Water Resources Element

APPENDIX D

INTRODUCTION

This report is an Appendix to **PlanQAC**, the County's 2021 Comprehensive Plan. It provides an assessment of impacts of existing and projected growth on the County's water resource limitations, challenges, and solutions summarized in **Chapter 5—Environmental Resources** and **Chapter 4—Land Use**. This report addresses the requirements for the Water Resource Element (WRE). The WRE analysis considers:

- Land use planning in a geographical context of watersheds.
- Estimated nutrient discharges for total nitrogen and phosphorus.
- Total Maximum Daily Loadings (TMDLs) for total phosphorus and total nitrogen by eight-digit watersheds.
- Drinking Water supply to support current and future populations.
- Drinking Water treatment plant capacity.
- Wastewater capacity to support current and future populations.
- Wastewater treatment plant capacity.
- Stormwater impacts on water resources with respect to total nitrogen and phosphorous.
- Best Management Practices Toolkit.
- Conclusions and recommendations.

This WRE assessment provides a complete assessment of projected growth and public facility availability. In addition, the Towns of Centreville, Queenstown, and Church Hill have prepared assessments with respect to water resources within their jurisdictions as part of their Comprehensive Plans. This WRE analysis incorporates those assessments. This Appendix may be incorporated by reference into each Town Comprehensive Plan.

PURPOSE

The purpose of the WRE is to ensure that the future development considered in the County's Comprehensive Plan and Town Comprehensive Plans reflect the opportunities and limitations presented by local and regional water resources. Local and regional water supply sources are predominantly the Aquia, Matawan, Magothy, and Upper and Lower Patapsco aquifers, and local and regional receiving waters for stormwater are within the Chester River watershed, Choptank River watershed, and the Eastern Bay watershed. The WRE also identifies suitable strategies to reduce nutrients to these local and regional receiving waters. Planning and assessment for the WRE is done at the eight-digit watershed level.

This assessment provides the basis for future collaboration with others in the region on a watershed basis. HB 1141, passed in 2006, encourages counties and local municipalities to consider water availability and source water protection issues when determining land use and zoning, and to involve state agencies early in the development process, in order to avoid situations where development may be impacted due to water-related issues.

REGIONAL & COUNTY/TOWN WATER RESOURCE ISSUES

During this planning cycle, the community finds itself nearing the limits of adequate public facilities including transportation infrastructure on its state and local roads, the Chesapeake Bay Bridge, local school capacity and sewerage capacity permit restrictions at the County's KNSG Wastewater Treatment Plant. In addition to these infrastructure challenges, the County must contemplate sustainable and resilient land use policies in the face of necessary hazard planning.

Many of the County's waterbodies are impaired. Impairments can be the result of one or more pollutant levels that exceed established thresholds for the waterbody. Impairments can be result of local conditions and/or regional conditions that may share the water resource. Adequate steps must be taken at the regional and County/Town level to ensure that pollutant loadings are minimized. Total Maximum Daily Load (TMDLs) results for total nitrogen and total phosphorous have been completed for several watersheds in the County.

Surface and groundwater supplies on the Eastern Shore are generally sufficient; however, they are facing increasing demand from growing population and land irrigation. With growth and development comes a variety of impacts on the region's water resources. Regional issues include:

- Increasing ground water recharge and stream base flows
- Reducing nonpoint sources and point sources
- Reducing stormwater runoff and erosion
- Reducing the frequency and magnitude of flooding
- Sustaining the quantity of ground and surface waters to support current and future water usage (water supply, irrigation, in stream aquatic resources, recreation and others)
- Protecting sources of public drinking water supplies from pollutants
- Confining withdrawals from water supplies (aquifers) for public drinking water or irrigation to the limitations of the water source (aquifer)
- Improving the integrated planning of land use and infrastructure to guide growth into the most desirable areas and to protect rural and natural lands
- Climate change

At the County level, the economy is heavily dependent on clean streams and bays to support vital aquatic ecosystems and recreational opportunities.

In 2015, Queen Anne's County's freshwater demand included 1.95 mgd from surface sources and 12.42 mgd from groundwater sources for a total of 14.37 mgd, including 2.72 mgd for residential use and 9.50 mgd for livestock watering and irrigation. Groundwater supplies are believed to be sufficient for existing and projected demand; however, limited groundwater withdrawal from the Aquia aquifer in Kent Island is necessary to reduce further brackish-water intrusion into the Aquia aquifer. Shallow private wells in the Templeville area have experience elevated concentrations of nitrates. In addition to those regional issues previously identified, the following is a listing of key County/Town issues associated with water resources with emphasis on drinking water, wastewater and stormwater. These issues provide the framework for study analysis, as well as the premise for recommended strategies to remedy associated consequences.

Drinking Water	Wastewater	Stormwater
▪ Limited detailed hydro-geologic studies ▪ Brackish water intrusion into the Aquia aquifer and future impacts of continued eastward migration ▪ Additional water treatment for deeper aquifer sources ▪ Increasing water storage capacity ▪ Agricultural irrigation impacts	▪ Limited sewage treatment plant capacity and limited assimilative capacity of streams can impact development opportunities, particularly in Growth Areas ▪ Limited spray irrigation lands ▪ Water resources and water quality infrastructure must have sufficient capacity or ability for expansion to accommodate planned growth and development	▪ The amount of impervious surface across the County as well as in developed areas impact the quality, volume, and rate of stormwater runoff and pollution of waterways

The County and others across the State and Chesapeake Bay Watershed are challenged to develop best practices and best methods integrating water resources planning, policies and strategies with growth management planning, policies and strategies.

The key indicators for measuring impacts to Water Resources include:

- Preservation/conservation of environmentally sensitive lands
- Current and future land use patterns:
    - Percentage of development in and outside of Growth Areas and Towns
    - Percentage of development within Critical Areas
    - Nitrogen and phosphorus loads (point source and nonpoint source)
- Conversion of Agricultural and Forest lands to development; and increases in impervious surfaces, especially outside of Growth Areas and Towns

VISION FOR WATER RESOURCES

The following vision statement describes the desired outcome for the County's water resources serving as the foundation for more specific goals, objectives and policies developed in this report and the 2021 Comprehensive Plan.

> *Despite the increase in population, Queen Anne's County is a sustainable region because County government, with strong citizen support and education, coordinated the management of land and water resources; collected, tracked and analyzed essential data; secured adequate funding for water resources planning and management; prepared and continued to update a Water Management Plan; and embraced water conservation through practicing best management practices.*

The following community perspective includes a vision statement related to resource conservation and environmental protection (water resources being just one of those resources for conservation and protection) as well as key objectives to be addressed throughout the planning and implementation process. The vision for resource conservation and environmental protection envisions:

> *Queen Anne's County will remain a rural, agricultural, and maritime County because it restores, enhances, protects and conserves its valuable land, air and water resources through such measures as:*
>
> - *Conservation and protection of agricultural lands, open spaces, woodlands, wetlands, mineral resources, wildlife and their habitats*
> - *Conservation and protection of all water resources: bays, rivers, creeks, lakes, groundwater, and shorelines, including adherence to environmental regulations and low-impact stormwater practices that seek to restore the Chesapeake Bay*
> - *Preservation of good air quality and viewscapes, including but not limited to the night sky*
> - *Support for agricultural, maritime, and tourism industries*
> - *Environmental education programs aimed to promoting energy efficiency, comprehensive recycling practices for residences, businesses and public buildings, clean air and water policies, resource conservation and good land use.*

WATER RESOURCE GOALS & OBJECTIVES

The overarching goals to support achievement of this vision as it relates to water resources are outlined below.

- Adopt policies, regulations, legislation, enforcement procedures and appropriate funding for programs and projects necessary to restore, enhance, protect and conserve our land, air and water resources; and establish programs designed to generate an awareness of and support for these measures.
- Maintain safe and adequate drinking water supply to accommodate the needs of current and future populations of the County.
- Identify a variety of land management practices, best management practices and other tools and techniques that protect surface water and groundwater quality and quantity.

- Promote intergovernmental cooperation and coordination with respect to land use planning and implementation with the intent to minimize impacts on water resources.
- Educate and engage the general public in watershed conservation and stewardship.

The following objectives are important to achieve the vision and overarching goals for water resources:

- Achieve nutrient, sediment and pollution reduction necessary to remove each waterway from the MDE Integrated Report of Surface Water Quality
- Continue to adopt programs to promote and facilitate the permanent protection of Sensitive Areas
- Protect Critical Areas
- Protect vulnerable resources from impacts of climate change
- Prevent negative impacts from development on sourcewater quantity
- Protect functioning soil resources
- Provide adequate public facilities (water, wastewater and stormwater management)
- Regulate environmentally sensitive private water and sewage disposal systems (i.e. private wells, on-lot septic systems, and community water and sewerage systems).

RESULTS OF WATER RESOURCES ASSESSMENT

CONCLUSIONS & RECOMMENDATIONS

The use of best practices and innovative technologies are key implementation strategies to strengthen the sustainability of the County. Strengthening sustainability through better protection and management of water resources will achieve the County's land use goals of:

- Remaining a quintessential rural agricultural community
- Protecting the Chesapeake Bay and its tributaries
- Improving quality and quantity of stormwater treatment
- Directing residential and non-residential growth to designated Growth Areas
- Providing adequate public infrastructure and supporting services

The following conclusions come from the information contained in this report highlighted from various reports and studies cited pertaining to water resources; recommendations are provided based upon study results and assessment of current and future needs in the context of land use policies, strategies and regulation.

GROUNDWATER/DRINKING WATER	
Conclusions	Recommendations
▪ There are adequate drinking water supplies for future population growth; however, the drinking water source will be at a deeper depth and require additional treatment as compared to traditionally-used shallow aquifers. ▪ In Growth Areas, projected population increases will produce increased demand on groundwater resources resulting in more and additional pumping and treatment from public–supply wells to meet capacity needs will be necessary. Increased pumping of the Aquia aquifer on Southern Kent Island, beyond established limits, will produce decreases in water levels which in turn may increase brackish-water intrusion and regional water level issues. ▪ Pumping restrictions on Kent Island for using the Aquia aquifer to serve future demand within Growth Areas and water service areas may require shifts in pumpage distribution between various aquifers and require additional treatment. ▪ Significant withdrawals from near surface artesian aquifers rather than from deep aquifer sources may cause water levels in those artesian aquifers to decline, which in turn, may cause situations such as: brackish-water intrusion and well failure due to water levels falling below the pump intake.	An essential component to successful implementation of a growth management strategy to direct new development and infill development to existing Growth Areas is the ability to serve these areas with municipal water. The following recommendations are crucial to meeting growth management goals and objectives with respect to public water supplies and facilities. ▪ Require the development and use of Water Supply Capacity Management Plans for each community water system to support new allocations or connections to the system and to prevent capacity over-allocation. ▪ Establish watershed or wellhead protection strategies for water supply sources. ▪ Establish water service areas in the County's Comprehensive Water and Sewerage Plan consistent with the Land Use Chapter based upon ability of the water resource to support development based on population growth as well as development capacity analysis based upon zoning (i.e. make any necessary updates based upon changes to Growth Areas, Town annexations and Priority Funding Areas). ▪ Develop a Water Protection Plan working collaboratively through inter-jurisdictional agreements between the County and the Towns for planning and implementation. ○ Tracking water-level declines of groundwater resources. ○ Continued monitoring and study to ensure an adequate supply of necessary water resources. ▪ Implement water conservation policies, guidelines and regulations. ▪ Update the County's Comprehensive Water and Sewerage Plan consistent with any changes in land use within the 2021 Comprehensive Plan Update.

WASTEWATER	
Conclusions	Recommendations
▪ Increased sewer capacity and treatment, especially to accommodate future growth in the Growth Areas of Centreville and Queenstown, will be necessary to meet current and future population needs and reduce nutrient loadings. Public health concerns suggest a need for elimination or reduction of on-site disposal systems on southern Kent Island. ▪ The Sudlersville Wastewater Treatment Plant has the most remaining capacity out of the five public systems in the County; however, 40,000 gpd of that capacity is reserved for connection to the Town of Barclay. Anticipated flow associated with growth may require expansion of plant capacity. ▪ Existing sewer capacity at the Kent Narrows/Stevensville/Grasonville Wastewater Treatment Plant (KNSG WWTP) is severely limited, with remaining capacity committed "on paper." This may require restricting additional large-scale residential developments and instead reserving remaining capacity for commercial uses.	To continue successful implementation of the County's growth management strategy, it is imperative that new development and infill development (particularly large-scale residential development) is directed to existing Growth Areas where they can be served by municipal sewer, as the County's sewer capacity is severely limited. The following recommendations are crucial to meeting growth management goals and objectives with respect to public and private wastewater facilities. ▪ Immediately amend the Allocation Policy (Appendix 1 of the *Comprehensive Water and Sewerage Plan*) to clearly address the current sewer capacity limitations and define timeframes and reservations for the use of any remaining permit capacity additions. ▪ Continue implementing the recommendations contained in the Queen Anne's County Comprehensive Water and Sewerage Plan and update that document consistent with any changes in land use within the 2021 Comprehensive Plan Update. ▪ Continue addressing on-lot septic system failures on Southern Kent Island (SKI), with the KNSG WWTP capacity that has been allocated for this and other areas of concern. ▪ Use of innovative methods including Best Available Technology (BAT) for onsite treatment and disposal of wastewater to address public health concerns by reducing nitrogen discharge levels. ▪ Continued compliance with State and federal requirements with respect to permitting and reaching nitrogen reduction standards (use of Enhanced Nutrient Reduction (ENR) technologies) for the purpose of contributing to maintaining acceptable levels of water quality. ▪ Upgrade/replace existing facilities within the Towns using innovative technology to meet current and future capacity needs. ▪ Enhanced coordination between the County and Municipalities to identify water and sewerage service areas to identify additional water infrastructure and supply development needed to serve expected growth. ▪ Develop a financing, operation and maintenance plan for water connections.

