzzards Bay Water District	2010
Chatham Water District	2008-2010
Cotuit Water District	2009-2011
Dennis Water District	2007-2009
Eastham	No Town Water
Falmouth Water District	2008-2010
Harwich Water District	2004-2010
Hyannis Water Division	April 2006-December 2011
Mashpee Water District	2008-2011
North Sagamore Water District	Data Not Available
Orleans Water District	2008-2011
Osterville Water District (COMM)	2009-2011
Provincetown Water District	Data Not Available
Sandwich Water District	2007-2010
Truro	No Town Water
Wellfleet Water District	2008-2010
Yarmouth Water District	2005-2011

This project task enabled the Commission to accurately characterize Cape Cod water use and number of dwelling units. Initially it was found that the number of accounts was far below the number of estimated dwelling units. As a result, the database was queried for multiple accounts on a single parcel. There are approximately 2,600 parcels that have multiple water accounts, and an average of 4 dwellings on multiple dwelling unit parcels. However this account of multi-dwelling units is not all inclusive. There are a number of land uses that have multi-dwellings that may be served by one water use account such as trailer parks and condominiums. Information from the Mass Department of Revenue was queried and evaluated resulting in a determination that there are approximately 7,700 parcels with multiple dwelling units.

The total number of parcels on Cape Cod is 133,500. 120,500 are single family residential, 7,700 are multi-family residential, 5,300 are non-residential. Approximately 85% of the parcels are served by Town water with 15 percent on private wells. The majority of the private wells are located on the Outer Cape with several large private well areas in West Barnstable and Sandwich. The water use information also helped evaluate and confirm the number of parcels with multiple dwelling units

The total amount of water used on Cape Cod was confirmed by comparing the accumulative water use from water records and comparing that to the total amount reported in the Annual statistic reports. The ASR collectively account for an annual public water supply use of 9.3 billion gallons per year. Applying average water use rates for residential and non-residential uses to parcels served by private wells accounts for 1.2 billion GPY. Combining public and private user amounts results in a Cape-Wide water use of 10.5 billion of GPY. The sources of water use information that were checked and compared results in the use of well-defined and defensible conversation factors for the use of estimating wastewater volumes.

Cape-wide Buildout

The Commission conducted a cape-wide buildout analysis, using the data described above, in order to quantify the growth potential in the region and with the aim of understanding the spatial distribution of this future growth. The steps taken in this analysis are described briefly below; however, a detailed description of the methodology followed for this task is described in Appendix A, including a description of the assumptions, formulas and data sets used in the analysis. The buildout analysis was run on all developable properties, including those that were already developed, in order for any under-developed properties to be captured in the calculations.

1. Data sets critical to conducting the buildout analysis were gathered from a variety of sources. In addition to the up-to-date parcel and assessing information described above, these include state zoning overlays, wetlands and open space layers.
2. The state zoning layer was modified to reflect any local overlay districts that affect buildout potential. For example, overlay districts that result in changes to the residential density or allowable lot coverage under the zoning regulations, i.e. certain wellhead protection districts, were modified. This modified state zoning layer is then used to assign a combined zoning/overlay designation to each parcel.
3. The Commission assigned each state zoning/overlay designation either a density for residential development, or an Effective Floor Area Ratio (Effective FAR) for non-residential development, or both in the case of a mixed use category. These formulas were derived from an extensive review of the local zoning regulations applicable to the state zoning layers.
4. A constraint layer was established that included all areas or resources that were to be excluded from the buildout analysis. This layer included all permanently

protected open space, wetlands, water bodies, rights-of-way and all the parcels with state class codes that the Commission determined should be excluded from the buildout analysis.

5. A GIS layer was created that includes information about the existing development on each property, including the existing dwellings and non-residential square footage listed in the Assessor's data.
6. The Commission used Community Viz software to run the buildout analysis. A calculation of the potential development on each parcel is made (based on the density or Effective FAR) and the net additional development is calculated by subtracting the existing development from the maximum buildout potential. The analysis results in the additional development potential being expressed as either dwelling units and/or non-residential square footage for each parcel.
7. Once the buildout is completed, the Commission links this parcel level future land use information to the parcel level water use, parcel and assessor's data.

The results of the analysis are provided below, broken down by town (Table 2), and by watershed (Table 3). Both tables show the number of additional dwellings calculated and the estimated amount of non-residential square footage calculated per category. Percentage increase are also shown for each category and totaled for the region as a whole.

