Town of Groton
Conservation Commission

Open Space Economic Value Model

User Manual and Supporting Data

Version: 2.6

Date: April 2020

THE ECONOMIC BENEFITS OF PROTECTING OPEN SPACE

This support document of the Space Plan for Groton Connecticut was drafted by the Groton Town Conservation Comission, and explains the economic model utilized to quantify the many ways in which open spaces actually saves the town money and supports its economy, and provides user instructions for executing and computer based analysis model. It can be used to conduct a comparative analysis between open space proposals and open space versus development proposals. When combined with the qualitative benefits of open spaces, the information will allow Town Staff, Town Council members, Representatives to the Town Meeting and the general public to fully understand the economic, community and cultural impacts of a land use proposal from the viewpoint of the Groton Town Conservation Commission.

1.0 The Model Components

The key function for the anaylsis is to calculate the overall economic value of an open space proposal as defined by the following formula:

Open Space Economic Value = (NSV + PCV - PSC + LAV + NTR)

NSV = Natural Systems Value
PCV = Pollutant Credit Value
PSC = Public Services Cost
LAV = Leisure Activity Value
NTR = Net Tax Revenue for proposal

Calculation of each factor requires a specific methodology. These methodologies will vary by factor; from a unique study, to industry recognized values, to estimates by the commission. Each of these factors is presented below with a definition of the term, a summary of the results of studies that provide data for this factor, and how the model uses this factor.

1.1 Natural Systems Value

The NSV provides quantification of the value to the town based on open space natural benefits such as: water filtration and impact on water supply, water quality, disturbance mitigation, biological control, wildlife habitat, soil formation/retention, and pollination benefits. These can be grouped into two primary catagories: interior land and coastal ecosystems.

Interior Land Ecosystem Benefits

Many land infrastructure projects are very expensive to engineer. An engineered service like storm water management or flood control may only provide a fraction of the services provided by natural systems. Protecting forested watersheds used for drinking water sources can reduce capital, operational and maintenance costs for drinking water treatment. Researchers found that watersheds with greater percentages of protected forest correlate to fewer water treatment expenditures: for each 10% increase in watershed forest cover, there is about a 20% decrease in treatment costs. An Environmental Protection Agency (EPA) study of drinking water source protection efforts concluded that, for every $1 spent on source-water protection, an average of $27 was saved in water treatment costs. [Clean Water Optimization Program (Maryland, April 2015)]

Coastal Ecosystem Benefits

Climate change impacts to transportation, commercial property, homes, and town infrastructure can be mitigated by protection of selected coastal areas. Cost of mitigation should be considered when coastal open space proposals are under evaluation. Town costs to overcome coastal flooding vs tax revenues can only be estimated on a case by case basis. The Town can also benefit from coastal commercial fishing and clamming thru increased tax revenue and local jobs. Salt marshes are intertidal grasslands that form in low.energy, wave protected shorelines along continental margins. Extensive salt marshes (>2 km in width) establish and grow both behind barrier.island

systems and along the wave.protected shorelines of bays and estuaries. Based on recent studies the value of marsh land, which includes: Coastal protection (dissipates waves), water purification and carbon sequestration has been include in the model.

Data Sources:

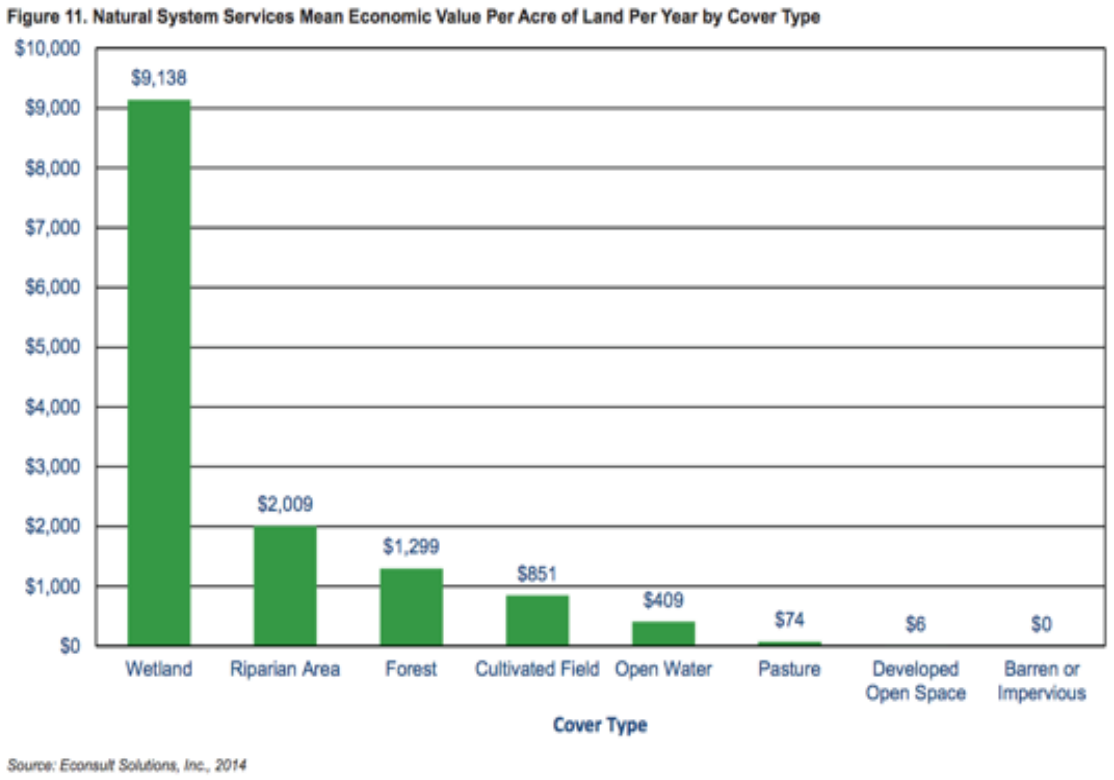
The Costanza and Econsult Solution 2014 studies were combined to provide an estimated monetary benefit to the Town of Groton.