STORMWATER	
▪ A reduction in nutrient loading from designated uses and projected uses is necessary to protect water resources, reduce flooding and other impacts to the natural environment. ▪ A balanced land use pattern across sub-watersheds with new development and redevelopment targeted for areas with existing Growth Areas with impervious surface areas not exceeding more than 10% of the sub-watershed land area without increased nutrient management treatment. ▪ Stormwater regulations address increased State nutrient reduction requirements and retrofit of existing stormwater systems that do not currently meet the new regulations.	Providing adequate treatment for the quality, volume and rate of stormwater run-off is an essential component directing new development and infill development to the County and Town Planning. The following recommendations are crucial to meeting growth management goals and objectives with respect to stormwater management. ▪ Continue to implement the WIP, working collaboratively through inter-jurisdictional agreements between the County and the Towns for planning and implementation. ▪ Balance the impacts of land use patterns across all landscapes (i.e. natural, agricultural, rural residential, suburban and town/village) by directing new development and infill development to existing Growth Areas. ▪ Continue to implement and update as needed the County's stormwater management practices and procedures and Environmental Sensitive Design Manual practices and procedures. ▪ Evaluate the location of Transfer of Development Rights (TDR) receiving areas to ensure appropriate location within watersheds containing designated Growth Areas that can receive development without exceeding 10% of the watershed land area with impervious surfaces. ▪ Assess development plans with respect to effectiveness to implement load reduction alternatives on non-point source pollutant loads applying Environmental Sensitive Design (ESD) standards. ▪ Measure post-construction tributary assimilative capacities for impacted sub-watersheds. ▪ Utilize open space and land preservation programs to provide water protection measures. ▪ Review and modify existing zoning and development regulations to direct growth to designated Growth Areas (i.e. ensure adequate receiving areas for TDRs, increase density in Growth Areas, and evaluate other growth management tools, such as, low impact development ordinance, household pollution reduction education programs, landscaping demonstration projects, and use of best management practices for road reconstructions). ▪ Identify water resource protection criteria in Forest Conservation Plans for individual developments. ▪ Establish appropriate buffers, setbacks and impervious surface regulations to protect water quality from impacts of development. ▪ Work collaboratively with the municipalities and surrounding counties to adopt water resource protection strategies and regulations.

SUMMARY OF WATER RESOURCE ASSESSMENT

This section provides summary level information with respect to wetlands, Chesapeake Bay Critical Areas, wastewater, drinking water and stormwater as well as a summary of point and nonpoint source impacts.

RESOURCE LANDS—AGRICULTURAL, FORESTED & WETLANDS

An inventory of resource lands such as agricultural lands, forested lands and wetlands identify changes in acreages between 2008 and 2019 as shown in **Table 1-1**. Overall changes in these land use classifications reflect that 2,849.3 acres or approximately 1.4% of total lands within the County were reclassified to other uses between 2008 and 2019. Resource lands could be reduced if sustainable smart growth management strategy is not continued.

Table 1-1. Change in Inventory of Agricultural and Forested Lands & Wetlands

Select Resource Land Use Classifications	Acreage					Change 2008-2019	
	1973	1997	2002	2008	2019	Acres	%
Agricultural	155,014.8	151,335.3	150,107.2	142,962.6	133,077.2	-9,885.4	-6.9%
Forested	72,110.3	63,664.6	63,069.5	59,742.8	72,588.4	+12,845.6	+21.5%
Wetlands	3,664.6	3,760.4	3,839.7	3,609.1	3,498.3	-110.8	-3.1%
Total County Acreage	238,038 Total Acres						
Calculated from Datasets	230,789.8	218,760.3	217,016.4	206,314.6	209,163.9	+2,849.3	+1.4%

*Source: Queen Anne's County, LGE & MDE/MDP Datasets. *This dataset is consistent with all impervious surface data found within this Plan and does not reflect lot coverage calculations which must be captured on a parcel by parcel basis per the Critical Area regulations.*

RESOURCE LANDS—CHESAPEAKE BAY CRITICAL AREAS

Approximately 41,790 acres of land in the County fall within the Chesapeake Bay Critical Area. This includes all lands within 1,000 feet of the mean high water line of tidal waters. Development is not prohibited in the Critical Area, but development is reviewed for compliance with one of three designations. The most restrictive Critical Area sub-category is the Resource Conservation Areas (RCA), which limits densities to no greater than 1 dwelling unit per 20 acres and limits lot coverage generally to a maximum of 15%. RCA areas are generally undeveloped areas or areas characterized by agricultural use, forests or other natural resources. Approximately 31,806 acres of land area are designated as RCA with a total of 768 acres, or 2.4% of the RCA area estimated to be impervious.

The density and intensity of use in the Limited Development Areas (LDA) and Intensely Developed Areas (IDA) are established by the underlying local zoning classifications. Lot coverage is generally limited to a maximum of 15% of the lot area in the LDA. Approximately 8,417 acres of land are designated as LDA with a total of 1,358 acres, or 16.1% of the LDA area estimated to be impervious. Approximately 1,568 acres of land are designated as IDA with a total of 499 acres, or 31.9% of the IDA area estimated to be impervious. **Table 1-2** depicts the existing coverage within Critical Areas for the Intensely Developed Areas (IDA), Limited Development Areas (LDA) and Resource Conservation Areas (RCA) designated areas of the County. Currently, over 6% of total lands within the Critical Area are impervious. When development or redevelopment occurs, impervious surface area and stormwater runoff are minimized based upon ESD application. In addition, development and redevelopment on land designated IDA prompts compliance with what is commonly referred to as the "10% Rule". The criteria specifies that the treatment practices must be capable of reducing stormwater pollutant loads from a development site to a level at least 10% below the load generated by the same site prior to development. See **Table 1-5** for a comprehensive look at overall impervious surface calculations by watershed and the affiliated stormwater analysis.

Table 1-2. Impervious Surface by Critical Area Designation*

Critical Areas	Impervious Surface		Undeveloped Land		Total Acres
	Acres	%	Acres	%	
IDA—Intensely Developed Area	499.3	31.9%	1,068.3	68.1%	1,567.6
LDA—Limited Development Area	1,357.8	16.1%	7,059.7	83.9%	8,416.9
RCA—Resource Conservation Area	767.8	2.4%	31,038.1	97.6%	31,805.9
Total Critical Areas	2,624.3		39,166.1		41,790.4

*Source: Queen Anne's County, LGE & MDE/MDP Datasets. *This dataset is consistent with all impervious surface data found within this Plan and does not reflect lot coverage calculations, which must be captured on a parcel-by-parcel basis per the Critical Area regulations.*

WATER RESOURCES—WASTEWATER

Table 1-3 identifies the demand and capacity of public wastewater treatment systems for various Growth Areas. The available capacity of existing public systems is limited, both for current and future populations; additional capacity would be necessary to support additional growth within the various wastewater service areas. The wastewater treatment facilities are not interconnected and serve specific geographic Growth Areas where future growth is to be directed or has been extended to correct septic tank failures. While re-rating of the KNSG WWTP may increase capacity slightly, even that additional capacity may be difficult to take advantage of due to nitrogen limits set in place by the Chesapeake Bay TMDL and other associated environmental programs. It will be very difficult and expensive to add additional capacity in the future, if this is even a possibility. During this planning cycle, the community finds itself nearing the limits of adequate public facilities, including transportation infrastructure on its state and local roads, the Chesapeake Bay Bridge, local school capacity, and sewerage capacity permit restrictions at the County's Kent Narrows/Stevensville/Grasonville Wastewater Treatment Plant (KNSG). The existing 3 MGD capacity at KNSG is now nearly fully obligated by estimated existing and future capacity commitments. These commitments are estimated using a combination of the reported actual hydraulic flow through the plant and the reserved flow allocations for unbuilt development. The resulting estimates conclude that there is an insignificant amount of the estimated remaining capacity available. In order to address this limitation, the County is committed to amending the sewer portion of the Allocation Policy (**Appendix 1** of the **2011 Comprehensive Water and Sewerage Plan**). Further, the County will address short-term and long-term measures which are outlined in Opinion Strategies No. 1 and No. 2 included herein (see pages AD33-AD37).

Table 1-3. Public Sewer Systems Demand & Capacity Summary

Facility	Million Gallons per Day (MGD)			Comments
	Design Capacity	Average Daily Flow	Remaining Capacity	
KNSG	3.000	2.183	(0.110)	Includes residential, commercial, and multi-use commitments of 425,910 gpd (including 14,200 gpd for residential infill), 284,755 gpd of reserve for SKI failing septic areas, and 58,720 gpd reserve for commercial/institutional use.
Queenstown	0.200	0.102	0.098	The current maximum 200,000 gpd capacity of the Queenstown WWTP will be adequate to service the existing, committed, and projected flows of 185,365 gpd for Sewer Service Areas S-1 through S-4. The modular design of the plant allows for expansion as needed. Expansion of up to 400,000 gpd is possible and will be necessary to service long-term future flows including S-5 and S-6 service anticipated at 395,514 gpd. Modification to the discharge permit is necessary for capacity increase.
Centreville	0.542	0.484	0.058	The treatment plant can be expanded to treat approximately 750,000 gpd with approximately $20M in improvements. With more substantial improvements, the treatment plant can be expanded to treat approximately 1,000,000 gpd. The amount of water and sewer capacity that the Town will provide will have a direct impact on the amount of new development that the Town can accommodate. Capacity currently restricted due to available spray irrigation lands.
Church Hill	0.080	0.051	0.029	The capacity assessment indicates the WWTP will need to be expanded by 2030 in order to provide service for the 2030 forecast and of the full development of the Town. Any expansions of the Church Hill WWTP to accommodate additional growth would also need to improve the quality of treatment at the plant. Improved treatment levels would mean lower concentrations of BODs, suspended solids, phosphorus, and other substances and nutrients.
Sudlersville & Barclay*	0.200	0.087	0.113	Of the remaining capacity, 40,000 gpd is reserved for the connection to the Town of Barclay. Anticipated flow associated with growth will require expansion of plant capacity.
Millington	0.140	0.065	0.075	Serves approximately 281 connections within the Town. Service is provided to portions of Kent County (outside Town boundaries), but there are no connections outside of the Town boundaries in Queen Anne's County.

** Barclay is dependent on Sudlersville for Capacity. Source: QAC KNSG Sewer Capacity Estimate (June 2021); Town of Queenstown 2017 Comprehensive Plan & Town Consultant Data; Town of Centreville 2009 Comprehensive Plan; Town of Church Hill 2010 Comprehensive Plan; Millington Town Manager (January 2022). Average Daily Flow = flows from 2017, 2018, 2019*

WATER RESOURCES—DRINKING WATER

Drinking water assessment is typically accomplished by analyzing data on groundwater withdrawal by facility, treatment capacity, and an analysis of each water system's demand and capacity. MDE issues Groundwater Appropriation Permits (GAP) for facilities or projects that withdrawn an average of 10,000 gallons per day or greater. **Table 1-4** provides the GAP Well Withdrawal Limits and 2019 Daily Well Withdrawal quantities by service area. Under the current demands, many of the service areas appear to be near capacity in the GAP Average GPD withdrawal limits and two service areas—Bayside and Thompson Creek—are over capacity in terms of average GPD. New development in these service areas should be carefully considered in terms of water capacity and efforts to increase water capacity production could be evaluated if future growth is anticipated in these areas.