Table 2: Buildout results per town

	Existing dwellings (All Land Use Codes)	Additional Dwellings (All Land Use Codes)	% change	Existing Non-residential sf. (Land Use Codes 013, 031, 300-999)	Additional non-residential sf. (Land use Codes 013, 031, 300-999)	% change
Barnstable	25,167	4,296	17	19,442,037	4,577,937	24
Bourne	9,587	2,524	26	3,977,036	4,743,325	119
Brewster	7,440	1,661	22	1,092,877	1,184,883	108
Chatham	6,729	904	13	3,203,061	857,329	27
Dennis	14,816	1,185	8	3,021,445	3,313,741	110
Eastham	5,930	565	10	709,739	1,062,236	150
Falmouth	20,940	3,774	18	7,728,402	2,955,858	38
Harwich	10,038	2,063	21	1,993,037	1,062,282	53
Mashpee	9,687	1,559	16	2,406,349	3,922,966	163
Orleans	5,049	778	15	1,924,894	1,579,296	82
Provincetown	4,306	1,325	31	1,561,678	125,475	8
Sandwich	9,258	2,492	27	1,959,446	3,122,267	159
Truro	2,941	1,697	58	457,248	533,608	117
Wellfleet	3,958	1,463	37	583,288	794,772	136
Yarmouth	16,307	1,556	10	9,863,508	2,206,716	22
Total	**152,153**	**27,842**	**18**	**59,924,044**	**32,042,693**	**53**

Table 3: Buildout results per watershed

Watershed	Existing dwellings (All Land Use codes)	Additional Dwellings (All LU)	% change	Existing Non-residential sf. (Land Use Codes 013, 031, 300-999)	Additional non-residential sf. (Land Use Codes 013, 031, 300-999)	% change
Back River/Eel Pond	777	197	25	206,180	1,203,488	584
Phinneys Harbor	744	28	4	86,605	69,527	80
West Falmouth Harbor	728	147	20	504,416	1,084,028	215
Oyster Pond	213	27	13	0	0	0
Little Pond	1,242	138	11	1,160,523	380,512	33
Great Pond	4,543	800	18	558,422	281,011	50
Green Pond	1,356	177	13	151,319	39,980	26
Bournes Pond	1,105	239	22	120,540	65,083	54
Waquoit Bay East	3,854	617	16	504,594	1,615,510	320
Popponesset Bay	7,399	1,590	21	2,081,492	2,383,796	115
Rushy Marsh Pond	8	1	13	0	0	0
Three Bay	7,002	902	13	2,043,921	441,248	22
Centerville River	7,026	425	6	1,879,125	161,167	9
Lewis Bay	10,231	2,526	25	14,322,583	3,366,068	24
Parkers River	3,409	124	4	1,217,964	301,474	25
Bass River	11,207	806	7	5,129,297	1,942,023	38
Allen Harbor	314	70	22	60,393	11,980	20
Wychmere Harbor	160	4	3	31,384	0	0
Saquatucket Harbor	1,182	196	17	237,287	28,548	12

Watershed	Existing dwellings (All Land Use codes)	Additional Dwellings (All LU)	% change	Existing Non-residential sf. (Land Use Codes 013, 031, 300-999)	Additional non-residential sf. (Land Use Codes 013, 031, 300-999)	% change
Taylors Pond/Mill Creek	690	79	11	233,541	135,115	58
Sulfur Springs/Bucks Creek	1,065	110	10	331,874	304,539	92
Stage Harbor	1,829	260	14	1,468,610	222,509	15
Muddy Creek	1,182	209	18	143,496	22,510	16
Bassing Harbor/Ryders Cove	1,155	135	12	435,823	118,244	27
Pleasant Bay	4,869	1,171	24	999,346	467,050	47
Rock Harbor	598	49	8	304,727	331,882	109
Little Namskaket Creek	407	38	9	247,514	264,917	107
Namskaket Creek	592	103	17	232,716	291,276	125
Total	**74,887**	**11,168**	**15**	**34,693,690**	**15,533,488**	**45**

The buildout analysis was also used to generate a future buildout conditions map illustrating both the future residential development (dwelling units per acre) and future non-residential development (square feet per acre) for the region. Figures 5 (residential development) and 7 (non-residential development) show this information displayed on a quarter-mile grid cell and overlaid with nitrogen sensitive watersheds. Figure 6 is a more detailed look at the future residential density in a watershed with a TMDL that crosses town boundaries. Figure 8 is a detailed look at the future non-residential square footage in the same watershed.