In the model we use the following values from Costanza et al. (2006), and modified by the Econsult Solution study below:

Costanza et al. Data (2006):

Natural System Service	Number of Studies	Minimum (per acre/year)	Mean (per acre/year)	Maximum (per acre/year)
Water Supply	23	$3	$1,101	$3,839
Water Quality	3	$44	$309	$838
Disturbance (Flood) Mitigation	5	$6	$768	$3,657
Biological Control	3	$2	$9	$12
Wildlife Habitat	12	$1	$772	$3,883
Soil Formation/Retention	3	$1	$3	$6
Pollination	4	$2	$56	$265
Total	53	$59	$3,018	$12,500

Econsult Solution Study Data:



1.2 Pollutant Credit Value

This PCV factor defines the value from the pollutants removed (Appendix A). By measuring the volume of pollutant removal one can assign an economic value to the open space.

This section of the model also includes the value of carbon sequestration that is provided by forest (and all trees). Carbon sequestration value varies by age of tree, species, etc, but a straightforward value has been estimated at $4.64 per tree/year.

Data Source:

See Appendix A

1.3 Public Services Cost

The PSC factor quantifies the cost of delivering town services including schools and infrastructure maintenance to different types of land use such as open space, farm, rural, suburban, urban, industrial and commercial.

The conventional wisdom among many decision makers and taxpayers is that development is the "highest and best use" of vacant land for increasing municipal revenues. The belief is that development increases the tax base and thereby lowers each individual's property tax payments. In most situations, this conventional wisdom is erroneous. When open space is transformed into single family homes, the taxes of existing residents invariably increase because while development

generates tax revenue, the cost of providing public services and infrastructure to that development is likely to exceed the tax revenue emanating from it. This conclusion emerges from a review

(Crompton 2004) of cost of community services studies reported by more than 50 research teams in 21 states.

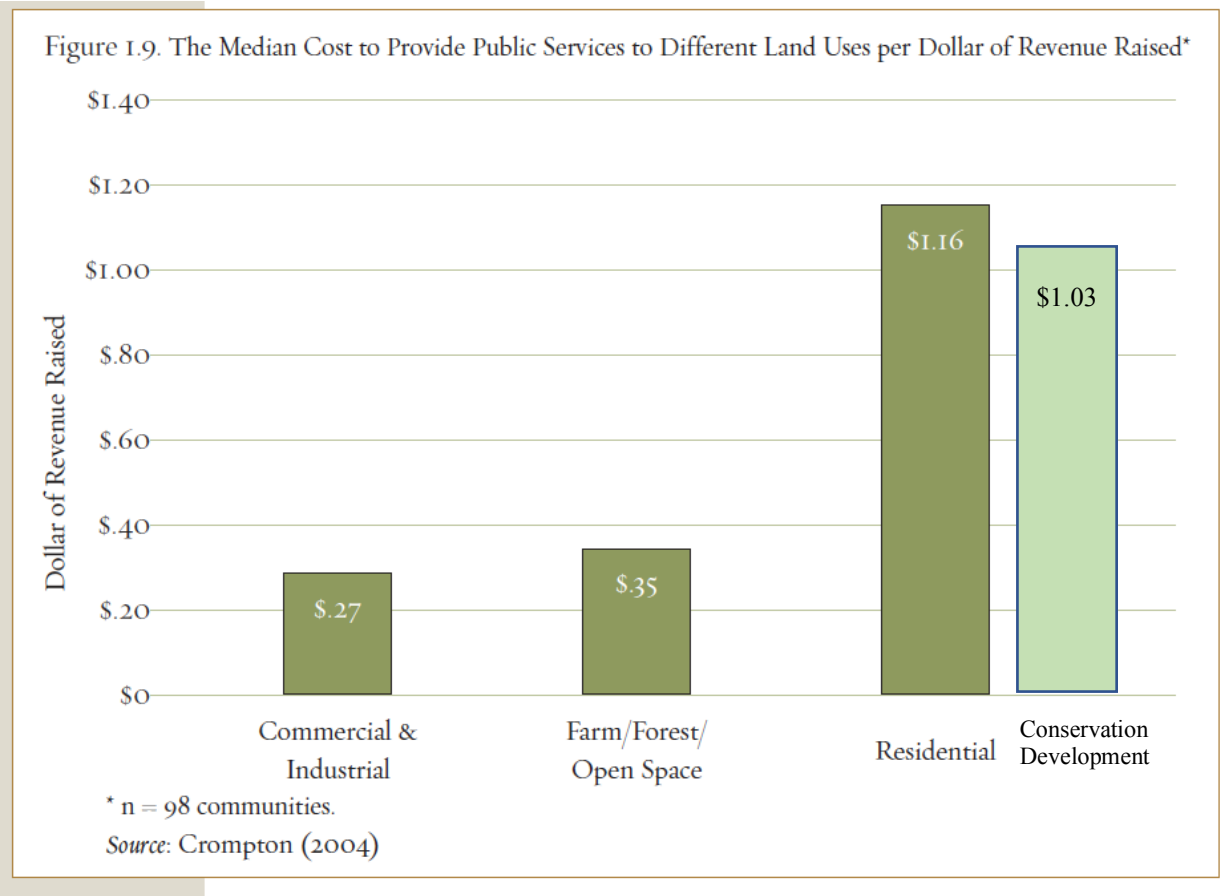


Figure 1.9 above provides a summary of the "Crompton" results, showing the median cost among almost 100 studies of per dollar of revenue raised to provide public services to each of three different land uses. Thus, for every $1 million in tax revenues these communities received from commercial/industrial uses and from farm/forest/open space uses, the median amount they had to expend was only $270,000 and $350,000, respectively, to provide them with public services. In contrast, for every $1 million received in revenues from residential developments, the median amount the communities had to expend to service them was $1,160,000. The results of these studies indicate that favoring residential development at the expense of open land does not alleviate the financial problems of communities. Indeed, it is likely to exacerbate them.

The evidence clearly indicates that preserving open space can be a less expensive alternative to development. Hence, a number of communities have elected to purchase park and open space land, rather than allow it to be used for residential development, because this potentially reduces the net tax for their residents, which would occur if new homes were built on that land.