Table 1-4. GAP Well Withdrawal Limits Comparison

Service Area	GAP Well Withdrawal Limits		2019 Daily Well Withdrawal		Total 2019 Well Withdrawal GPD
	Maximum GPD	Average GPD	Maximum GPD	Average GPD	
County Facilities					
Bayside	255,000	144,000	206,693	155,490	1,865,875
Bridge Pointe	150,000	100,000	30,410	7,426	89,110
Business Park	500,000	400,000	317,111	391,067	3,805,328
Grasonville	210,000	100,000	91,448	77,035	924,414
Kent Island Village	20,000	15,000	458	210	2,516
Oyster Cove	300,000	200,000	115,968	67,076	804,909
Prospect Bay	195,000	125,000	114,728	71,783	861,392
Queen's Landing	45,000	27,000	29,042	11,631	139,573
Riverside	8,500	5,100	5,403	4,359	52,312
Stevensville	500,000	350,000	285,484	174,609	2,095,312
Thompson Creek	500,000	210,000	330,620	249,245	2,990,945
Town Facilities					
Centreville-North Brook	645,000				
Centreville-Comet Drive	500,000	400,000	391,067	317,111	3,805,328
Queenstown	100,000	70,000	82,000	76,000	1,468,000
Sudlersville	17,500				

Source: Queen Anne's County Department of Public Works; Queenstown Planning Consultant Data. GAP—Groundwater Allocation Permit. GPD—Gallons Per Day.

WATER RESOURCES—STORMWATER

A change in land cover from vegetated or forested conditions to impervious surface increases stormwater run-off volumes, which when unmanaged can contribute to a reduction in water quality and can have the potential for flooding downstream properties, which can also be tide dependent. Construction associated with a wide array of community development activities results in a reduction of functioning soils resources which increases rates of stormwater run-off. Therefore, there are County stormwater regulations for stormwater management when development occurs to require development activities to retain and treat stormwater to a level that reduces the output of the site as if it were in the forested condition.

Studies have documented that the quality of aquatic habitat in streams, lakes and wetlands begins to decline when the area of impervious surface within a watershed reaches 5% of the total land area and at 10%, the watershed may face irreparable harm. Based on the 2016 conditions depicted in **Table 1-5**, two watersheds already exceed 10% impervious coverage (Kent Island Bay and Eastern Bay Watersheds) and another two have exceeded the 5% coverage threshold: Kent Narrows and Lower Chester River Watersheds.

There have not been any local updates to the impervious surface coverage analysis since 2016—this is something the County should consider developing to not only identify more current existing conditions, but to assist in watershed planning and implementation prioritization efforts. In the intervening period, it is possible to calculate impervious coverages utilizing established land use-impervious cover coefficients; however, this analysis is not as accurate as other forms of study.

The first deliverable due under the County's MS4 permit is an impervious surface baseline for the County's urban area (Census Urbanized Area), which falls in unincorporated areas of Kent Island. In the permit's later years, it is anticipated that the impervious cover analysis will be completed for the entire County.

Table 1-5. Impervious Surface Coverage—Existing Conditions (2016)

Watershed	Total Watershed Acres*	Impervious Surface Acres	2016 % Impervious Surface
Corsica River Watershed	23,922.1	1,085.9	4.5%
Eastern Bay Watershed	11,650.6	1,216.0	10.4%
Kent Island Bay Watershed	5,184.5	613.3	11.8%
Kent Narrows Watershed	6,940.2	453.8	6.5%
Lower Chesapeake Bay Watershed	3.4	0.1	2.9%
Lower Chester River Watershed	17,902.7	942.2	5.3%
Middle Chester River Watershed	7,871.7	352.1	4.5%
Southeast Creek Watershed	34,789.0	867.3	2.5%
Tuckahoe Creek Watershed	46,095.3	931.7	2.0%
Upper Chester River Watershed	52,079.3	1,413.7	2.7%
Upper Choptank Watershed	1,928.4	25.2	1.3%
Wye River Watershed	29,671.4	1,021.4	3.4%
Total	238,038.7	8,922.7	3.7%

BEST MANAGEMENT PRACTICES, TOOLS & TECHNIQUES

Water resources are best protected when a variety of best management practices, tools and techniques are available for use based upon both general characteristics of the assigned landscape typology as well as site specific conditions. **Table 1-6** summaries the best management practices (BMP), tools, techniques and strategies typically associated with general characteristics of landscapes organized by State Tributary Strategy. The State Tributary Strategies as outlined in Maryland's *Chesapeake Bay Tributary Strategy Statewide Implementation Plan* includes a variety of strategies that Counties should consider through implementation of land use and environmental regulation of development.

Table 1-6. Summary of Best Management Practices, Tools, Techniques & Strategies

Strategy	Landscape				
	Agricultural	Natural	Rural Residential	Suburban	Town/Village
Point /Urban Source	—			Expand Water & Wastewater Systems	
Stormwater	BMPs & Ag Best Practices	BMPs, C/P & Ag Best Practices	BMPs & ESD		
Onsite Sewage Disposal	INRT			SE & INRT	SE
Growth Management	C/P	TDR, C/P & Restrict CA Buffer Dev.	Cluster Dev., ESD & Existing Infrastructure	Public Water & Wastewater	Infill/ Redevelopment
Agricultural	Ag BMPs, SW BMPs & C/P	SW BMPs & C/P	SW BMPs, C/P & Cluster Dev.	TDR RA	
Waterway	Buffers, C/P & Tree Planting	Buffers, C/P, Tree Planting & Living Shore Construction		Buffers, Tree Planting & Living Shore Construction	
Air Deposition	FC & Preserve Green Infrastructure		FC & WLS	FC, WLS, Greenbelts & Trails/Paths	Walkable Communities & Expand Transit

Notes: Ag – Agriculture; BMP – Best Management Practice; C/P – Conservation/Preservation; ESD – Environmentally Sensitive Design; FC – Forest Conservation; INRT – Innovative Nutrient Reduction Technology; RA – Receiving Areas; SE – Septic Elimination; SW – Stormwater; TDR – Transfer of Development Rights; WLS – Wooded Lot Standards

DETERMINING PREFERRED FUTURE LAND USE

Land use and water resources are unequivocally linked. The type of land and the intensity of its use will have a strong influence on the receiving water resource. Depending upon the type of land use, the impacts on either the quantity or quality of water can be substantial.

SUSTAINABLE SMART GROWTH MANAGEMENT STRATEGY

Existing development and development potential to the year 2040 and beyond were studied to determine the impacts on environmentally sensitive areas and water resources. Through the analysis of development potential, preservation opportunities and impacts on water resources, a Sustainable Smart Growth Management Strategy was determined to be the preferred planning approach to map the preferred future land use for the County.

This Sustainable Smart Growth Management Strategy applies the Twelve Visions of the *Land Use Article*, water resource protection strategies, and smart growth principles emphasizing new growth to be directed to Growth Areas. This analysis and study of future land use takes into the following key components of sustainable smart growth management as they relate to Queen Anne's County:

- Protection of sensitive areas and water resources applying a variety of tools and techniques such as resiliency and hazard planning and restricting floodplains, stream buffers, and environmentally sensitive areas from consideration for development;

- Protection of agricultural lands for the purpose of achieving the County's Priority Preservation Goal in order to maximize preservation opportunities. The analysis limits onsite development within Agriculture (AG) and Countryside (CS) zoning districts and utilizing TDRs to direct growth to Growth Areas.
- Concentrating growth within Growth Areas at an average density of 3.5 dwelling units per acre while preserving land with the rural agricultural areas.
- Consideration of adequate public facilities with respect to water, sewer, and transportation improvements.

EXISTING & PROJECTED CONDITIONS

POPULATION PROJECTIONS

The following tables represent population trends and projections supplied by the Maryland Department of Planning, **Table 1-7**.

Table 1-7. Population Trends & Population Projections

Jurisdiction	1970	1980	1990	2000	2010	2020	2030	2040	'20-'40 Change
Queen Anne's County	18,422	25,508	33,953	40,563	47,798	50,810	56,320	62,040	22.1%
Upper Eastern Shore	131,322	151,380	180,726	209,295	239,951	244,820	266,620	292,490	19.5%
Maryland	3,923,897	4,216,933	4,780,753	5,296,486	5,773,552	6,074,750	6,413,690	6,739,410	10.9%

Source: Maryland Department of Planning December 2020 Historical & Projected Total Population for Maryland's Jurisdictions. Upper Eastern Shore includes Caroline, Cecil, Kent, Queen Anne's, and Talbot Counties. These figures do not reflect recently released 2020 Decennial Census Data.

WATERSHEDS

Queen Anne's County is located within the Chesapeake Bay Watershed, a watershed that stretches over an area over 64,000 square miles in size and encompassing six states. The Chesapeake Bay Watershed contains many smaller sub-watersheds. These smaller sub-watershed areas to be used by local jurisdictions to elevate water resources are referred to by the Maryland Department of Environment (MDE) as "eight-digit" watersheds. Eight-digit refers to the Hydrologic Unit Code (HUC) as carried out to 8 places, meaning that these sheds are sub-sheds to the larger watershed. Queen Anne's County is divided between eleven eight-digit watersheds. **Map 5-2** depicts the eight-digit watersheds in Queen Anne's County.

MS4 & NPDES

PHASE I

Under its NPDES regulatory program, the *Clean Water Act* makes it illegal to discharge pollutants from a point source to the waters of the U.S without a permit. The *NPDES Stormwater Phase I Rule* established stormwater discharge control requirements for 11 categories of industrial activity and for municipal separate storm sewer systems (MS4s) serving populations of 100,000 or greater. These regulated MS4s must obtain a NPDES permit and develop a stormwater management program to prevent harmful pollutants from entering the MS4 and being discharged into local waterbodies. Maryland is unique in that its Phase I MS4 permittees are required to prepare watershed restoration plans, which is a powerful driver. Because NPDES permits must be renewed every five years, watershed plans may be updated on this regular cycle as well.

Phase I MS4 permittees must conduct a systematic assessment of water quality within all watersheds in the community. These assessments should include detailed water quality analysis, identification of water quality improvement opportunities, and the development and

implementation of plans to control stormwater discharges. The overall goal is to evaluate and develop a plan for each watershed to maximize water quality improvements. During each permit term, 10% of the community's untreated impervious area should be restored by implementing the watershed restoration action plans. Within one year of permit issuance, restoration efforts should be implemented to restore an additional 10% of the community's impervious surface area. All restoration efforts should be monitored to determine effectiveness in improving water quality. Annual reporting must be done on progress, implementation costs, and monitoring. In Maryland, 10 jurisdictions (i.e. Anne Arundel County, Baltimore City, Baltimore County, Carroll County, Charles County, Frederick County, Harford County, Howard County, Montgomery County, and Prince George's County) and the State Highway Administration are covered under the Phase I program and are required to obtain an individual municipal NPDES stormwater permit.

PHASE II

The *Stormwater Phase II Final Rule* requires operators of small MS4s ("small" is defined by specific criteria set forth by the EPA) to obtain an NPDES permit and develop a stormwater management program to prevent harmful pollutants from entering the MS4 and being discharged into local waterbodies. Phase II communities are also required to develop local programs to address six minimum management measures: public education and outreach; public participation and involvement; illicit discharge detection and elimination; construction site runoff control; post-construction runoff control; and pollution prevention/good housekeeping. These minimum measures are designed to improve the quality of Maryland's streams, rivers, and the Chesapeake Bay and a local watershed plan is frequently helpful in meeting these goals. Approximately 49 municipalities in Maryland and two additional counties were designated for coverage under Phase II.

Queen Anne's County is a Phase II MS4 community. The newly mandated MS4 Phase II permit will add another lens and funded resource layer to approach comprehensive watershed studies to focus future restoration and conservation efforts. The County will be required to restore 200 acres of impervious area within Kent Island's Urban Area that are untreated or are without modern day, maintained stormwater BMPs. Initial restoration requirements will be met by septic elimination efforts on Kent Island, while future restoration efforts will be informed by findings in watershed studies showing critical preservation areas and areas vulnerable to climate change. Many of the minimum control measures add an additional reporting layer to already mandated stormwater controls such as inspecting and maintaining private and public stormwater Best Management Practices (BMPs) on a regular basis. These include many older stormwater ponds that were built prior to ESD mandates and practices. Educating homeowners on how to regularly maintain their BMPs will be an important outcome of the permit.

Outfall inspections will be a new layer of regulation brought on by the MS4 permit. In the coming years, the County will need to develop an outfall inspection program to monitor water quality at mapped outfalls throughout the County. The MS4 permit provides an opportunity for the County to stay informed of the latest innovations in stormwater controls and their corresponding estimates on pollution reduction to the Chesapeake Bay.

PHASE III

The Phase III WIP builds on lessons learned in Phase I and II and charts a course to 2025 that is locally driven, achievable, and balanced. In developing the Phase III WIP, State agencies met with County public works and planning departments, municipalities, soil conservation districts, NGOs, and the public to better understand which restoration strategies are working, which are not, what additional plans and restoration actions are anticipated between now and 2025, and where resources and collaborations are needed to achieve them. This information was compiled, along with information regarding local pollution sources, progress to date, and any pollution reductions required by permit or contract, into local summaries that establish local planning goals. These local goals, combined with State-level pollution reduction strategies, are projected to achieve Maryland's 2025 Chesapeake Bay restoration targets.