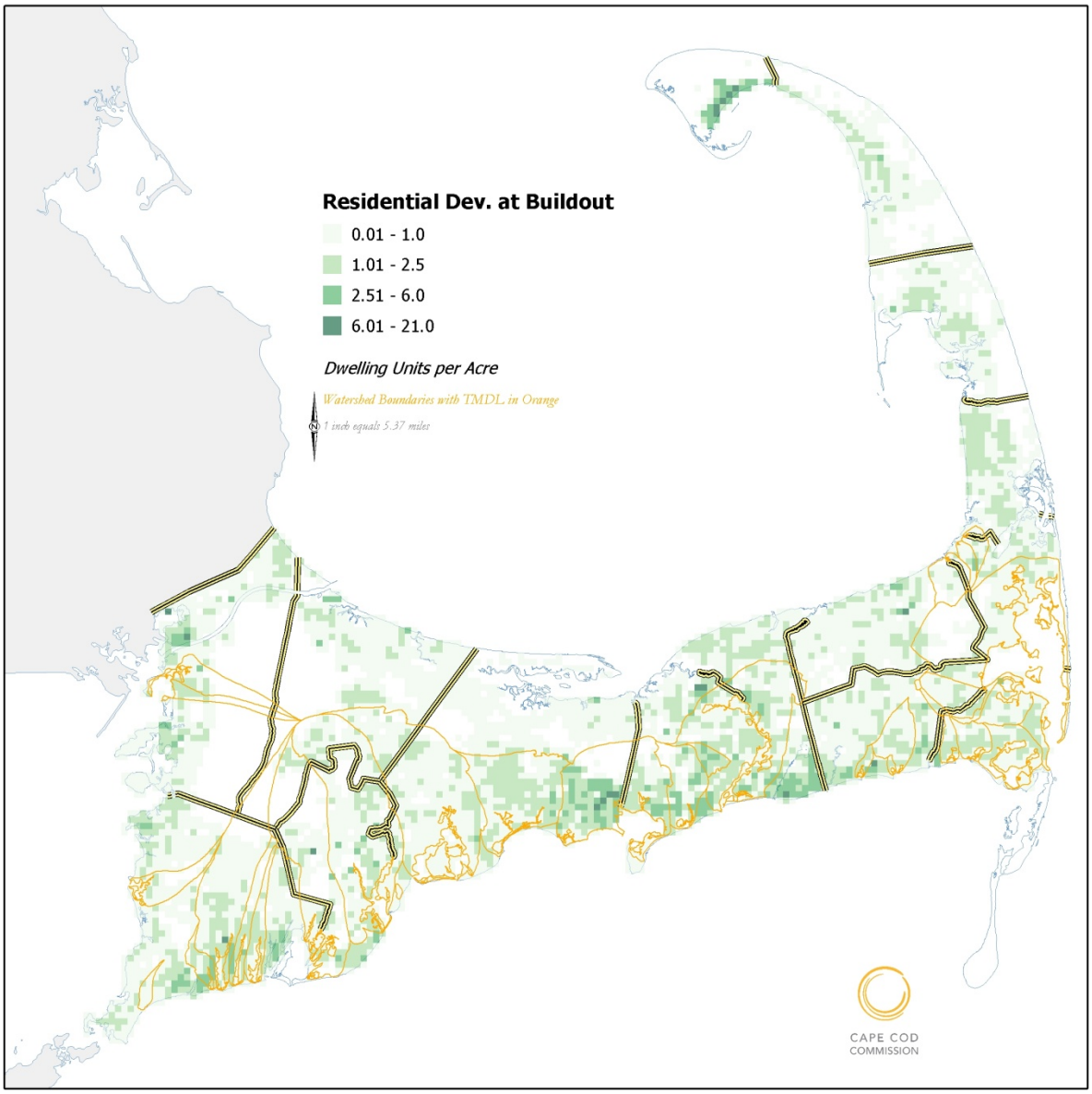

Figure 5: Cape-wide residential development at buildout (dwelling units/acre).