There is an alternative option; Conservation Residential Development (section 4.1.6). Let's take the example for a conservation development….the public services costs go down by 4-8% due to density of residences. Assuming a 6% value, the Residential tax differential goes from 1.16 X to 1.09X. Additionally the appraised value is increased +6.5% (see section 1.6), then the tax differential goes to ~1.03X.

The conclusion is that a strategy of conserving parks and open space is not contrary to a community's economic health, but rather it is an integral part of it.

Data Source:

ANJEC Open Space is a Good Investment; The Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design, May 2010 Active Living Research and Crompton Study - Median Cost to Provide public services per dollar of revenue raised. Groton Budget 2018 provided the local costs to the town.

1.4 Leisure Activity Value

Leisure Activity Value includes factors for both resident and tourist use of open space land translated to either value of the activity or local sales associated with that activity

The value of leisure activity in the Groton area will be estimated based on relevant studies. The source used by the Commission will be based on the Lehigh Valley Planning commission as structured below. This includes participant value, associated goods/services and jobs supporting leisure activity as a result of open spaces and coastal areas. Activities included are:

- Fishing (freshwater)
- Hunting (all types)
- Walking (on trails, in parks and on streets)
- Running (on and off-road)
- Bicycle-based recreation (on paved roads or off-road)
- Camp-based recreation (in a tent or RV)
- Water-based recreation (kayaking, recreational/whitewater, rafting and canoeing)
- Marine based recreation (fishing, boating, clamming etc.)
- Trail-based recreation (hiking on an unpaved trail, backpacking and climbing natural rock)
- Wildlife viewing
- Birding (near home and away from home, bird feeding, watching and photography)
- Nature Study/Outdoor education

The example table below from Lehigh Valley Planning commission demonstrates the translation of participation into direct and indirect/induced economic impact. Data for the Town of Groton will be estimated based on this study.

Table 16
Outdoor Recreation Direct Economic Impacts

Outdoor Recreational Activity	Low Economic Contribution Scenario				Expected Economic Contribution Scenario			
	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)	Participation Rate (%)	Number of Participants	Annual Spending	Direct Economic Impact (millions/year)
Walking	60	388,339	$96	$37.3	60	388,339	$96	$37.3
Fishing	11	71,196	$409	$29.1	14	90,612	$409	$37.1
Hunting	5	32,362	$687	$22.2	11	71,196	$1,207	$85.9
Birding/Bird Watching	5	32,362	$211	$6.8	31	200,642	$329	$66.0
Wildlife Watching	8	51,779	$308	$15.9	35	226,531	$308	$69.8
Camping	6	38,834	$600	$23.3	6	38,834	$600	$23.3
Kayaking/Canoeing	3	19,417	$375	$7.3	14	90,612	$375	$34.0
Bicycling	16	103,557	$453	$46.9	17	110,029	$600	$66.0
Hiking/Backpacking	10	64,723	$280	$18.1	10	64,723	$458	$29.6
Running/Jogging	16	103,557	$238	$24.6	16	103,557	$900	$93.2
Nature Study	9	58,251	$150	$8.7	14	90,612	$150	$13.6
Totals				**$240.4**				**$555.8**

Source: Keystone Conservation Trust and Lehigh Valley Planning Commission, 2014

Based on the Town of Groton Grand List, there are 189 leisure based business in the area. The business have a total appraised value of $17.5M generating $290,000 in tax revenue.

Data Source:

Data was sourced from Keystone Conservation Trust and Lehigh Valley Planning Commission 2014.

1.5 Net Tax Revenue

This value factor calculates the increase in property assessments and resultant property taxes associated with proximity to an open space property based on the type of open space property. It allows comparison between Open Space, Residential Development, Conservation Development and Commercial Development.

Proximity to Open Space

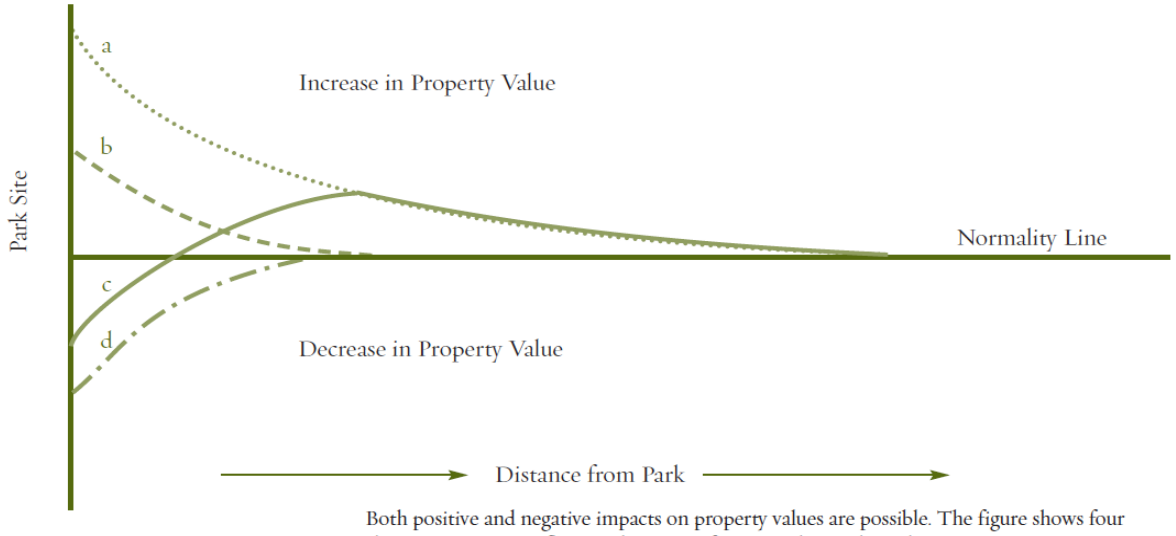
The reality is that the increases discussed below will occur over time as the actual assessed value determined by sale of homes near open space property takes several years to impact the grand list value. To account for this effect, the model provides results with NO tax increase and results with tax increase. This allows a basis for discussion on the short vs long term impact of open space on the grand list.