TOTAL MAXIMUM DAILY LOADS

Total Maximum Daily Loads (TMDLs) are a requirement of the *Clean Water Act*, which calls on each state to list its polluted water bodies and to set priorities for TMDL development. Water bodies are classified as "impaired" when they are too polluted or otherwise degraded to support their designated and existing uses. The impaired waters list is called the 303(d) list, named after the section in the Act that requires it. For each combination of waterbody and pollutant on the 303(d) list, states must estimate the maximum allowable pollutant load, or TMDL, that the water body can receive and still meet water quality standards. Many experts believe the loading or stressor goals set by a TMDL analysis provide the best hope for the clean-up and restoration of our most polluted waters.

ANTI-DEGRADATION POLICY

The State's anti-degradation policies regulate discharges to surface waters to maintain or improve the existing level of water quality. The policies provide differing degrees of protection according to one of three "tiers" of water quality protection assigned to all surface waters depending on their function. These anti-degradation policies are used to evaluate new discharges to waterways according to the water body's "tier" designation. Since there are no Tier I and III designated surface waters identified in the following subsection emphasizes Tier II waters.

TIER I WATERS

Tier I mandates that water uses and the level of water quality necessary to protect the uses (i.e. fishable and swimmable) Any pollutant discharged to a waterway that could endanger this level of protection is prohibited.

TIER II WATERS

The Tier II designation is assigned to waters where existing water quality is better than the levels needed to meet the Federal Clean Water Act standards. Tier II waters may not receive new or increased discharges that would degrade water quality of the water body below the Tier II standards.

The Maryland Department of the Environment (MDE) describes Tier II water bodies as the following; "In addition to protecting existing uses and meeting the minimum water quality goals (sometimes referred to as "fishable and swimmable") which are subject to the MDE anti-degradation review policy. The goal of MDE anti-degradation review for projects in watersheds containing Tier II waters is to ensure that water quality is not degraded beyond the capacity to maintain a high quality status. Applicants proposing activities that will potentially impact Tier II waters must undergo anti-degradation review before permits are approved or activities can be added to a county's water and sewer plan."

The following are applicable policies, regulations and requirements established by the MDE with respect to county plans, reviews and exemptions.

- County Plans –If a proposed amendment to a County Water and Sewer Plan results in a new discharge or a major modification of an existing discharge to a Tier II water body, the applicant shall perform a Tier II anti-degradation review.
- Tier II Anti-degradation Review – The analysis must include reasonable alternatives that do not require direct discharge to a Tier II water body (no-discharge alternative). The analysis must include cost data and estimates to determine the cost effectiveness of the alternatives.
- Exemptions – The requirement to perform a Tier II anti-degradation review does not apply to individual discharges of treated sanitary wastewater of less than 5,000 gallons per day, if all of the existing and current uses continue to be met.

TIER III WATERS

Tier III governs high-quality waters that are considered outstanding national resources, such as waters of national and State parks and wildlife refuges, or waters of exceptional recreational or ecological significance. Tier III guidelines prevent any action that would threaten the quality of these waters.

TIER II WATERS IN THE COUNTY

The Tier II catchments areas encompass approximately 35.2% of the land area of the County, which includes approximately 83,771.8 acres. **Table 1-8**, Tier II Catchment Areas by Watershed illustrates the percentage of each watershed that is in a Tier II Catchment Area. The Sanitary Sewer Service Areas within Tier II High Quality Waterways located in Queen Anne's County's 13 Tier II catchment areas are illustrated in **Map 5-9**.

Table 1-8. Tier II Catchment Areas by Watershed

	Tier II Catchments	
Watershed	Acres	% of Watershed
Corsica River	13,334.6	55.7%
Eastern Bay	0.0	0.0%
Kent Island Bay	0.0	0.0%
Kent Narrows	0.0	0.0%
Lower Chester River	0.0	0.0%
Middle Chester River	0.0	0.0%
Southeast Creek	16,099.3	46.3%
Tuckahoe Creek	37,208.6	80.7%
Upper Chester River	10,666.6	20.5%
Upper Choptank	227.7	11.8%
Wye River	6,181.4	20.8%
Total	83,718.2	35.2%

Within the Tier II catchment areas, there are nineteen listed surface water streams that have been designated by the MDE as Tier II waters. **Table 1-9, Queen Anne's County Tier II Waters**, indicates the date the stream segment was listed, the 12-digit watershed and the Index of Biotic Integrity (IBI).

The Index of Biotic Integrity (IBI) is a tool or scale which is used to determine the health and integrity of the fish community in a given waterway. Maryland utilizes a scale of 1-5. The higher the score, the healthier the system is to support a variety of aquatic habitats.

Table 1-9. Queen Anne's County Tier II Waters

Date Listed	Stream Name	12 Digit Watershed	Fish IBI*	Benthic IBI*
2008	Alder Branch 1	021305070395	4.67	4.71
2003	Andover Branch 1	021305100425	4.17	4.57
2009	Andover Branch 2	021305100425	4.33	5.00
2007	Andover Branch UT 1	021305100425	4.67	4.71
2007	Blockstone Branch UT 1	021304050529	4.00	4.14
2008	Browns Branch 1	021305080401	4.33	4.71
2008	Browns Branch 2	021305080401	4.44	4.71
2007	Granny Finley Branch 1	021305080399	4.00	4.00
2008	Mill Stream Branch 1	021305070396	4.67	4.43
2007	Norwich Creek 1	021304050522	4.67	4.71
2003	Red Lion Branch 1	021305100419	,4.30	4.45
2007	Red Lion Branch UT 1	021305100420	4.33	4.14
2007	Southeast Creek 1	021305060401	4.67	4.43
2008	Southeast Creek 2	021305080401	4.17	4.29
2003	Southeast Creek UT 1	021305080403	4.33	5.00
2007	Three Bridges Branch 1	021305070397	4.17	4.43
2008	Tuckahoe River 1	021304050531	4.67	5.00
2007	Wye East River UT 1	021305030436	4.67	4.71
2008	Wye East River UT 2	021305030436	4.00	4.14

*Source: Maryland Department of the Environment, 2009. Note: Specific latitude and longitude for each stream section can be obtained on MDE's website. *IBI = Index of Biotic Integrity*

IMPAIRED WATER BODIES & TMDLs

According to MDE, impaired watersheds occur where required water quality standards are not met. There are numerous standards including dissolved oxygen, nutrients, sediments, bacteria, metals, and other toxic contaminants, and biological criteria that must be met to achieve the designation requirement for water to "support aquatic life." The Federal Clean Water Act requires that these impairments be addressed as part of a State water quality management program. The impaired waters list is reviewed and revised, with public comment, every two years on an even year.

Also, according to MDE, Total Maximum Daily Loads (TMDLs) are based on assessments that are required to be completed for impaired waters. TMDLs include estimates of pollution loads from all sources and Waters are classified as impaired when they exceed the water quality standards established for the water body. There are numerous standards or thresholds, including dissolved oxygen, nutrients (such as nitrogen and phosphorous), sediments, bacteria, metals, and other toxic contaminants, and biological criteria that can be measured to determine if the water body can meet the requirement to "support aquatic life."

Total Maximum Daily Loads (TMDLs) are assessments of the water bodies' threshold for accepting pollutant loads. A TMDL assessment includes estimates of the maximum amount of pollution loads, from all sources, at which the water quality standards of that water body are attained. **Table 1-10** lists the impairment status and available TMDL values for nitrogen and phosphorus.

US EPA and the State are required to update TMDLs; there is an established reporting schedule for this effort. Latest updates indicate that data has been collected and results will likely be published within the next year.

Table 1-10. Watershed Impairment & Established TMDL Thresholds

8-Digit Watershed	Watershed Name	Impairment Status	TMDL Status	TMDL for Nitrogen	TMDL for Phosphorus
02130404	Upper Choptank	Impaired	Approved 2012	1,155,905	122,617
02130405	Tuckahoe Creek	Impaired	Approved 2004	590,637	60,850
02130501	Eastern Bay	Impaired	Approved 2012	897,352	64,557
02130503	Wye River	Impaired	Relisted 2014	689,453	50,703
02130504	Kent Narrows	Impaired	Relisted 2014	689,453	50,703
02130505	Lower Chester River	Impaired	Approved 2012	689,453	50,703
02130507	Corsica River	Impaired	Approved 2012	287,670	22,244
02130508	Southeast Creek	Impaired	Approved 2009	*Not Studied*	21,113
02130509	Middle Chester River	Impaired	Approved 2012	275,437	16,709
02130510	Upper Chester River	Impaired	Approved 2012	614,612	34,354
02130511	Kent Island Bay	Impaired	Approved 2012	689,453	50,703

REGIONAL GROUNDWATER CONDITIONS

Groundwater is the primary source of water supply in Queen Anne's County and surrounding region. Groundwater is water that is found underground in the cracks and spaces in soil, sand, and rock. Groundwater is stored in--and moves slowly through--layers of soil, sand, and rocks called aquifers. Aquifers typically consist of gravel, sand, sandstone, or fractured rock, like limestone. These materials are permeable because they have large, connected spaces that allow water to flow through. The speed at which groundwater flows is dependent on several factors such as the size of spaces in the soil or rock and connectivity between these spaces.

The Coastal Plains aquifers supply the majority of water needs in Queen Anne's County and surrounding region. Within the Coastal Plains, between 2020 and 2040, the Upper Easter Shore is expected to grow by 47,670 people, and Queen Anne's County projected to grow by 11,230 people during the same timeframe.

FRESHWATER WITHDRAWALS

The following table, **Table 1-11**, shows the distribution of countywide water use in 2015. The USGS' National Water Use Information Program compiles and publishes water use data, which is reported every five years, working in cooperation with local, state, and federal agencies. Although this information is somewhat dated, the distribution of usage indicated the County's major water users are irrigation (64%), Residential Self-Supplied (19%), and public supply distribution (12%).

Table 1-11. Freshwater Withdrawals

Type of Withdrawal	Total Withdrawals (MGD)			% of Total Withdrawals
	Surface Water	Groundwater	Total	
Public Supply Distribution	0.00	1.77	1.77	12.3%
Residential Self-Supplied	0.00	2.72	2.72	18.9%
Industrial	0.00	0.22	0.22	1.5%
Irrigation	1.80	7.35	9.15	63.7%
Aquaculture	0.06	0.00	0.06	0.4%
Livestock Watering	0.09	0.26	0.35	2.4%
Mining	0.00	0.10	0.10	0.7%
Thermoelectric	0.00	0.00	0.00	0.0%
Total	1.95	12.42	14.37	100.0%

Source: 2015 USGS MD-DE-DE Water Science Center (refresh date June 2018)

Groundwater is the sole source for municipal, industrial and private water supplies in the County. This is due to the availability of groundwater of good quality and the lack of suitable surface impoundment sites in the Aquia Formation, little treatment is required for potable water supplies, although water quality can vary within the aquifer. The Magothy Formation has high iron content that requires more extensive treatment. The following formation descriptions are from the Queen Anne's County *Comprehensive Water and Sewerage Plan*.

- **Wicomico Formation.** This formation is a major part of the Pleistocene Series that exists as surface deposits over most of Queen Anne's County. The deposits fall into two general types--terrace and plains deposits. The terrace deposits have little value as a source of groundwater supply. The thickness of the plains deposits varies considerably, depending on the topography. In the eastern, flat-lying areas it is only about 25 feet thick. Along the Bay's shore there are deposits ranging from 60-90 feet thick. Because nearly all wells tapping the Wicomico Formation are domestic dug or driven wells equipped with pumps yielding only a few gallons a minute, reliable data on yields is not available. The permeability and porosity of the sand and gravel that make up the formation favor the storage and recovery of groundwater. Because of its proximity to the surface, there is a high probability of groundwater contamination in this formation.
- **Calvert Formation.** The Calvert Formation is part of the Miocene Series. It dips about 15 feet per mile toward the southeast, thickening in the direction of the dip. It outcrops near Millington and at spots along the Wye and Chester Rivers. This formation also occurs as infill in paleochannels penetrating the Nanjemoy Formation Aquiclude. Quality of the groundwater is generally good except for high silica content that may necessitate treatment if used for boiler purposes. The high yields and specific capacities of the few wells tapping the formation are probably the result of vertical leakage from the overlying Pleistocene deposits. Many wells have been drilled through the Calvert Formation to deeper aquifers as water was not found in the formation in sufficient quantity. It is not considered to be as important as some of the other aquifers found in Queen Anne's County.
- **Aquia Greensand Formation.** This formation is part of the Eocene Series. The dip is toward the southeast and varies from 30 feet per mile in the north, to 15 feet per mile in the south. Outcrop of the formation is poor and appears mostly in a belt lying along the sides of the topographic rise that forms the backbone of Kent County. Because of the limited outcropping, it is thought that the formation is mainly recharged indirectly from overlying pervious sediments. Subcropping beneath the Talbot and Kent Island Formation at Love Point and beneath the sediments of the Bay has been identified. The Aquia Greensand is currently the most important source of groundwater in

Queen Anne's County. Several hundred wells withdraw water from this formation. Most of the wells are located in a limited area on Kent Island and on the mainland at Grasonville and Queenstown. Analyses show that the groundwater from this formation contains less iron and is softer than that from the Monmouth Formation. However, saltwater intrusion is being experienced on Kent Island. The Maryland Geological Survey and the Maryland Department of Natural Resources has published a Report of Investigation No. 51 and its update No. 72 that includes extensive modeling of the aquifers involved. The cone of depression created by heavy pumping in the Talbot County towns of Easton and St. Michael's areas has, when combined with the Kent Island pumpage, created brackish water intrusion that is beginning to affect water quality on the northwestern half of Kent Island. Recent years of summer droughts have created a great demand for irrigation purposes by agricultural uses into the Aquia aquifer raising concern that the irrigation demand may impact adjacent residential wells. The Aquia also has a band a few miles wide within its formation that exceeds the drinking water standard for Arsenic. This band extends from the vicinity of Prospect Bay West's community, and extends north northeast through Queenstown, Centreville, and Sudlersville. All these communities have had to treat to remove Arsenic.