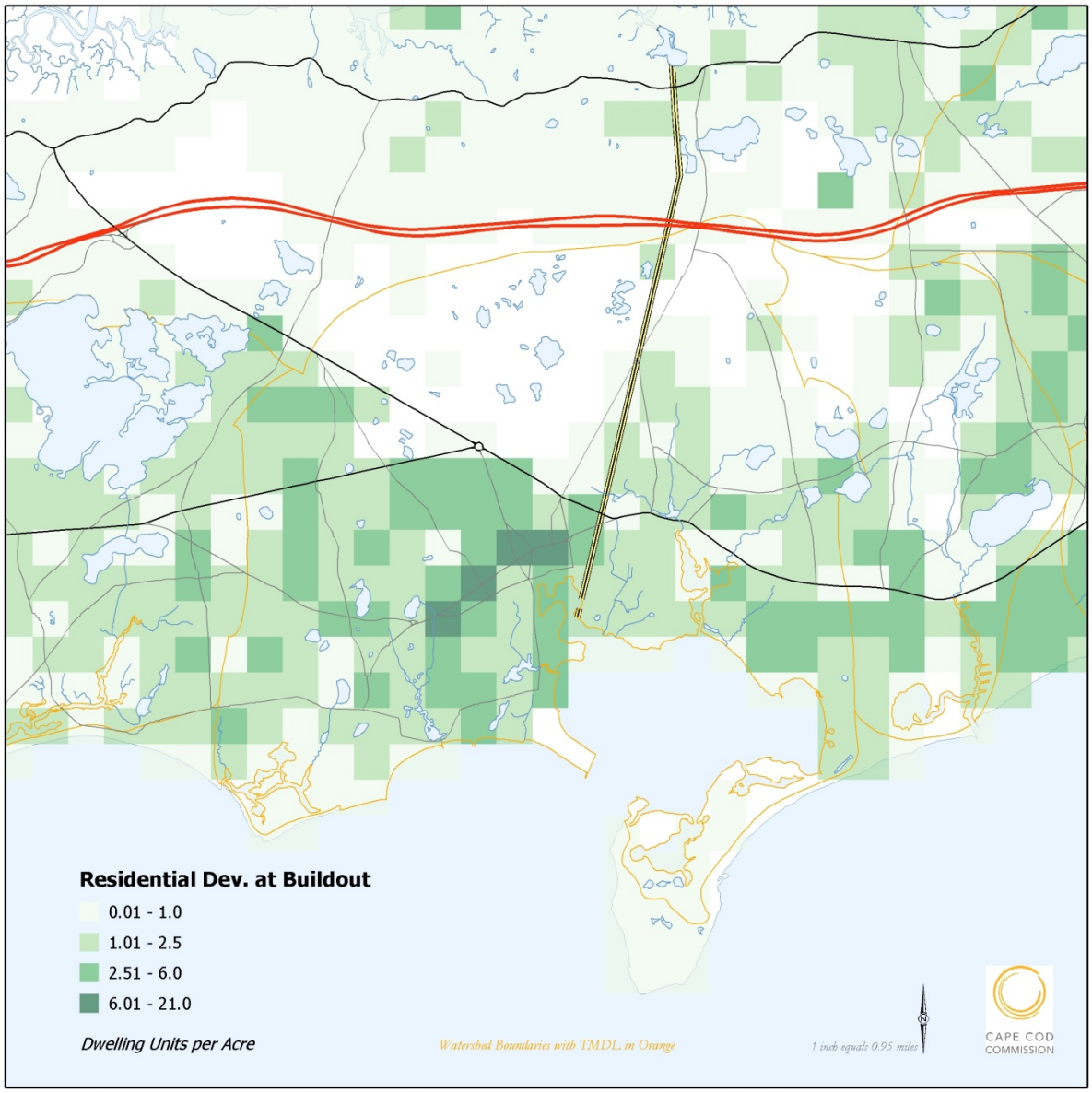

Figure 6: A closer look at residential development at buildout in the Lewis Bay Watershed, which has a TMDL associated with it and is shared by Barnstable and Yarmouth.