A summary of Hedonic studies resulted in the Appendix B. It provides estimates of increased home value based on proximity to various types of open spaces. This combined with local tax rates can provide a view of the increased tax based driven by open spaces. The model should provide variable inputs to allow a Groton tax impact to be calculated. The net is that there would be an increase in assessed value for properties that would now be adjacent to a permanently

protected open space or potential decrease in value to the conversion of an unprotected open space to a new development.

Alternative value based on Contingent Value (CV) can be combined with above to provide a range or best estimate. Appendix C provides this information. Based upon these studies each proposal will be assigned a percentage property value increase (or decrease) based on type of open space and proximity. The associated tax as a result will be part of the evaluation.

Figure 1.8. Alternate Scenarios Reflecting the Range of Impacts That Parks and Open Spaces May Exercise on Property Values



Both positive and negative impacts on property values are possible. The figure shows four alternate scenarios reflecting the range of impacts that parks and open spaces may exercise on proximate property values:

a) A large, high-quality, natural resource-based, signature park that is well maintained to which residents are passionately attached. The measurable positive impact on property value may extend out to 2,000 feet.

b) A smaller high-quality, natural-resource based, community-level park, with some charm and dignity, that is well maintained and regarded with affection by the community. The measurable positive impact on property values may extend out 500 feet.

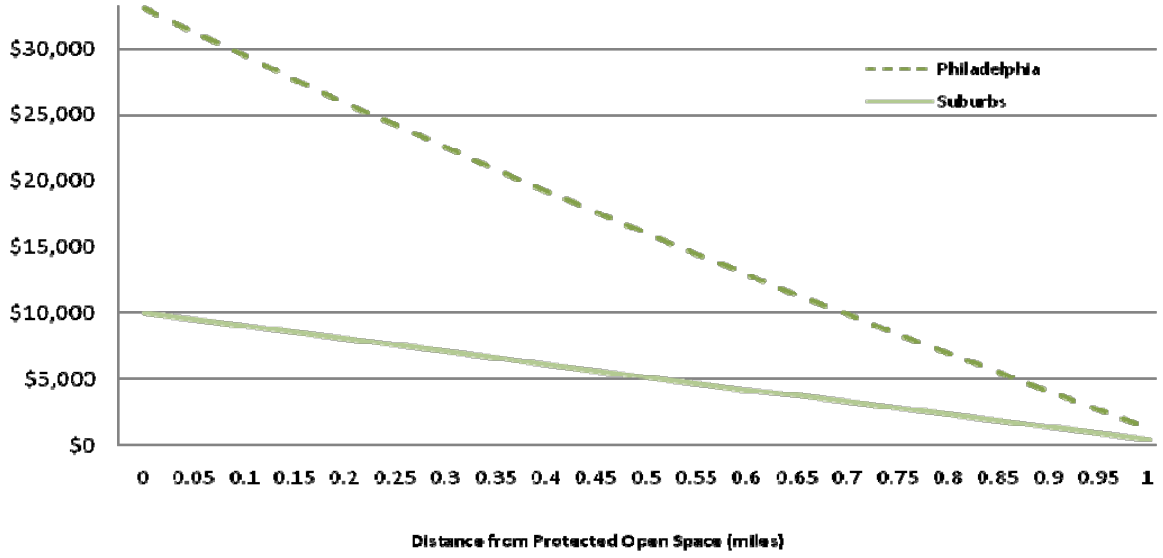
c) A large, intensively used park with athletic facilities, floodlights, noise, congestion at the entrances, and extensive traffic. These factors lead to negative values on properties in close proximity to the park, but benefits accrue to those living away from the immediate nuisance but within easy access, typically two or three blocks away.

d) A dilapidated, dirty, blighted park with decrepit facilities and broken equipment in which undesirable groups congregate. The community rejects it and regards it with disgust. The negative impact does not extend as far as the positive impact of scenario (a) because people avoid it.

In scenarios (a) and (b) property value benefit increments associated with proximity and accessibility decay as distance from the park increases. Scenarios (c) and (d) suggest that any negative values are likely to be limited to properties in close proximity to the park, and these will decay more rapidly than positive impacts as distance from the park increases—that is, the positive curve is likely to be flatter than the negative curve.

Another study in Pennsylvania is that the value that a home captures as a result of its proximity to open space varies with distance, rising to its highest level for homes immediately adjacent to open space and reducing to zero at a distance of one mile. In Figure below, these values are expressed in dollar amounts for homes in Philadelphia (dotted green line) and homes in Bucks, Chester, Delaware, and Montgomery counties (solid green line). These values were calculated using 2009 home sales values. In Philadelphia, a home directly adjacent to a parcel of protected open space that is larger than five acres is worth an average of $35,000 more than a comparable home located more than one mile from protected open space. A city home located a half-mile from the nearest protected open space enjoys an average increase in value of $15,000 compared to a similar home located more than one mile from open space.

Average Increase in Home Values Due to Proximity to Open Space



In Bucks, Chester, Delaware, and Montgomery counties, homes immediately adjacent to protected open space can claim an average of $10,000 in additional value over comparable homes farther than one mile from open space, and homes a half-mile from open space enjoy an average increase of $5,000. It is likely that homes in Philadelphia capture a higher percentage increase in value compared to
suburban homes due to lower average house prices and the relative scarcity of protected open space in the city. Because dense urban environments generally have less open space than suburban and rural environments, the value of proximity is higher in urban areas than outside of them, where open space generally exists in greater abundance.

Further analysis estimates the average increase in value for homes within a five-minute walk, or a quarter-mile, of protected open space. In Philadelphia, homes within this distance of a protected open space that is larger than five acres capture an average

additional value of 7 percent. Homes within a five-minute walk of protected open space in Bucks, Chester, Delaware, and Montgomery counties
capture an average additional value of 5.5 percent. This additional value is an increase over the value of a comparable home that is farther than one mile from protected open space.

Clearly there are a variety of factors in determining the impact of open space on adjacent and nearby property, distance, type of open space, urban vs suburban vs rural, etc. The ranges with these factors are from -.5% to +16%. The model will use type of open space closest to Groton topology and average from the studies in the references.