- **Matawan Formation.** The Matawan formation is the oldest of the marine Upper Cretaceous formations of Maryland. It crops out along a 1 to 2 mile wide belt, which extends from the Delaware state line near Chesapeake City southwestward across Cecil County and Kent County to the Chesapeake Bay a few miles north of Rock Hall. The formation differs in lithology from the older Cretaceous formations. It is characteristically a dark gray, micaceous, glauconite, silty or clayey sand. The strata commonly vary from light colored iron stained sand to very dark carbonaceous clay, which has the general appearance of the underlying Magothy clay. Where samples are available the clays can be differentiated, because the clay of the Matawan contains glauconite and the clay of the Magothy generally does not. The depth to which wells must be drilled to obtain water from the Matawan formation varies with the topography and the location. The average thickness of the water bearing zones in the formation ranges 5 to 10 feet, based on the driller's logs. The sandy beds at the top of the Matawan formation, which are in contact with the Monmouth formation, probably are hydrologically connected with the basal beds of the overlying unit.
- **Monmouth Formation.** This formation is part of the Upper Cretaceous Series. It dips southeast at about 25 feet per mile. The best exposures of the formation are in the northern portion of the County and in the State of Delaware along the Chesapeake and Delaware Canal. Water from this formation requires treatment due to excessive iron content. In the southern parts of Queen Anne's County this formation acts as a layer separating aquifers.
- Piney Point Formation – The Piney Point Aquifer overlies the Nanjemoy Formation and is overlain by the Calvert Formation in the southeast portion of the County. The chemical constituents of the water in the Piney Point indicate that the overlying Calvert Formation recharges the aquifer. Water in this aquifer ranges in chemical character from calcium bicarbonate, containing less than 250mg/l-dissolved solids, to sodium chloride bicarbonate containing more than 1,000 mg/l-dissolved solids. This aquifer is an important source of water in southeast Queen Anne's County.
- **Magothy Formation.** This formation is also part of the Upper Cretaceous Series. The Magothy is the oldest of those formations that have a fairly broad lateral distribution of homogeneous material. It appears to be closely connected hydrologically with the adjacent formations and, as a result, has often been passed by as an aquifer. The formation crops out along a two-mile band in Cecil County and dips southeast about 30 feet per mile. The Magothy Formation is an important potential source of groundwater; however, iron removal will almost certainly be required. An increasing number of wells in Queen Anne's County are penetrating the Magothy Formation at this time as a result of new Aquia Greensand appropriations being restricted in the Grasonville and Kent Island area. For Kent Island, the Magothy and deeper formations will be the only sources available due to the over pumping and brackish water intrusion of the Aquia.

- **Raritan Formation.** This formation is part of the Lower Cretaceous Series. The Raritan Formation lies just above the Patapsco Formation and is lithologically and hydrologically similar. The formation dips and thickens toward the southeast about 30 feet per mile. Outcrops of the Raritan Formation appear in Cecil County and reappear in Kent County. Water from this formation has high iron concentrations. Although seldom tapped at this time due to its depth, the Raritan Formation is a potential water-bearing formation for the future.
- **Patapsco Formation.** This formation is the deepest part of the Lower Cretaceous Series. It is made up of lenticular bodies of cross-bedded sand, clay, and sandy clay. Although lenses may be thin and of limited lateral extent, taken together they form a large unit of water-bearing material. The Patapsco has a southeast dip of about 40 feet per mile. Limited outcrops appear in a belt averaging nine miles wide that crosses central Cecil County in a northeast direction. During the winter of 1999, the Sanitary District constructed a test well into the Patapsco aquifer at the Stevensville water treatment plant. The results of the water quality analysis indicated an iron content of less than 5 parts per million, only one-sixth the iron produced by the on-site Magothy aquifer wells. As a result the Sanitary District has now drilled a production well into the Patapsco to replace the Magothy as the primary source of potable water at both the Stevensville WTP and at the Business Park WTP.
- **Patuxent Formation.** This formation, which makes up the Lower Cretaceous Series, lies on Precambrian crystalline basement rocks. The thickness varies because of non-conformities becoming generally thicker in the direction of its dip toward the southeast. Its outcrop in Cecil County is poorly exposed and extends over a large area. The Patuxent Formation is a very deep aquifer in Queen Anne's County, and because large quantities of water are readily available in other aquifers, the Patuxent must be considered a reserve source rather than a source to be tapped in the immediate future.

SURFACE WATER

MDE's *Prioritizing Sites for Wetland Restoration, Mitigation – Queen Anne's County* provided descriptions of surface waters within Queen Anne's County including streams and wetlands-ponds.

STREAMS

Most of the surface water drains in one of three directions from the highest natural point in the County, located one mile northwest of Starr--into the Chester River, the Choptank River (via Tuckahoe Creek) or Eastern Bay (via the Wye River, Prospect Bay, Crab Alley Bay, and Cox Creek). The western edge of Kent Island drains directly into the Chesapeake Bay.

Because the County is relatively flat and near sea level, the streams in the County are slow moving. The downstream portion of many rivers in the County are influenced by the tides and tend to have very slow "flushing" rates, reducing their ability to act as points of discharge for sewerage treatment systems.

All surface waters of Queen Anne's County have been classified as Class I or Class II. Class I waters are to be maintained as suitable for contact recreation and aquatic life. Class II waters are to be maintained as suitable for shellfish harvesting. The Code of Maryland Regulations Water Quality Regulations (COMAR 26.08.02) gives the specific water quality parameters for both classes. Limitations have been set for bacteria, nitrogen, phosphorus, sedimentation, oil, and several other pollutants.

WETLANDS & PONDS

Wetlands are often credited with providing natural habitat, stormwater, and flood control benefits. Inland wetlands adjacent to rivers, streams and creeks hold excess discharge and runoff during periods of increased precipitation such as storms and snow melts. Coastal wetlands also hold excess discharge from inland drainage networks as well as tidal waters during storms. They also offer protection to sea level rise and inundation and, over time, they may migrate upland while being in competition with existing development.

Ponds, marshes and oxbows serve an important function by receiving excess water during the rainy season and holding it throughout the dry season. These features receive water directly from a rising river or stream during the rainy season and then drain back into the river or stream as water levels drop. These water bodies serve as refuges for fish and other aquatic organisms.

MUNICIPAL GROWTH ELEMENTS

Table 1-12 summarizes planned municipal growth within incorporated Towns within Queen Anne's County as described in their Municipal Growth Elements.

Table 1-12. Summary of Municipal Growth Elements

Incorporated Town	Growth Area		Change in Incorporated Boundary (Annexation)
	Existing	Future	
Barclay	Approximately 76-acre Growth Area east and west of Goldsboro Road. The Growth Area does not contain Critical Area.		No immediate annexations are anticipated. Properties in the Growth Area may be annexed subject to sewer availability supplied by Sudlersville through agreement.
Centreville	Previously expanded to include Greenbelt Areas and the County Business Park; current Growth Area is approximately 2,010 acres to the east and southwest of Town boundary (1,720 acres excluding Greenbelt Areas and Business Park). Approximately 17 acres of the current Growth Area is in the RCA Critical Area.	See updated Centreville Comprehensive Plan (in progress) for proposed changes.	See updated Centreville Comprehensive Plan (in progress) for proposed changes.
Church Hill	226-acre Growth Area to the north and east of current boundaries. The Growth Area does not contain Critical Area.		No immediate annexations are anticipated. The Growth Area includes 7 subareas used to estimate and communicate where and how much development might occur.
Millington	All of the Millington Growth Area is in Kent County.	No changes proposed within Queen Anne's County.	No changes proposed within Queen Anne's County.

Queen Anne	No Growth Area identified.	Not served by public water or sewer; significant future growth unlikely.	No immediate annexations are anticipated.
Queenstown	Growth Area of approximately 810 acres to the east of current Town boundaries. Approximately 50 acres of the Growth Area is in the Critical Area: 17 acres in RCA and 33 acres in LDA.		Annexation is anticipated; however, improvements may be needed before long-term plans are achieved.
Sudlersville	Growth Area of approximately 640 acres to the north and west of current Town boundaries, identified as Inner- and Outer-Loops. The Growth Area does not contain Critical Area.		Sudlersville anticipates annexation of Inner-Loop properties as water and sewer become available and development is proposed.
Templeville	Growth Area of approximately 324 acres (approximately 105 acres in Queen Anne's County; remaining Growth Area within Caroline County). The Growth Area does not contain Critical Area.		Templeville anticipates annexation of parcels that are currently split between the County and Town jurisdiction. Growth will be subject to provision of water and sewer from Caroline County. Templeville is currently 48 acres in size, 30 of which are in Queen Anne's County.

COUNTY COMPREHENSIVE WATER & SEWERAGE PLAN

After adoption of the 2021 Comprehensive Plan, the County should revise its Comprehensive Water and Sewerage Plan and incorporate land use changes identified, particularly due to sewer capacity limitations. Revisions should be based upon ability of the water resource (drinking water and wastewater) to support development based on population growth as well as development capacity analysis based upon zoning. Plans for water treatment and wastewater treatment facilities and collection and conveyance systems should be considered. The revisions should also take into account Town Annexations to accommodate growth in and around the Towns when identifying water and sewer service areas with appropriate phasing and timing consistent with land use plans.

- Conduct water availability studies and/or collaborate on regional and statewide studies.
- Evaluate regional solutions to future water supply capacity planning.
- Utilize eight-digit watersheds to identify appropriate restrictions and protections to ensure water supply to support the timing, phasing, density and intensity of land uses.
- New development must pay for the cost of providing water and sewer.

DRINKING WATER ASSESSMENT

A safe and adequate drinking water supply is critical to the sustainability of existing communities and to the viability of future planned growth.

GENERAL—WATER SERVICE AREAS

Water service areas are identified in the County's *Comprehensive Water and Sewerage Plan*. The *Comprehensive Water and Sewerage Plan* also provides a description of Water Service Areas and the Water Service Areas (and those areas of Public Health Concerns).

COUNTY WATER TREATMENT FACILITIES

The Queen Anne's County *Comprehensive Water and Sewerage Plan* provides an in-depth description of treatment facilities, water supplies, and water demand.

BAYSIDE-QUEENS LANDING WATER SYSTEM

The Bayside facility has two 10-inch wells into the Upper Patapsco aquifer, which were constructed in 2006 and 2010 after both existing wells suffered irreparable casing failure. Its net treatment capacity increased from 90 gpm to 160 gpm by the addition of an ion exchange unit upstream of the filters in 2005. It has a maximum output of 193,000 gpd assuming a 20-hour run time as the maximum allowable. Its average groundwater consumption in year 2020 was 86,000 gpd. Storage consists of a 14,000-gallon clear well and the system is connected via a 10-inch main to the Queens Landing standpipe and a 12-inch main to the Bridgepointe/Kent Island Village service areas.

The Queens Landing facility has two 10-inch wells into the Aquia aquifer. It has a net treatment capacity of 135 gpm with a maximum output of 165,000 gpd assuming a 20-hour run time as the maximum allowable. Its average groundwater consumption in year 2020 was 21,000 gpd. Storage consists of a 425,000-gallon standpipe (of which only 120,000 gallons is considered usable from an adequate pressure point of view), shared with Bayside's water system.

BRIDGE POINT WATER SYSTEM

This facility has two 6-inch wells into the Magothy aquifer. It has a net treatment capacity of 115 gpm with a maximum output of 140,000 gpd assuming a 20-hour run time as the maximum allowable. An ion exchange unit was added in 2002 to enhance iron removal. Its average groundwater consumption in year 2020 was 57,000 gpd. Storage consists of one 10,000-gallon and one 7,000-gallon hydro pneumatic tank, as well as a 300,000-gallon ground storage tank serviced by a booster pump station. It is interconnected via an 8-inch water main to the Kent Island Village plant, and via a 12-inch main to the Bayside/Queens Landing service area.

GRASONVILLE WATER SYSTEM

This facility has two 10-inch wells into the Magothy, each with a yield of 700 gpm. The treatment capacity initially will be 120 gpm. The site also has a 290,000-gallon ground storage tank. Its average groundwater consumption in 2020 was 85,500 gpd. An ion exchange unit was added in 2005 to enhance iron removal.