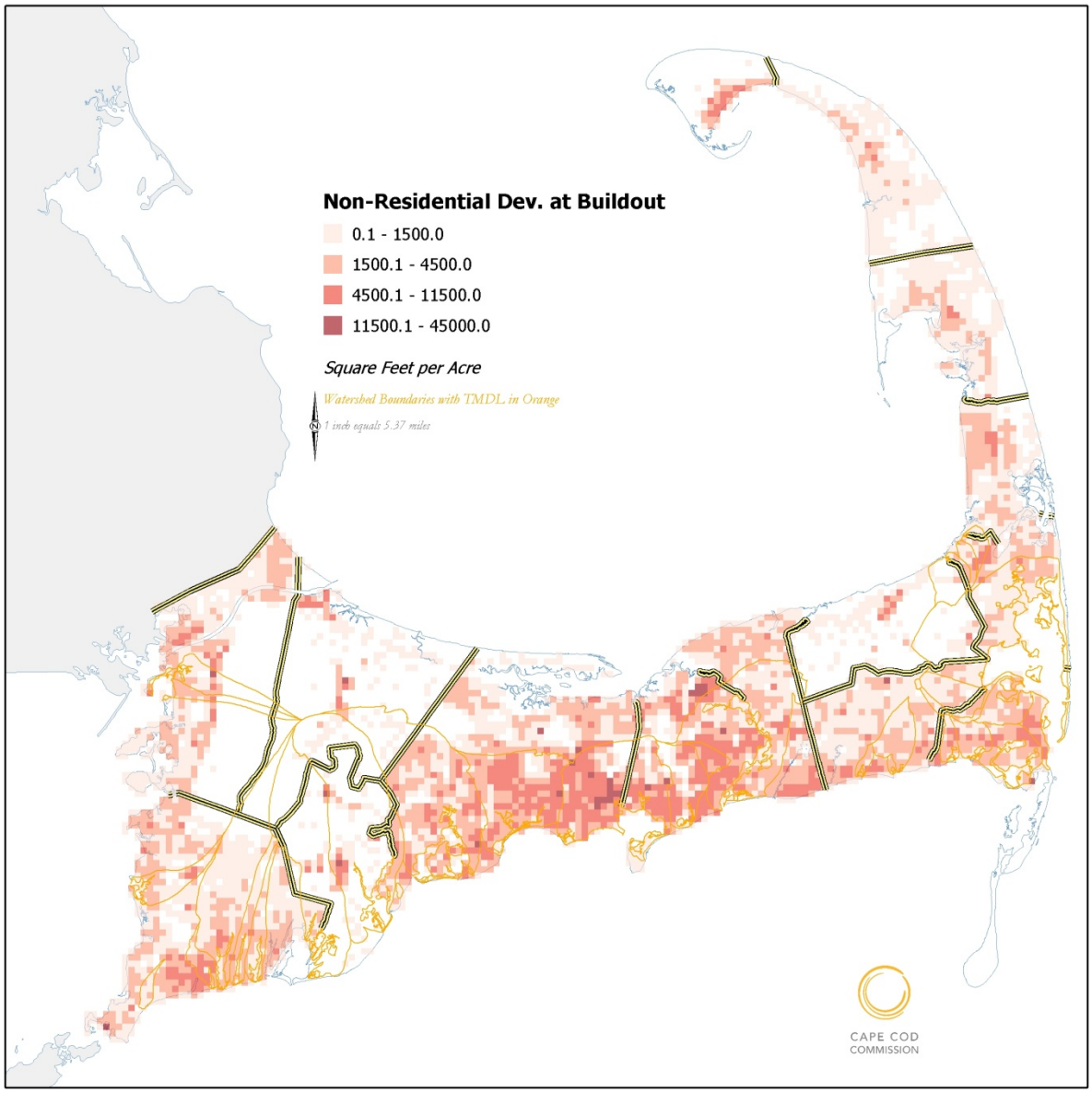

Figure 7: Cape-wide non-residential development at buildout (square feett/acre).