Natural Areas (walkable)
- Model uses 9.5%

Parks and Recreation
- Model uses 8.5%

Neighborhood Parks (normally less than 1 acre)
- Model uses -.5%

Wetlands
- Model uses +2.3%

Data Sources:

- The Economic Benefits of Land Conservation, The Trust for Public Land 2007
- Conservation Subdivision Provisions for Local Land Use Regulations; State of Minnesota
- THE ECONOMICS OF CONSERVATION SUBDIVISIONS Price Premiums, Improvement Costs, and Absorption Rates – Wayne State University 2006
- Contingent Valuation, A Comprehensive Bibliography and History, Richard Carson 2011 (1,300 studies)
- City of Philadelphia Department of Records, Trend MLS(courtesy of Prudential Fox & Roach, Econsult calculations.

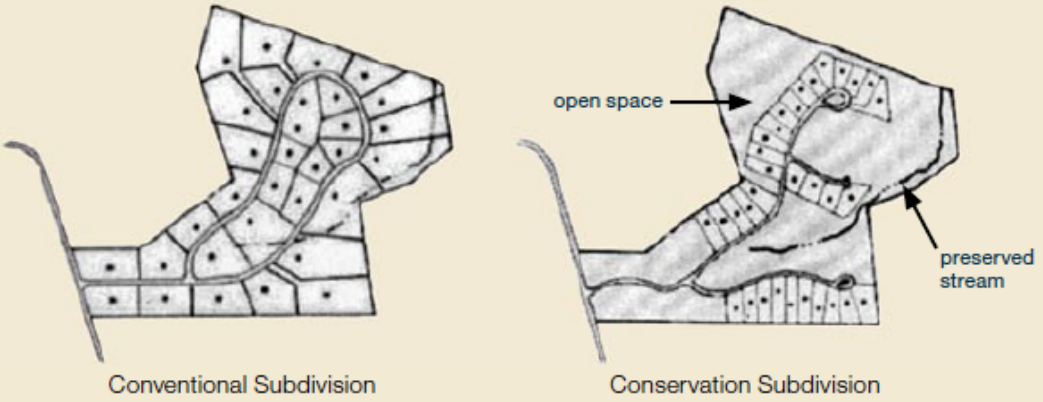
Conservation Developments (High Density):

Consumers are willing to pay a premium to locate in walkable developments featuring open space. Sites that are more walkable generally command higher property values across property type, including office, retail, apartment and industrial to the developer. Depending on the property type, a 10 percent increase in walkability increases property values by between 5 percent and 8 percent. Lots in a compact, walkable subdivision in South Kingston, R.I., sold for $122,000 to $125,000 per acre, while lots in conventional subdivisions sold for $107,000 to $109,000 per acre (14% and 14.7%). This translates into premiums ranging from $13,000 to $18,000 per acre for lots in

walkable subdivisions over lots in conventional subdivisions. For developers, these economic benefits may translate into reduced financial liability, faster sales and ultimately higher profits. A recent development in Lake Elmo, Minn., highlighted by the Urban Land Institute, demonstrated a similar principle by offering a high-density alternative in an area of large-lot development. The developer used only 40 percent of the 241-acre site for the development of 111 home sites, leaving 60 percent of the land to permanent open space composed of farmland, a tree nursery, horticultural gardens, wooded slopes, two ponds and restored native prairie. Close to 80 percent of the homes sold within six months of their offering in two phases. The model uses a 6.5% benefit for 'walkability' for a Conservation Development.

An example of generic vs conservation approach to development is below:

FIGURE 3. **Generic Conventional and Conservation Subdivisions**[77]



In another example (Conservation Subdivisions code for Minnesota) states: "long-term maintenance costs are significantly less, since infrastructure is reduced. More compact layouts also

result in shorter sewer and water connections and arterial roads. An additional benefit is that public service costs of such developments are 4 to 8 percent lower than the cost for large lot-block developments.

A 1989 study by the Florida Department of Community Affairs found that the infrastructure support cost per "compact" housing unit in downtown was $9,252, versus between $15,316 and $23,960 for more "scattered" suburban style housing units (amounts adjusted to 2019 dollars). When one does the math on those costs against the tax revenues in Sarasota County, it took 42 years to pay off its infrastructure.

Data Sources:

Conservation Subdivision Provisions for Local Land Use Regulations; State of Minnesota and THE ECONOMICS OF CONSERVATION SUBDIVISIONS Price Premiums, Improvement Costs, and Absorption Rates – Wayne State University 2006.

1.6 Open Space Weighting Criteria

The criteria weighs Open Space Economic value at approximately 35% of the weighting and the subjective values the remaining 65% as detailed in the pubished Open Space Plan.

2.0 Open Space Economic Value Calculation - Example

To best way to illustrate the Economic Model is to provide an example. The Merritt Family Forest (Property) land will be used to provide context. Background material was sourced from the Town's records.

The available EXCEL spreadsheet workbook has the model available for illustrative purposes. Each worksheet represents the components of the basic equation below:

Open Space Economic Value = (NSV + PCV - PSC + LAV + NTR)

NSV = Natural Systems Value
PCV = Pollutant Credit Value
PSC = Public Services Cost
LAV = Leisure Activity Value
NTR = Net Tax Revenue

The summary allows comparison between four options:

a. Open Space – no development on the property
b. Developed – standard residential development with proposed development f 49 units on record. Includes a $1.7M sales price to the town

c. Open Space W/O Adjacent Property Tax. Discounts the long-term impact of adjacent property value increase

d. Conservation or High-Density Subdivision Development

The model can be run for each property considered by the Commission as input to the Open Space criteria. For the Merritt example the options are:

D.2 Final Development Proposal (49 houses, 23.5 acres development of the 78 total acres)