OYSTER COVE WATER SYSTEM

This facility has two 6-inch wells into the Aquia aquifer. It has a net treatment capacity of 195 gpm with a maximum output of 234,000 gpd assuming a 20-hour run time as the maximum allowable; however, production from this site is restricted to 200,000 gpd due to the Groundwater Appropriation Permit. Its average groundwater consumption in year 2020 was 68,500 gpd. Storage consists of a 20,000-gallon ground storage tank and an 180,000-gallon ground storage tank. This system was connected to the Stevensville water system in 2019 via a 12-inch water main

placed within Main Street; however, the systems remain 'separated' by a check valve to maintain the Oyster Cove system's higher operating pressures. The check valve will open in times of high demand, such as a fire event, and will provide redundancy to the Oyster Cove system in the event of the Oyster Cove treatment system having to be taken offline.

PROSPECT BAY WATER SYSTEM

This facility has two 10-inch wells into the Aquia aquifer. It has a treatment capacity of 220 gpm with a maximum output of 264,000 gpd assuming a 20-hour run time as the maximum allowable. Its average groundwater consumption for 2020 was 67,500 gpd. Storage consists of a 300,000-gallon elevated storage tower. This is the only County facility that requires arsenic removal.

RIVERSIDE WATER SYSTEM

This facility has one 6-inch well into the Magothy aquifer. It has a net treatment capacity of 50 gpm with a maximum output of 60,000 gpd assuming a 20-hour run time as the maximum allowable. Its average groundwater consumption in year 2020 was 5,000 gpd.

STEVENSVILLE WATER SYSTEM

The Stevensville facility has a single 20-inch well into the lower Patapsco. It has a net treatment capacity of 340 gpm with a maximum output of 410,000 gpd assuming a 20-hour run time as the maximum allowable. Its average groundwater consumption in year 2020 was 246,000 gpd. Storage consists of a 36,000-gallon clear well and a 290,000-gallon ground storage tank.

The Thompson Creek facility has one 12-inch well into the lower Patapsco. It has a net treatment capacity of 300 gpm with a maximum output of 360,000 gpd assuming a 20-hour run time as the maximum allowable. Its average groundwater consumption for year 2020 was 175,000 gpd. Storage consists of a 270,000-gallon ground storage tank.

The Chesapeake Bay Business Park facility has one 12-inch well into the Lower Patapsco aquifer. Net water production is 145 gpm. Its average groundwater consumption in 2020 was 338,500 gpd. Storage consists of a 250,000-gallon elevated tower shared with Thompson Creek and Stevensville and a 20,000-gallon clear well. This plant is connected via a 12-inch main to the Stevensville service area.

In 2018, elevated storage was augmented via a 500,000-gallon tower constructed by the developers of Four Seasons.

TOWN WATER TREATMENT FACILITIES

In addition to County managed facilities there are several Township managed facilities, including the following as illustrated in **Table 1-13** and further described in this section.

Table 1-13. Incorporated Town Water Treatment Facilities

Water Supply/Facility	Provides Service To	Water Source-Aquifer	Watershed
Centreville	Centreville Growth Area	Aquia	Corsica River
Church Hill	Church Hill	Aquia	Southeast Creek
Millington	Millington	Aquia	Upper Chester River
Queenstown	Queenstown Growth Area	Matawan	Wye River/Corsica River
Sudlersville	Sudlersville	Aquia	Upper Chester River

BARCLAY

The residents of Barclay, a small incorporated town with a reported population of 183 per 2020 Decennial Census Redistricting Data, obtain their water from private wells. Many are shallow wells which range from a depth of 25 to 35 feet and utilize the surface deposits of the Wicomico Formation for their source of water. Because the shallow aquifer has shown increasing nitrate/nitrogen levels, new wells and replacement wells are now being drilled in the Aquia aquifer.

Two 4-inch wells are used for fire protection. One is 54 feet deep with a yield of 45 gpm and the other is 60 feet deep with a yield of 270 gpm. The location of the two wells permits every building in the town to be protected from fire damage using normal firefighting equipment.

Existing facilities for water supply are considered adequate and can be expected to serve well into the future.

CENTREVILLE WATER SYSTEM

The Town of Centreville, with a reported population of 4,7274 per 2020 Decennial Census Redistricting data, has a water supply system that serves most of the Town and some adjacent properties. Presently, there are approximately 925 building connections serving an estimated 3,300 people throughout an area of about 1,450 acres.

The main distribution lines are of 6-inch, 8-inch, and 10-inch diameters. Storage is provided by three elevated tanks with capacities of 100,000, 200,000, and 300,000 gallons. There are two water treatment plants serving the Town. Any 4-inch service mains still existing will be eliminated and aging mains and service laterals replaced as funds allow upgrades to the distribution system. The Town also plans to construct an elevated tank near MD 304 with a capacity of up to 600,000 gallons, as well as additional looped distribution piping to enhance the system's reliability.

Presently, the entire area within Town boundaries is serviced. The Town annexed the Providence Farm historic farmhouse and surrounding properties, which were connected during the restoration process. Ultimately, the Centreville water system may be expanded to reach other developments that may occur when properties are annexed.

The Centreville water system is authorized to use an average of 355,000 gpd and a maximum use of 400,000 gpd.

The Centreville water service map also shows an area designated as W-3 at the intersection of US 301/MD 304. This is an area that has a mixture of commercial, industrial, and municipal uses. In addition, there are some parcels that are currently agricultural. It was suggested that the vacant areas be developed into a County-developed business park.

During PlanQAC discussions, Town staff indicated a desire for the County to allow treated effluent for use on neighboring farms, which would be one step toward limiting utilization of high use aquifers.

CHURCH HILL

In the past, residents of the Town of Church Hill, a community with a reported population of 808 per 2020 Decennial Census Redistricting Data, obtained their water from surface deposits using private shallow wells. Most of these wells were abandoned in favor of deeper wells into the Aquia that are more reliable in dry periods. The deep wells in the area are about 130-140 feet deep, utilizing the Aquia Greensand Formation. Yields range from 20-60 gpm and the water quality is generally good.

For fire protection, there are two deep public wells located within the Town. A sewerage system was built, which should protect groundwater in the surface deposits from contamination. The Town evaluated the potential of providing water and decided that water may be a requirement for any newly annexed lands and extensions of these systems would eventually service the existing Town environs.

The Pond at Church Hill, a senior housing facility added in 2005, has a small water treatment system to service 43 age-restricted senior housing units with average daily water flow of 4,300 gpd. The Pine Ridge system was also added, serving 16 condominiums. Water is supplied by four wells with four units sharing one well.

MILLINGTON

Most of the Town of Millington lies in Kent County; however, a small portion of the Town is within Queen Anne's County. The Town's population (including those in both Kent and Queen Anne's County) was 549 per 2020 Decennial Census Redistricting Data. Previously, all water needs were supplied by private wells, some of them being deep wells. In 2006, a water system was constructed with two wells into the Aquia aquifer, with chlorination and elevated storage. The wells were screened in the Aquia at 155-185 feet. Elevated storage of 250,000 gallons was also provided. The service area includes all Town limits, including the Queen Anne's County portion, as well as the existing sewer service area located within Kent County to the west.

QUEEN ANNE

The small incorporated Town of Queen Anne lies in both Queen Anne's County and Talbot County. The Town's population (including those in both Talbot and Queen Anne's County) was 192 per 2020 Decennial Census Redistricting Data. Presently, private wells supply all the water needs of the area except fire protection. Most of the wells are deep; however, a few are shallow. The shallow wells obtain a sufficient quantity of water from the Wicomico Formation at depths of 20-30 feet; however, water from these wells is high in iron content. The deep wells appear to achieve better water quality utilizing the Cheswold Formation, found at 80-100 feet, or the Piney Point aquifer at 160-200 feet.

To provide for fire protection, Queen Anne has a dry main and hydrant system. When required, water is pumped from Tuckahoe Creek into a distribution system of 4-inch diameter piping.

QUEENSTOWN WATER SYSTEM

The Charter of the Town of Queenstown, a community with a reported population of 705 per 2020 Decennial Census Redistricting Data, requires all developed properties within Town limits to be served by a public water system owned and operated by the Town. In addition, the Town provides water service to Friel's Lumber Company and the Queen Anne's County Animal Control Facility, which are located outside its corporate limits. The Town presently serves water to approximately 645 people, plus daytime commercial use, through approximately 265 residential and 30 commercial building connections. The Town presently serves water to its approximately 705 residents plus daytime commercial use, through approximately 307 residential and 30 commercial building connections.

The Town's water appropriation permit allows for the average daily withdrawal of 70,000 gpd. The Town filed an application with the State in 2021 to increase its permit allocation to 275,000 gpd in conjunction with a proposed new well in the Matawan aquifer.

The Town has two wells drilled into the Matawan aquifer and one in the Aquia aquifer. Currently, it draws water from only the two Matawan wells. The Del Rhodes Avenue Well and the Outlet Center Well each have pumps rated at 150 gpm. The third well is located in the Aquia aquifer and has high levels of arsenic, which exceed the federal limit for arsenic in drinking water of 10 ppb and is only used for non-potable purposes, if at all. A new well has recently been proposed in the Matawan along with an increase in the GAP withdrawal capacity from 70,000 gpd to 275,000 gpd to facilitate existing service and future connections within the Town.

The water distribution system, which contains approximately 27,228 feet of pipe ranging in size from 1-10 inches in diameter, was originally installed around 1935.

Two elevated storage tanks (tower) serve the Town. One is located by the Wall Street Well, which has a capacity of 50,000 gallons. The other is located by the Outlet Center Well and has a capacity of 100,000 gallons. Both tanks are inspected and serviced on a regular basis. The Outlet Center tower is in good working condition, but the Wall Street tower is in need of repair and maintenance. The Town is evaluating whether to keep the Wall Street tower in service. Due to the relatively small size of the water storage capacity compared to the estimated future growth and water demand, the Town is pursuing the construction of a new 250,000 gpd water tower along Del Rhodes Avenue adjacent to the proposed new well in the Matawan aquifer.

Both the Town and County Comprehensive Plans call for a mix of residential and commercial land uses on lands in and adjacent to the Town and within the Queenstown Growth Area. Any future connections or annexations will require the Town to provide water and sewer service, per the Town's Charter. The density and timing of future growth has been estimated through engineering studies performed by the Town; these studies indicate that water service of 275,000 gpd will be required to serve full build-out through W-5 service areas and roughly 450,000 gpd through W-6 service areas.

SUDLERSVILLE WATER SYSTEM

Sudlersville is an incorporated town with a reported population of 507 per 2020 Decennial Census Redistricting Data. Its residents are connected to a water system with treatment to reduce arsenic, which was placed online in 2007 with a 12-inch water main extending from the water treatment plant (located next to Town Hall), north along Church Street (MD 313) to approximately Miller Street. The Town constructed a 500,000-gallon elevated storage tank and water mains to connect the remaining residents to the public water system.

TEMPLEVILLE

Templeville is a small incorporated town with a reported population of 113 per 2020 Decennial Census Redistricting Data—two-thirds of the population live in Queen Anne's County and the other one-third live in Caroline County. Residents use individual wells for their water supply. Many of the wells are shallow, utilizing the Wicomico Formation at depths of 15-30 feet. The most dependable source of good water in the area is the Aquia Greensand Formation used by deep wells of 150-200 feet.

Present conditions are adequate at this time and will remain so, providing that surface deposits are not contaminated.

WATER CAPACITY ASSESSMENT

Drinking water assessment is typically accomplished by analyzing data on groundwater withdrawal by facility, treatment capacity, and an analysis of each water system's demand and capacity. MDE issues Groundwater Appropriation Permits (GAP) for facilities or projects that withdraw an average of 10,000 gpd or greater. **Table 1-14** provides the GAP Well Withdrawal Limits and 2019 Daily Well Withdrawal quantities by service area. Under current demands, many of the service areas appear to be near capacity in the GAP Average GPD withdrawal limits and two service areas—Bayside and Thompson Creek—are over capacity in terms of average GPD. New development in these service areas should be carefully considered in terms of water capacity and efforts to increase water capacity production could be evaluated if future growth is anticipated in these areas.

Table 1-14. GAP Well Withdrawal Limits Comparison (GPD)

Service Area	GAP Well Withdrawal Limits		2019 Daily Well Withdrawal		Total 2019 Well Withdrawal GPD
	Maximum GPD	Average GPD	Maximum GPD	Average GPD	
County Facilities					
Bayside	255,000	144,000	206,693	155,490	1,865,875
Bridge Pointe	150,000	100,000	30,410	7,426	89,110
Grasonville	210,000	100,000	91,448	77,035	924,414
Kent Island Village	20,000	15,000	458	210	2,516
Oyster Cove	300,000	200,000	115,968	67,076	804,909
Prospect Bay	195,000	125,000	114,728	71,783	861,392
Queen's Landing	45,000	27,000	29,042	11,631	139,573
Riverside	8,500	5,100	5,403	4,359	52,312
Stevensville	500,000	350,000	285,484	174,609	2,095,312
Thompson Creek	500,000	210,000	330,620	249,245	2,990,945
Town Facilities					
Centreville-North Brook	645,000				
Centreville-Comet Drive	500,000	400,000	391,067	317,111	3,805,328
Queenstown	100,000	70,000	82,000	76,000	1,468,000
Sudlersville	200,000	125,000			

Source: Queen Anne's County Department of Public Works; Queenstown Planning Consultant. GAP—Groundwater Allocation Permit. GPD—Gallons Per Day.