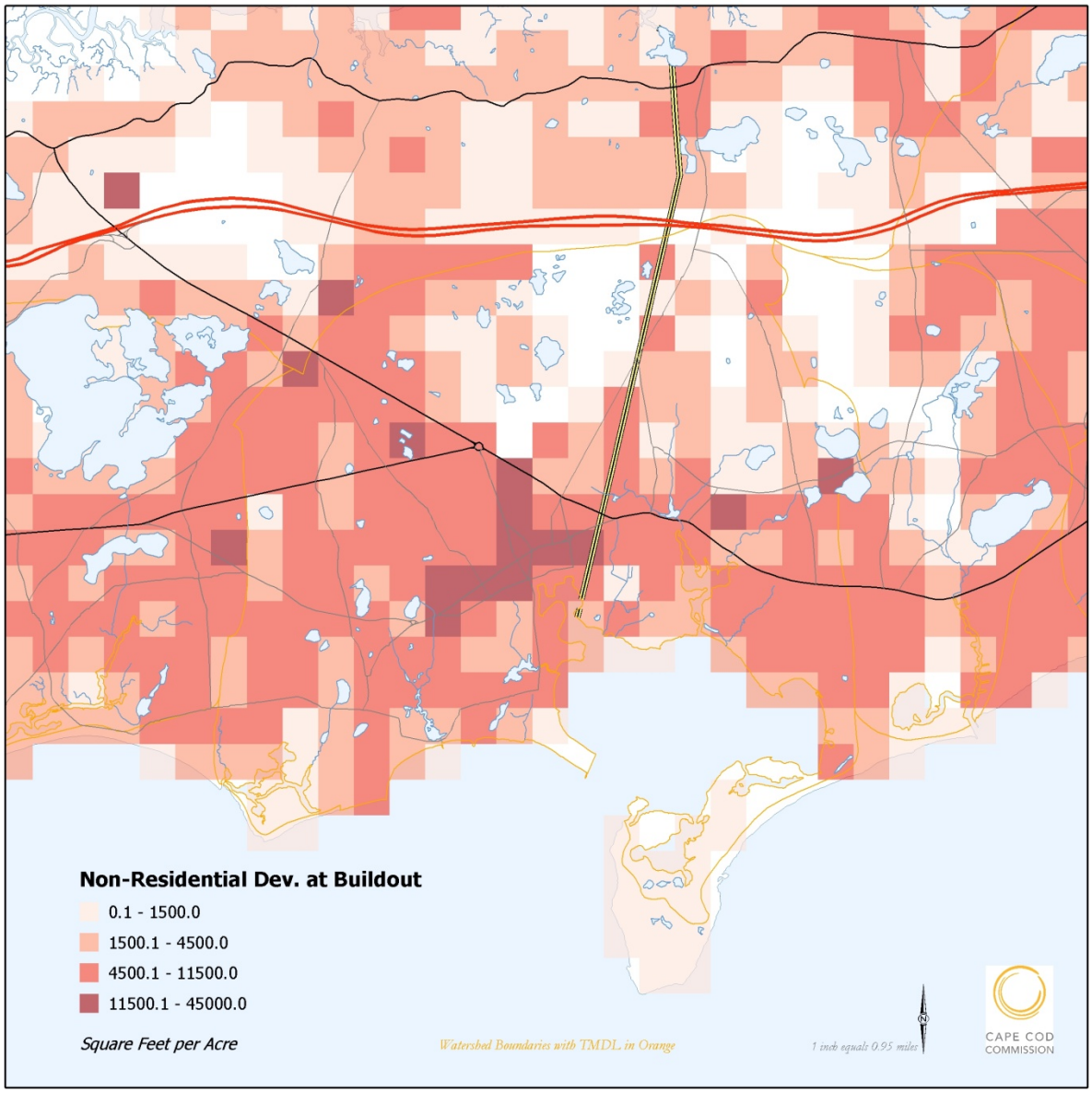

Figure 8: A closer look at non-residential development at buildout in the Lewis Bay Watershed, which has a TMDL associated with it and is shared by Barnstable and Yarmouth.

The Commission also created a map that shows just the areas of residential and non-residential buildout growth potential. An example of the additional residential growth on the Cape is shown in Figure 9.