Developed Economic Value (Merritt Property) = $67,000 / Year

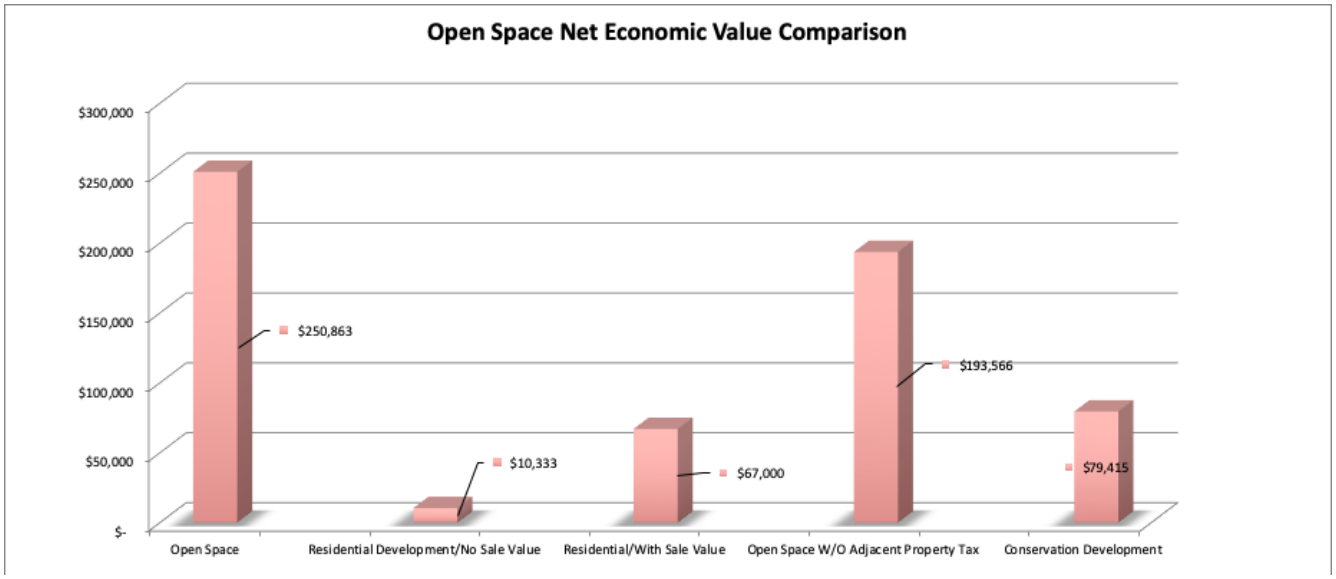
D.3 Open Space Proposal (0 houses)

Open Space Economic Value (Merritt Property) = $250,863 / Year ($193,566 with delayed open space tax benefit)

D.4 Conservation Development Proposal (projected)

If the property was developed as a conservation development, you could get 56 acres of open space to 20 acres of denser development retaining all the tax benefits plus benefit of reduction in public services cost of 16% gives an adjusted Open Space Economic Value of:
Conservation Developed Economic Value (Merritt Property) = $79,415 / Year

The results are then automatically shown in graphical format as below:



Note: The actual spreadsheet model is available on request from the Conservation Commission.

3.0 Model Workbook Details

The basic formula utilized by the model is :

Open Space Economic Value = (NSV + PCV - PSC + LAV + NTR)

The model then use individual worksheets for each component of the formula. A detailed description for each component is provided below.

3.1 NSV = Natural Systems Value

This tab utilizes the Costanza and Econsult research (specific values are in the model). The approach weights the Costanza model with the Econsult information providing an 'average' value for each type of environment. The input is the acreage for the following land types:

Beach
Estuary
Salt Water Marshes
Fresh Water Wetland
Riparian Area
Forest
Cultivated Field
Open Water
Pasture
Developed Open Space
Barren or Impervious

3.2 PCV = Pollutant Credit Value

This tab computes the nitrogen released 'value' for forest vs residential lawn (refs 17, 18, 19) and Appendix A. Again the input is number of acres of each. This is viewed as incremental to the NSV values calculated in section 3.1 above.

3.3 PSC = Public Services Cost

This tab developes the cost avoidance for public services resulting from keeping land without and services compared to residential or commercial support services being provided by the town.

This tab inputs are:

Proposed units
- Single
- High density

The data is derived from the Town budget, residential studies on the number of students per type of dwelling and studies projecting the cost savings of conservation development vs 'normal' residential development. Appendix D provides specific details.

3.4 LAV = Leisure Activity Value

This tab develops the leisure activity value based on commission estimates of the number of people utilizing the open space for a variety of uses:

Walking
Fishing
Hunting
Birding/Bird Watching
Wildlife Watching
Camping
Kayaking/Canoeing
Bicycling
Hiking/Backpacking
Running/Jogging
Nature Study

Based on the Lehigh Valley studies (4), the economic impact is converted to participate spend and taxes generated by that spend.

3.5 NTR = Net Tax Revenue (Increase/Decrease in Property Tax Revenue)

This tab develops the tax revenue input, which is the number of units/houses within walking distance of the proposed open space planned, the estimated assessed value for those units and the current town tax mill rate. An increase in assessed value for a permant open space based on extensive studies (Appendix B and C) is utilized to provide the open space 'bump' in assessed value for proximity to the open space property.

The offset to the 'value' side is the standard tax revenue under normal residential development. The number of new units, type of open space in proposal and average assessed value and current town mill rate are the inputs.

APPENDIX A – POLLUTION REMOVAL RATES

The table below represents pollution removal rates as measured by Nowak, David J., Daniel E. Crane, and Jack C. Stevens. 2006. "Air Pollution Removal by Urban Trees and Shrubs in the United States." *Urban Forestry and Urban Greening*

Pollutant Removal Rates (pounds/acre of tree canopy)			
Pollutant	Low	Expected	High
Carbon Sequestration	n/a	2676.53	n/a
Carbon Storage	n/a	81188.3	n/a
Ozone	8.17	30.83	39.83
Particulate Matter 10	12.66	32.33	50.33
Nitrogen Dioxide	7.67	7.67	20.5
Sulfur Dioxide	3.67	6.83	11.33
Carbon Monoxide	1.67	1.67	1.67

APPENDIX B – Hedonic Price Studies

Table 1. Estimated Values of Open Space Proximity from Selected Hedonic Price Studies