The most limiting factor for water sources could include one of following: total permitted annual average daily appropriations, well-field capacity during drought, safe yield of the reservoir system, treatment capacity, or pump capacity. Three of the seven County managed wells have as a limiting factor "well-field capacity during drought;" the remainder have "total permitted annual average daily appropriations" as the limiting factor.

Table 1-15. Summary of Water Supply & Demand (County Facilities)

Water Supply Facility	Bayside*	Bridge Pointe**	Grasonville	Oyster Cove	Prospect Bay	Riverside	Stevensville***	Water Supply
Provides Service to[1]:	Chester GA	Chester GA	Grasonville GA	Kent Narrows GA	Stevensville GA	Chester GA	Stevensville GA, CBBP, TC	
Aquifer[2]	A, M	A, M	M	A	A	M	A, M, P	
Watershed	Lower Chester	Eastern Bay	Lower Chester	Kent Narrows	Eastern Bay	Eastern Bay	Eastern Bay, Kent Island	
A. Permitted Appropriations								
Total Annual Average Daily								
Average Day Capacity								
Limiting Factor	*Drought Wellfield Capacity 1.3 Peak Factor*	*Drought Wellfield Capacity 1.3 Peak Factor*	*Permitted Average Daily Appropriations*	*Permitted Average Daily Appropriations*	*Permitted Average Daily Appropriations*	*Permitted Average Daily Appropriations*	*Drought Wellfield Capacity 1.3 Peak Factor*	
B. Existing Demand								
Average Day Drought Demand								
Population Served								
# Connections								
C. Excess Annual Average Daily Capacity (A-B)								
Excess Average Day Capacity								
D. Planned or Anticipated Capacity Needs (demand based on known developments – residential and non-residential)								
Potential Annual Avg. Daily Demand								
E. Net Excess Capacity (C-D)								
Net Excess Capacity								
F. Potential Additional Users based on Net Excess Capacity (E/250 GPD)								
Potential Additional Units								

*Source: WRE Water Capacity Supply Worksheets. Notes: [1]GA-Growth Area; CBBP-Chesapeake Bay Business Park; TC-Thompson Creek. [2]A-Aquia; M-Magothy; P-Patapsco. *Bayside includes Bayside and Queen's Landing Facilities. **Bridge Pointe includes Bridge Pointe and Kent Island Facilities. ***Stevensville includes Stevensville, Chesapeake Bay Business Park, and Thompson Creek Facilities. Conclusion: Water Service Areas that have negative Daily Capacity or Net Excess Capacity (in red) may need to consider upgrades or changes in policy to meet anticipated growth.*

Table 1-16. Summary of Water Supply & Demand (Town Facilities)

Water Supply Facility	Centreville	Queenstown	Sudlersville	Water Supply
Provides Service to:	Centreville Growth Area	Queenstown Growth Area	Sudlersville	
Aquifer	Aquia	Matawan	Aquia	
Watershed	Corsica River	Corsica River, Wye River	Upper Chester River	
A. Permitted Appropriations				
Total Annual Average Daily	645,000 gpd	68,000 gpd (2017-19 avg)	17,500 gpd	739,500 gpd
Average Day Capacity	775,400 gpd	70,000 gpd	17,700 gpd	930,100 gpd
Limiting Factor				
B. Existing Demand				
Average Day Drought Demand	459,800 gpd	102,000 gpd	19,470 gpd	581,270 gpd
Population Served		705	432	1,067
# Connections		337	293	933
C. Excess Annual Average Daily Capacity (A-B)				
Excess Average Day Capacity	185,200 gpd	-32,000 gpd	-1,970 gpd	158,230 gpd
D. Planned or Anticipated Capacity Needs (demand based on known developments – residential and non-residential)				
Potential Annual Avg. Daily Demand	20,000 gpd	275,000 gpd	83,000 gpd	283,000 gpd
E. Net Excess Capacity (C-D)				
Net Excess Capacity	165,200 gpd	-307,000 gpd	-84,970 gpd	-124,770 gpd
F. Potential Additional Users based on Net Excess Capacity (E/250 GPD)				
Potential Additional Units	660 units	–	–	–

Source: WRE Water Capacity Supply Worksheets; Queenstown Planning Consultant. Conclusion: Water Service Areas that have negative Daily Capacity or Net Excess Capacity (in red) may need to consider upgrades or changes in policy to meet anticipated growth.

WASTEWATER ASSESSMENT

This section addresses the availability of suitable receiving waters and land areas to meet wastewater treatment and disposal needs. Suitable means that surface waters can assimilate pollutants from wastewater sources, including wastewater treatment plants, community and individual septic tanks and industrial sources, without violating water quality standards.

GENERAL—SEWER SERVICE AREAS

The Queen Anne's County *Comprehensive Water and Sewerage Plan* provided descriptions of Sewer Service Areas and the Sewer Service Areas (and those areas of Public Health Concerns) map provides the current status of Sewer Service Area Designations. There have been Community Plans completed for Queenstown, Centreville, Sudlersville, and Church Hill areas, and the planned or anticipated growth for these may require further modification to designated sewer service areas.

WASTEWATER TREATMENT FACILITIES

Wastewater treatment plant information was derived from the Queen Anne's County *Comprehensive Water and Sewerage Plan*, 2008 Town of Centreville Maryland, Wastewater Capacity Management Plan, recently completed Community Plans, and data as provided through Water Resource Element - Wastewater Capacity Management tables (MDE reporting tables). A summary table is provided.

Table 1-17. Wastewater Treatment Facilities Summary

Facility	Million Gallons per Day (MGD)			Comments
	Design Capacity	Average Daily Flow	Remaining Capacity	
KNSG	3.000	2.183	(0.110)	Includes residential, commercial, and multi-use commitments of 425,910 gpd (including 14,200 gpd for residential infill), 284,755 gpd of reserve for SKI failing septic areas, and 58,720 gpd reserve for commercial/institutional use.
Queenstown	0.200	0.102	0.098	The current maximum 200,000 gpd capacity of the Queenstown WWTP will be adequate to service the existing, committed, and projected flows of 185,365 gpd for Sewer Service Areas S-1 through S-4. The modular design of the plant allows for expansion as needed. Expansion of up to 400,000 gpd is possible and will be necessary to service long-term future flows including S-5 and S-6 service anticipated at 395,514 gpd. Modification to the discharge permit will be necessary upon increase in capacity.
Centreville	0.542	0.484	0.058	The treatment plant can be readily expanded to treat approximately 750,000 gpd with minor improvements. With more substantial improvements, the treatment plant can be expanded to treat approximately 1,000,000 gpd. The amount of water and sewer capacity that the Town will provide will have a direct impact on the amount of new development that the Town can accommodate. Capacity currently restricted due to available spray irrigation lands.
Church Hill	0.080	0.051	0.029	The capacity assessment indicates the WWTP will need to be expanded by 2030 in order to provide service for the 2030 forecast and of the full development of the Town. Any expansions of the Church Hill WWTP to accommodate additional growth would also need to improve the quality of treatment at the plant. Improved

				treatment levels would mean lower concentrations of BODs, suspended solids, phosphorus, and other substances and nutrients.
Sudlersville & Barclay*	0.200	0.087	0.113	Of the remaining capacity, 40,000 gpd is reserved for the connection to the Town of Barclay. Anticipated flow associated with growth will require expansion of plant capacity.
Millington	0.140	0.065	0.075	Serves approximately 281 connections within the Town. Service is provided to portions of Kent County (outside Town boundaries), but there are no connections outside of the Town boundaries in Queen Anne's County.

*Source: QAC KNSG Sewer Capacity Estimate (October 2019); Town of Queenstown 2017 Comprehensive Plan and 2021 Queenstown Planning Consultant Data; Town of Centreville 2009 Comprehensive Plan; Town of Church Hill 2010 Comprehensive Plan; Millington Town Manager (January 2022). Average Daily Flow = flows from 2017, 2018, 2019. * Barclay is dependent on Sudlersville for Capacity.*

TREATMENT CAPACITY LIMITATIONS

During this planning cycle, the community finds itself nearing the limits of adequate public facilities including, transportation infrastructure on its state and local roads, the Chesapeake Bay Bridge, local school capacity and sewerage capacity permit restrictions at the County's KNSG Wastewater Treatment Plant. In addition to these infrastructure challenges, the County must contemplate sustainable and resilient land use policies in the face of necessary hazard planning.

The existing 3 MGD capacity at the County's KNSG Wastewater Treatment Plant is now nearly fully obligated using the existing and estimated future capacity commitments (see **Table 1-18, Schedule A—Summation**). These commitments are calculated using a combination of the reported actual hydraulic flow through the plant and the reserved flow allocations for unbuilt development. The resulting estimates conclude that there is an insignificant amount of remaining available capacity.

Discharge of the plant is limited not so much by 'gallons,' but by the 'pounds of nutrients' allocated to the plant via the Chesapeake Bay Total Maximum Daily Load (TMDL) program, which is a component of the *1972 Federal Clean Water Act*. In accordance with KNSG's current National Permit Discharge Elimination System (NPDES) permit, KNSG may only discharge 36,547 pounds of nitrogen and 2,741 pounds of phosphorous per year. Nitrogen is the primary constraining factor, and the existing plant is operating with the best available nitrogen removal technology. The NPDES permit is the subject of federal and State review and renewal every five years. The next renewal application is November 1, 2023. These nutrient limits, known as the Waste Load Allocation (WLA), are assigned to the wastewater plant by the NPDES discharge permit. The controlling nutrient concentrations equate to 4 mg/l for nitrogen and 0.3 mg/l for phosphorous at the design flow of 3 MGD.

A number of recommendations were developed by the **PlanQAC** Technical Committee. These are incorporated into various chapters of the Plan *(see **Chapter 3—Community Facilities & Services**, **Chapter 4—Land Use**, **Chapter 5—Environmental Resources**, **Chapter 10—Town Planning Framework**, and **Chapter 11—Community Plans** for additional information).*

OPINION STRATEGY—NO. 1: SHORT-TERM OPTION—RE-RATING OF KNSG PLANT

The KNSG Plant has demonstrated outstanding operating performance and specifically has a superior nitrogen removal record. As a function of KNSG's permit renewal, the quality of the discharge will be assessed along with the nutrient load reduction achievement. This exercise may result in a modest re-rating of the plant capacity based on its nutrient removal performance. This could yield a modest increase in the overall maximum capacity; therefore, it is essential to realistically prioritize any performance re-rating capacity that may be gained. It is hoped that the re-rating will increase the flow-through capacity of the plant by 10% or an additional 300,000-gpd of capacity. If so, the maximum nitrogen

concentration allowed would be reduced from 4.0 mg/l to 3.6 mg/l. To be eligible for this re-rating, an engineering analysis would have to be undertaken and reviewed by MDE. Once this re-rated capacity is consumed, it will be very difficult and very expensive to add additional capacity, if that is even possible given the nitrogen constraint (pounds of nitrogen credits would have to be obtained from another source). In addition, capacity brings both debt and growth. New growth would be essential to fund the debt of a potential plant capacity expansion.

The following measures are suggested to address both the short-term (prior to the re-rating) and subsequent to the re-rating until such time a strategy to expand the plant further is developed, if such an expansion is deemed both feasible and desirable.

1. Reserve capacity for commercial uses
    a. There remain considerable vacant lands in the Chesapeake Bay Business Park that hold insufficient capacity to develop as well as a lot in the Matapeake Professional Park.
    b. Average allocation sold annually for commercial for the past 20-years ~7500-gpd (vs. ~25,000-gpd for residential).
2. Allow minor residential development
    a. Minor subdivisions – 7 lots or less (or allocation equivalent, i.e. 1,750-gpd max per project)
    b. Infill (should already hold a service commitment)
    c. TRUE commercial apartments – zoning may need to be refined such that the apartments would be ancillary to the commercial, not the other way around.
3. Prohibit any further large-scale residential development.
    a. Remove large vacant parcels from the Growth Area – rezone/downzone if required
    b. Remove large S-3 parcels from the Sewer Service Area or downgrade to S-4 or S-5 to acknowledge available treatment constraints.
4. Reserve capacity (130,000 gpd) to service Marling Farms and Dominion. Both subdivisions have been shown as problem areas for as long as Kent Island Estates and Romancoke.
    a. Dominion seems to be the worse of the two areas given its age—it consists of 192 parcels of which ~150 are single-family homes. Note there is some waterfront commercial potential there. Estimated capacity to serve is 50,000 gpd.
    b. Marling Farms consists of 389 parcels of which ~340 are single-family homes. Estimated capacity to serve is 80,000 gpd.