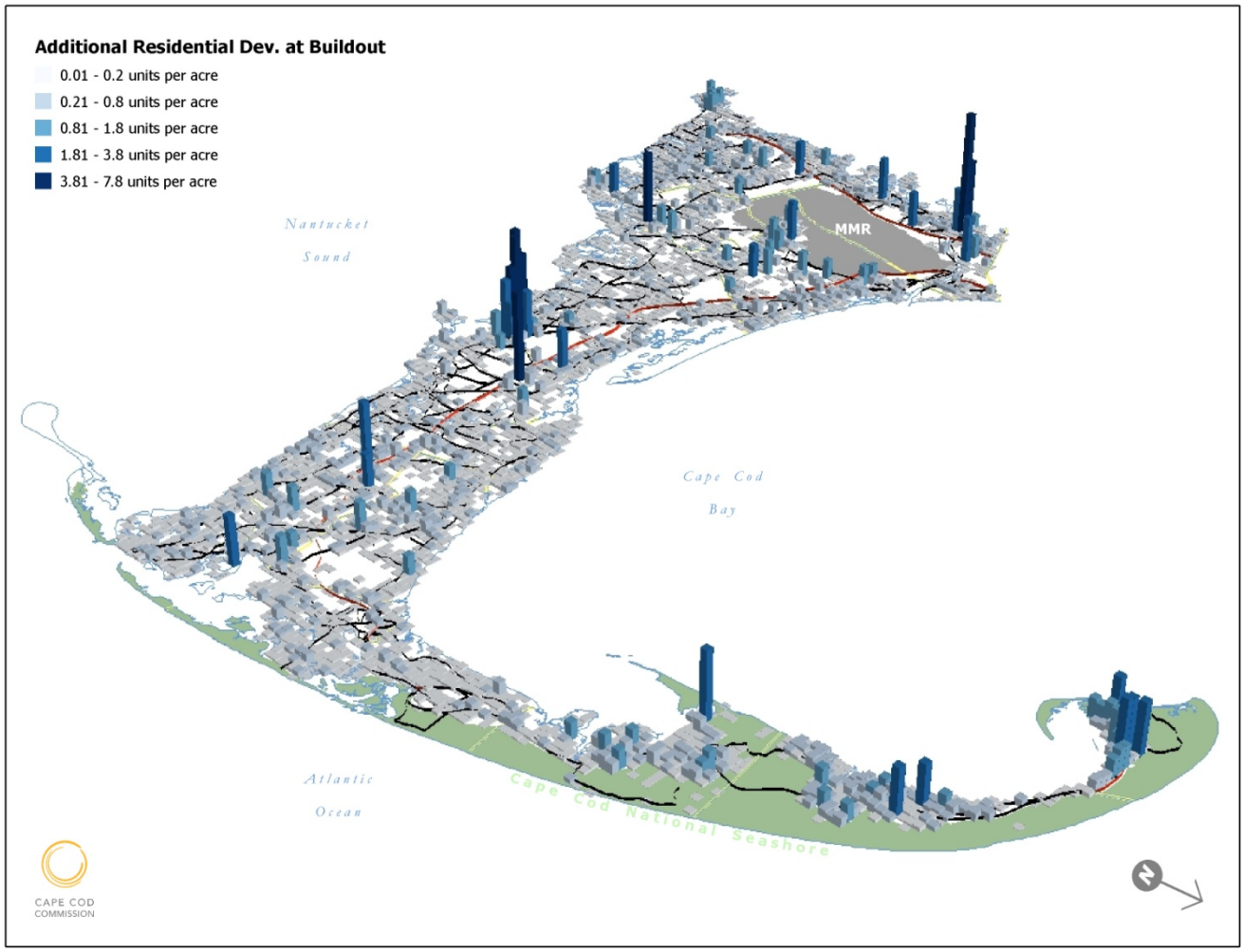

Figure 9: Additional residential development estimated with buildout highlights areas of future growth potential. Higher bars indicate larger numbers of future dwellings, corresponding with mixed use centers and private golf courses.

The buildout results and mapping provide a regional view of potential areas of growth. In many communities, large amounts of growth appear possible from the buildout calculations. However, on closer inspection of the buildout figures, many of these clusters of potential growth coincide with areas that are currently used for golf courses or are used less intensely than may be permitted under zoning regulations. Development of private golf courses is a possibility, and because of the large areas involved the potential number of units yielded may be relatively high compared to other areas of the community. However, the timeframe over which the development of these locations may occur is subject to debate, and the likelihood of all of them being developed to the maximum under zoning is small. Furthermore, the buildout analysis only uses the minimum lot size or density requirements of the zoning to estimate the additional dwelling units allowed. It does not account for additional requirements of the bylaws (particularly frontage requirements and shape requirements) that might otherwise further restrict the density allowed. In some communities, this results in higher than expected buildout numbers (particularly Provincetown, Truro and Wellfleet). Finally, in some communities certain

state class codes that were assumed to be developable areas (such as commercial parking lots and land held by charitable organizations) resulted in unusually large additional dwelling units. This is particularly true in Provincetown where the density allowed under zoning is higher than most other locations on the Cape. The Commission intends to investigate anomalies such as the ones described here and refine the assumptions and buildout layer in the future to establish a more fine-grained picture of the buildout potential in the region.