	Marginal value in $ (as percentage of mean house price)
Models with Dummy Variables [a]	
Lutzenhiser and Netusil (2000)	
Living within 1,500 feet of natural areas	$10,648 (16.1%)
Living within 1,500 feet of specialty parks/facilities	$5,657 (8.5%)
Living within 1,500 feet of urban parks	$1,214 (1.8%)
Thorsnes (2002)	
Backing to forest preserve	$5,800–$8,400 (19%–35% of **lot** price; 2.9%–6.8% of **house** price)
Models Using Distance	
Living 200 meters (approx. 1 city block) closer to each type of open space	
Anderson and West (2003) [b]	
Developed park	$458 - city; $0 - suburbs (0.44% - city)
Special park (state/regional park, natural area, wildlife refuge)	$600 - city; $0 - suburbs (0.58% - city)
Shultz and King (2001) [c]	
Large resource (natural) areas	$ 81
Class II wildlife habitat	$429
Undeveloped park	–$206
Regional/district park	–$ 98
Neighborhood park	–$568
Class I wildlife habitat	–$130
Doss and Taff (1996) [d]	
Forested wetland	–$ 960 (–0.91%)
Emergent-vegetation wetland	$2,720 (2.6%)
Open-water wetland	$1,980 (1.9%)
Scrub-shrub wetland	$2,900 (2.8%)

Mahan et al. (2000) [e]	
Wetland of any type	$286
	(0.23%)
Smith et al. (2002) [f]	
Public open space	–$553
	(–0.33%)
Models using % of surrounding land	
Irwin (2002)	
Conversion of 1 acre of developable pastureland to: [g]	
Conservation land	$3,307
	(1.87%)
Public (nonmilitary) land	$994
	(0.57%)
Forestland	–$1,424
	(–0.82%)
Low-density residential land	–$1,530
	(–0.89%)
Acharya and Bennett (2001)	
1% increase in open space surrounding house:	
In 1,600-m (1-mile) buffer	$75
	(0.06%)
Geoghegan et al. (2003) [h]	
1% increase in open space surrounding house:	
Private ag/forestland in easement status and public parks in 1,600-m buffer	$0 to $1,306 (0% to 0.71%)
Private ag/forestland in easement status and public parks in 100-m buffer	$0 to $1,106 (0% to 0.05%)
Private ag/forestland (developable) in 1,600-m buffer	–$599 to (–$312) (–0.39% to –0.21%)
Private ag/forestland (developable) in 100-m buffer	–$768 to $0 (–0.05% to 0%)

[a] The reported results for Lutzenhiser and Netusil are from the version of their model that has dummy variables for each open space type and acreage and acreage squared for each type; values in the table are for mean acreage and are 1990 dollars. Ranges for Thorsnes are for the three subdivisions in the study; lots were sold over a range of years and it is unclear from the study whether the house prices were deflated to same year. Values as a percentage of house price for the Thorsnes study are obtained by dividing estimated values from the building lot regression by mean house prices for the three subdivisions (the hedonic price study of house sales was not used here).

[b] Anderson and West include open space acreage and distance interacted with each

other for each type of open space. The reported values for distance are evaluated at mean acreage; at mean distance, the estimated values for acreage were insignificant and are not reported here.

[c] Shultz and King do not report mean house prices; thus, we are unable to report the values in percentage terms.

[d] Doss and Taff have a quadratic model in distance; values are calculated at mean distance for each type of wetland. Mahan et al. values are calculated at a distance of 1 mile and at mean house price. These authors also estimate the marginal value of increasing the nearest wetland size by 1 acre to be approximately $24 (evaluated at the mean house price).

[e] The mean house price for the 1995–98 years is used to calculate marginal value in terms of percentage of mean house price for the Smith et al. study.

[f] Irwin uses percentage of surrounding land in various categories as independent variables in the model (with the percentages summing to 100) and uses her results to calculate the dollar values we present here in the table—the dollar value of converting 1 acre of developable pastureland to each of the other categories.

[g] Values for both Irwin and Geoghegan et al. are evaluated at mean house prices. In Geoghegan et al., three counties are estimated with separate models, and thus a range of results is reported. Although both their focus and their methodology are similar, Geoghegan et al.'s results cannot be directly compared with Irwin. Dollar values in this table for the Irwin study are for conversion of an acre of land from developable farmland to the other categories listed (see previous footnote), whereas Geoghegan et al. dollar values are for a 1 percent increase in each category of open space, all else equal.

APPENDIX C – Contingent Value Studies

Table 2. Estimated Values for Open Space Services from Stated Preference Studies

Type of open space and study	Average WTP (2000 dollars)	Measure of value aggregated over households (2000 dollars)
Urban		
Undeveloped land parcel of 5.5 acres *Morey et al. 1998 (CV)* (1995$)	$264/household (one-time payment)	$1.5 million, total households within a 1- mile radius
Farmland		
Preserve farmland from development in South Carolina *Bergstrom et al. 1985 (CV)* (1982$)	$9–$16/household/year[a]	$23–$61/acre
Preserve farmland from development in Alaska *Beasley et al. 1998 (CV)* (1984$)	$126-239/household/yr[b]	$830/acre
Preserve land from development in Eastern Canada *Bowker and Didychuk 1994 (CV)* (1991$)	$62–$109/household/year[a]	$123/acre 6%–16% of value of farmland
Preserve western ranchland from development in Colorado *Rosenberger and Walsh 1997 (CV)* (1993$)	$86–$144/household/year[a]	
Preserve farmland from development in Suffolk County, New York *Johnston et al. 2001 (contingent choice)*[c] (1995$)	$40–$162/household/acre/year[a]	$1,355/acre/year
Wetlands		
Value of improvements in ecological and water quality benefits (nonrecreation benefits) *Lant and Roberts 1990 (CV)* (1987$)	$56–$71/year for improvements in wetlands	Recreational and ecological values said to be as high as market value of cropland.