Development Scenarios

The Commission is working with a consultant to develop a Cape-wide cost model to provide wastewater infrastructure cost estimates for various development scenarios. While this model is not yet complete, the model makes assumptions related to future growth and development and these assumptions are being verified by the buildout and water use data presented above. The outputs of this model will provide estimates of the capital costs and operation and maintenance costs associated with infrastructure to deal with existing and future wastewater needs. One approach to considering these costs has been to identify three Cape-wide treatment scenarios, as follows:

- A "no regionalization" scenario, where 13 treatment plants would treat all of the wastewater that is not managed by on-site systems or cluster/satellite systems.
- A "some regionalization" scenario, where 8 plants would treat all of the wastewater that is not managed by on-site systems or cluster/satellite systems.
- A "maximum regionalization" scenario, where 4 plants would treat all of the wastewater that is not managed by on-site systems or cluster/satellite systems.

While a range of cases with various assumptions are being investigated, here we will identify what we currently are considering a base case scenario. The base case assumes:

- An aggregate of 54% septic nitrogen removal is required from watersheds that have been studied by the Massachusetts Estuary Project (MEP),
- An estimate of 50% septic nitrogen removal is required from all of those watersheds that have a pending MEP report,
- Decentralized facilities will be used to address some of the nitrogen removal, disposal will occur both in watersheds that require septic nitrogen removal, and in some Zone IIs, and
- That growth will occur uniformly across Cape Cod.

The results of a preliminary analysis of the various scenarios listed above for this base case are shown in Table 4.

Table 4: Preliminary Analysis of Treatment Options for 2 Growth Scenarios

	No Growth	30% Growth	Growth Increment
Cape-wide Wastewater Flows (MGY)	9,607	12,489	2,882
Cape-wide Developed Parcels	133,215	165,187	31,972
% to be served by WWTF	47%	51%	
Proposed Infrastructure *			
New WWTF			
No Regionalization	13	13	
Some Regionalization	8	8	
Maximum Regionalization	4	4	
Capital Costs (mid-2012 basis)			
No Regionalization	$3,687 Million	$5,217 Million	$1,530 Million
Some Regionalization	$3,414 Million	$4,890 Million	$1,476 Million
Maximum Regionalization	$3,254 Million	$4,683 Million	$1,429 Million
Savings with Regionalization	**$433 Million**	**$534 Million**	
% Savings	11.7%	10.2%	
O&M Costs (mid-2012 basis)			
No Regionalization	$43 Million	$65.9 Million	$22.9 Million
Some Regionalization	$39.7 Million	$61.3 Million	$21.6 Million
Maximum Regionalization	$35.3 Million	$55.9 Million	$20.5 Million
Savings with Regionalization	**$7.7 Million**	**$10 Million**	
% Savings	17.8%	15.2%	

*In the "no growth" scenario, the proposed infrastructure options would serve 47% of Cape Cod's developed parcels, with the remaining 53% being served by on-site title 5 systems, on-site innovative/alternative systems, or cluster and satellite systems. In the "30% growth" scenario the proposed infrastructure options would serve a total of 51% of Cape Cod's developed parcels, with the remaining 49% being served by on-site title 5 systems, on-site innovative/alternative systems, or cluster and satellite systems.

This base case shows a comparison of regional infrastructure options that range from a municipality by municipality approach, in the 13 plant scenario, to a much more regionalized approach, in the 4 plant scenario, which maximizes and expands existing infrastructure to serve current and future needs.

Once wastewater controls have been provided for existing development, 100% of the future growth in the region must be controlled as well. One can see that the "30% growth" scenario

results in a greater percentage of developed parcels that require centralized wastewater infrastructure. This increased infrastructure results in increased capital and operation and maintenance costs, as well as a decreased savings from 11.7% in a "no growth" scenario to 10.2% in a "30% growth" scenario for capital costs and from 17.8% to 15.2% for operation and maintenance costs. Table 5 shows the percentage increase in cost between the "no growth" scenario and the "30% growth" scenario for the most cost efficient approach identified in Table 3 – Maximum Regionalization.

Table 5: Percentage Increase in Capital and Operation & Maintenance Costs for 30% Growth Cape-Wide

	% Increase Capital	% Increase Operation & Maintenance
Maximum Regionalization	43.9%	58.1%

The Cape Cod Commission plans to use the range of cost estimates provided from the Cape-wide Cost Model along with the Cape-wide buildout and Watershed MVP to consider a range of development scenarios that would begin to focus future growth in more appropriate areas, such as Economic Centers, Village Centers, and Industrial Service and Trade Areas, and away from nitrogen sensitive areas, allowing for more efficient and cost effective ways to provide infrastructure to manage wastewater on Cape Cod.