Value of storm water retention *Stevens et al. 1995 (CV)* (1993$)	$92/acre/year	
Meta-analysis of value of wetlands *Woodward and Wui (2001)* (1990$)		$1,205/acre average across all studies $1,597/acre for bird watching
Value of adjacency to water-based services *Earnhart 2001a (contingent choice and revealed preference)* (1996$)	$15,400/house (5.8% of house value in 1996)	
Value of adjacency to land-based services *Earnhart 2001a* (1996$)	$18,700/house (7.2% of house value in 1996)	
Value of adjacency to restored marsh (compared with degraded marsh) *Earnhart 2001a* (1996$)	$7,340 per house 2.7% of median house price in 1996	

[a] per thousand acres for increments of 25% additional land preserved.

[b] per thousand acres for an increment of 50% additional land preserved.

[c] These results tended to be sensitive to estimated model specification.

APPENDIX D – Demographics and Supporting Cost of Public Services

Groton Town demography as of 2018:

Number of Households: (Source: recent tax information) = 18,000

Number of students currently in public schools: (Source: School Board) = 4,519

Number of student's school system can accommodate before new facilities are needed: (Source: Education Dept. based on 20/20 plan.) = 400

Schools

Based on work of David Nissen (Rutgers University) in 1988 updated in 2002 based on ANJEC's Resource Center analysis for Cranbury, NJ the following approach can be used for Groton, resulting in the following:

Number of students generated by each proposed housing unit we can absorb:

- Single family: 1600 homes (at .25 school children per home)
- Townhouse: 3200 units (at .12 school children per home)

Based on the 2016 POCD full build out of the town could have 4,530 single units and 468 multiple units. Given the majority of land is raw or agricultural the infrastructure costs and school build out required would not be covered by the property taxes recovered over the 1,600 single family units.

Note: Groton has a 1% of student enrollment declining each year which includes graduating offset by home turnover and new students entering the town

Total Cost per student: (Source: School budget. Add capital budget and operating budget; divide by the number of students in the system.) is: $17,200 + 531 (debt service) = $17,731

New facility cost: (Once the incremental 400 new student threshold is exceeded, this figure comes into play). Capital outlay is roughly estimated: State requires 125 (elementary) and 150 (secondary) square feet of school space per student; approximate cost per square foot = $160; capital cost per student (150 X $160) = $24,000; capital charge factor based on a 20 year mortgage at 5 percent bonding cost (note - if inflation occurs, this charge factor will rise). This produces an additional annual cost per student of $1,900. Since new facilities are built with room to spare, and add-ons such as fields, parking, meeting rooms and additional amenities are often included in new school construction, a larger figure is more likely.)

Other Public Services (Police, Fire, Public Works, etc.)

Average cost of municipal services per household is: $3,219（Source: Municipal 2019-202 Budget). This is developed by subtracting the non-education cost from total outlay and then dividing by the total number of households. This number may be modified to reflect discussions with fire and police regarding at what point new facilities or equipment might be needed. Recognize that not all portions of the municipal budget vary directly with population increase or decrease.) Note that the property tax covers 74% of the total budget cost, the remainder is funded thru state/federal and other grant sources. It is an assumption this percent will remain the same in the future.

REFERENCES / DATA SOURCES

1) Groton Plan of Conservation and Development 2016
2) A Conservation Plan for Groton Connecticut 1990
3) The Business of Open Space: What's Next?? By Stephen J. Small 2013
4) Lehigh Valley Return on Environment; Lehigh Valley Planning Commission 2014
5) Clean Water Optimization Tool, Center for Watershed protection, Jan 2015
6) The Value of Open Space: Evidence from Studies of Nonmarket Benefits, Virginia McConnell and Margaret Wells, 2005
7) Open Space is a Good Investment, ANJEC
8) The Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design, May 2010 Active Living Research
9) The Economic Benefits of Land Conservation, The Trust for Public Land 2007
10) Conjoint Analysis of Groundwater Protection Programs; Thomas H. Stevens, Christopher Barrett, and Cleve E. Willis 1997
11) Adopted FYE 2018 Budget, June 6, 2017, Fiscal Year Ended June 30, 2018
12) Groton Public Schools, Board of Education February 22, 2017, 2017-2018 Budget
13) Preparing for Climate Change in Groton, CT: A model process for communities in the Northeast., April 2011, Stults and Pagach
14) Conservation Subdivision Provisions for Local Land Use Regulations; State of Minnesota
15) THE ECONOMICS OF CONSERVATION SUBDIVISIONS Price Premiums, Improvement Costs, and Absorption Rates – Wayne State University 2006
16) Air Pollution Removal by urban trees, David J Nowak et al 2006
17) The Economic Value of Protected Open Space In Southeastern Pennsylvania 2011
18) Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United State, James E. Smith Linda S. Heath Kenneth E. Skog Richard A. Birdsey 2005
19) Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013, Revised July 2015)
20) The Value of New Jersey's Ecosystem Services and Natural Capital . New Jersey Department of Environmental Protection. Costanza, Robert, Matthew Wilson, Austin Troy, Alexey Voinov, Shuang Liu, and John D'Agostino. 2006.
21) The Economic Value of Protected Open Space in Southeastern PA, Econsult Corp 2011
22) National Infrastructure Maintenance Strategy Budgeting Guideline cidb
23) Connecticut Coastal and Estuarine Land Conservation Program Plan, Connecticut Department of energy and Environmental Protection; October 2015
24) The value of estuarine and coastal ecosystem services; Edward B. Barbier , Sally D. Hacker … 01 May 2011
25) Valuing Ecosystem Services for Coastal Wetland Protection and Restoration: Progress and Challenges Edward B. Barbier 2013
26) The Economic Value of Protected Open Space in Southeastern PA, Econsult Corp 2011
27) National Infrastructure Maintenance Strategy Budgeting Guideline cidb
28) Connecticut Coastal and Estuarine Land Conservation Program Plan, Connecticut Department of energy and Environmental Protection; October 2015

29) The value of estuarine and coastal ecosystem services; Edward B. Barbier, Sally D. Hacker … 01 May 2011
30) Valuing Ecosystem Services for Coastal Wetland Protection and Restoration: Progress and Challenges Edward B. Barbier 2013
31) Nowak, David J., Daniel E. Crane, and Jack C. Stevens. 2006. "Air Pollution Removal by Urban Trees and Shrubs in the United States." Urban Forestry and Urban Greening