Table 1-18. Schedule A—Summation (November 2021)

Current Parameters		
Current Total Permitted Treatment Capacity		3,000,000 gpd
Current 3-Year Average Flow through Plant		(2,357,760) gpd
Capacity Remaining—Overall		642,240 gpd
Ongoing Projects Previously Granted Allocation		
Residential Units	1,606 dwellings	(321,200) gpd
Commercial Projects	176 commercial apartments, 169 hotel rooms, 56,000 sq. ft. other	(90,456) gpd
Reserve for SKI Failing Septic Areas	1,114 dwellings & commercial	(236,955) gpd
Reserve for Commercial/Institutional Use (04-68)	Approx.. 1,086,470 sq. ft. retail floor area	(54,324) gpd
Capacity Remaining		
		(60,703) gpd

Source: Queen Anne's County Department of Public Works

OPINION STRATEGY—NO. 2: LONG-TERM OPTIONS—PLANT CAPACITY EXPANSION

Below are several explorable options to expand the capacity of the KNSG Wastewater Treatment Plant. Each option has pros and cons. Each would require a modification of the discharge permit, which is a public process and depending on the level of concern and opposition, can take years to permit. A discharge permit is valid for five years. The current permit will renew on November 1, 2023, at which time a plant capacity re-rating may be under consideration (see **Opinion Strategy—No. 1**). Permit re-applications are required ~18 months in advance of the permit renewal date. Any of the following options, if pursued, will need to be incorporated into the permit renewal process.

OPTION 1: EXPAND THE CAPACITY OF THE PLANT— SPRAY IRRIGATION

This would require construction of new treatment facilities on the site of the current wastewater treatment plant and would be very expensive. Agricultural lands would have to be purchased, pipes installed from the plant to the spray fields, and irrigation pivots constructed. The advantage of this option is that the flow would not count against the 'nutrient budget;' in other words, any nitrogen discharged on land via spray irrigation would not count against the 36,547-pound limitation; however, the acreage of the lands required are a direct function of the soil types (i.e. how naturally well drained they are—ponding and run-off would be strictly prohibited), and soils on Kent Island are typically poorly drained. As an example, Centreville requires 300-acres to spray 542,000 gpd on well drained soils.

- Pros: Do not need Nitrogen Credits
- Cons: Most expensive option, need to expand the plant, need to run pipe to fields, need to buy fields, need to buy irrigation pivots. Need well drained soils to be effective. Unlikely to be able to spray year-round so would still have some impact on nutrient budget.

OPTION 2 - EXPAND THE CAPACITY OF THE PLANT – NUTRIENT CREDITS

This too would require construction of new facilities on the site of the current wastewater treatment plant and could be very expensive; however, probably less than the spray irrigation option. This expansion could not be undertaken without additional nutrient credits. There are some sub-options in this regard:

Retirement of Existing Septic Systems

The SKI project is generating nitrogen credits. These credits could then be incorporated into the discharge permit (they do not officially exist until incorporated).

- Pros: While still very expensive, may be the least expensive option.
- Cons: Need nutrient credits. Places the County at risk in assuming a great amount of debt to expand the wastewater treatment plant with no commitment from future developers to purchase the allocation gained.

Upgrade of other existing In-County Treatment Plants

If the County were to upgrade another treatment plant within the County that is still operating at non-nutrient removal discharge levels, then the County could transfer the nutrient credits gained from that upgrade to KNSG. Only Church Hill has not upgraded its plant, and the cost per pound achieved is likely to be prohibitively expensive—a new plant would have to be built for Church Hill as well as add new treatment capacity at Kent Island.

- Pros: Does not need nutrient credits.

- Cons: Very expensive option, requires another jurisdiction's approval and may likely require the County to operate their plant in perpetuity or other perpetual considerations. Capacity gained would be minimal (assuming Church Hill would want twice their current capacity (80,000-gpd) for their own growth, only 120,000-gpd would be gained).

Trading

Approach another jurisdiction that may have unused nutrient credits that would be willing to sell/trade. This would require a perpetual trade agreement (i.e. the trade would have to be forever). Unclear if such a trade has yet occurred, certainly not at the magnitude of pounds necessary to be of any value to the County.

- Pros: Uses another jurisdiction's nutrient credits.
- Cons: Many unknowns, trading is still in its infancy. Certainly, there will be a cost, most likely a perpetual cost, for the trade, and still need to expand KNSG. May not be enough credits available.

Other Considerations

Economics—All of the above options cost something. There are two costs that need to be considered.

- Cost per Pound of Nitrogen Removed: This should be the primary cost consideration in evaluating the various options. One suggestion is to add a new, or another type of technology, to the existing plant to remove more nitrogen. Hypothetically, you could add a reverse osmosis train to the end of the plant to remove 'all' nitrogen (although how would you dispose of the nitrogen enriched reject water – can't dump it in the sewer!). Reverse osmosis is quite expensive to construct and very expensive to operate – you need to generate intense pressure to force molecules through the filter membrane – pressure = energy. A similar analysis could be undertaken for each option. Any 'innovative' process will require MDE approval and may need a pilot project to demonstrate its effectiveness.
- Cost per Gallon: Allocation is sold 'per gallon'. The 2021 rate 'per gallon' is $36.73. The cost per gallon is set, in large part, to recover the cost to construct the plant's treatment capacity, or more to the point, to pay off the debt service on the new plant. If the cost of the new treatment plant is too high on a per gallon basis, new development may be unable or willing to pay that cost.

Debt—All the above options cost something, which equates to debt that the County must pay, regardless of developer demand. The last 'expansion' of 1 million gallons (which was truthfully the construction of 3 million gallons of capacity as little of the existing 2-million-gallon plant was salvageable) cost $34M – 45% of which was funded by grants. This equated to 20-years debt at $1M per year. Prior to executing that construction contract, we already had an executed DRRA with Four Seasons which guaranteed the payment of 1/3 of that cost. Even so, we had a very difficult time paying the debt until just recently. Indeed, we almost exhausted 30-years' worth of accumulated reserve funds to pay debt service. The cost of adding capacity is largely unknown. It is also unknown if any grant funds would be available to assist in the capital cost, past grant funds were solely to upgrade the plants nutrient removal ability, not to fund expansion, hence the 45% share.

SKI Nitrogen Credits—Each time a septic system is connected to our plant, a few pounds of nitrogen credit is eventually earned. The amount credited is a function of the location of the septic system to tidal waters (i.e. in the Critical Area or not) or proximity to perennial streams. Once all four phases of SKI's septic systems are connected, the County will gain approximately 13,000 pounds of nitrogen

credits. As noted previously, those credits don't 'exist' until incorporated into the plant's discharge permit – so probably 10 years from now. This would equate to about 1 million gallons of flow. Note this only allows you to expand your flow, you still need to expand the capacity of the treatment process at the plant.

MS4 vs. SKI Nitrogen Credits—The County remains in litigation with MDE on the implementation of the Municipal Separate Storm Sewer System (MS4) permit. Even so, it is a foregone conclusion that the County will not escape the permit, the litigation at this point is to seek clarity of certain aspects of the permit.

This permit is much like the County's sewer discharge permit, except that it is designed to 'treat' rain runoff, not sewage. 'Treatment' of the runoff is via various, and numerous, (and costly) small ponds, constructed wetlands, and other naturally filtering features. If areas are currently untreated, the permit requires the County to 'treat' the runoff by constructing various features.

In accordance with the permit, as currently written, the County is required to treat 200-acres of existing impervious area by 2025. Note these are not impervious acres that the County owns, the vast majority is on private property. The estimated cost to achieve this (ignoring the fact it would take numerous private property owners permission as well as their lands) was estimated to be $10 to $15 million. In addition to the construction cost, there is also a perpetual maintenance obligation that the County would have to assume.

However, in lieu of actual treatment, the permit allows nutrient credits as an 'in lieu' method of treatment. The 'in lieu' computation is on a 'so many acres per retired septic system' basis. The current metric is 0.39 acres per septic system, however that metric is subject to change. Assuming it doesn't, that would equate to about 500 septic systems.

SOUTHERN KENT ISLAND SANITARY PROJECT

The Southern Kent Island (SKI) Sanitary Project addresses concerns of public health and safety for the residents of SKI, specifically the residents and property owners of the nine subdivisions known as Matapeake Estates, Normans, Sunny Isle of Kent, Chesapeake Estates, Kentmorr, Queen Anne's Colony, Kent Island Estates, Romancoke on the Bay, and Tower Gardens.

At the outset of the project, the County Environmental Health Department estimated that 80% of the existing septic systems in the Kent Island Estates/Romancoke area discharged directly into groundwater on a seasonal basis (March and April) and that constitutes an uncorrectable failure. Uncorrectable failures are defined as those that cannot be remedied without utilizing direct groundwater penetration, or a holding tank, during the high water table season. Because of the small lot sizes, poor soil conditions, and seasonal high water table, on-site correction is not considered a long-term viable alternative.

To address the public health and safety concerns, the County is extending public sewer utilities to SKI. There were concerns that, as a consequence of providing public sewer services to these areas, some or all of the existing vacant lots within these communities would be developed; however, a large number of the existing lots are not buildable because of small lot sizes, high groundwater, and poor soil conditions.

STORMWATER MANAGEMENT

Stormwater runoff from development is a major contributor of pollutants and sediment to the Bay. The use of proper best management practices (BMPs) can reduce harmful impacts to the local hydrology.

The construction of roads, buildings and other impervious surfaces disrupts the natural hydrology of the landscape. Runoff from impervious surfaces carries nonpoint source pollutants such as nutrients, sediments, oil and a variety of toxic chemicals. The following provides general impacts to waterways for each of these components:

- Nutrients, primarily nitrogen and phosphorus, cause algal blooms which cloud water and cause "dead zones" without oxygen.
- Small sediment particles decrease water clarity.
- Larger sediment settles to the bottom of waterways, smothering bottom life and fish spawning areas.
- Heavy sediment loads can fill stream channels.
- Oil and toxic chemicals can kill aquatic life and impact the ability to swim in the Bay and make fish unsafe for human consumption.

Studies have documented that the quality of aquatic habitat in streams, lakes and wetlands begins to decline when the area of impervious surface located in upstream watersheds reaches 10% of the total land areas. When impervious surface reaches more than 25% within a watershed, waterways can only support few fish species able to tolerate high levels of pollution.

Maryland's smart growth policies emphasize concentrating growth where development already exists within Growth Areas to reduce sprawl and the increase of impervious surface across rural landscapes. An MS4 stormwater management policy has been established by the state that specifies a 200-acre reduction in impervious surface area below existing conditions or water quality treatment of the volume of runoff from 200 acres of a site's impervious surface.

Stormwater management practices help control nonpoint source pollution through the use of nonstructural and/or structure techniques to intercept surface runoff from developed areas, filter and treat this runoff, and then discharge it at a controlled rate.

ENVIRONMENTAL SITE DESIGN

If planning, policies and site evaluation are done well, nutrients entering the Chesapeake Bay via stormwater can be greatly reduced. Controlling problems at their source is almost always more effective and much less expensive over the long-run. The state has identified the following Environmental Site Design (ESD) principles to be applied locally:

- Develop a local ESD ordinance with specific benchmarks and ESD practices.
- Require increased onsite recharge and runoff reduction volumes.
- Require ESD mapping to ensure protection of environmentally sensitive features as part of initial site layout.
- Require ESD as the first step in site design as a mechanism to address needs while reducing need for costly infrastructure.
- Establish specific and numeric performance criteria to ensure a reduction of nutrient loadings to waterways.
- Identify stringent performance criteria for design, installation and maintenance of all stormwater and ESD practices.
- Establish specific triggers to promote non-structural controls for permanent stormwater management and for construction with the intent to maximize absorption of stormwater on-site.
- Establish standards for runoff leaving construction sites and should prohibit off-site discharges of sediment.
- Define more stringent stormwater criteria to protect special watersheds and maintain the biotic integrity of sensitive aquatic resources.
- Establish mandatory training and certification for ESD for County design and plan review staff as well as third-party inspection staff.
- Establish fees in accordance with Title 2 of the Financing Implementation portion of the Stormwater Management Act of 2007.

In 2008, the County adopted ESD standards to meet the requirements of this Act. The Maryland Department of the Environment (MDE) mandates the use of environmental site design (ESD) for all government and privately-funded projects through a regulatory program, effective April 1, 2010.

MARYLAND'S STORMWATER MANAGEMENT REGULATIONS

Maryland's stormwater management law is written in the Annotated Code of Maryland, Environment Article, Title 4, Subtitle 2. Stormwater regulations are contained in the Code of Maryland Regulations (COMAR) 26.17.02. and, the procedure for calculating the size of stormwater BMPs is outlined in the Maryland Stormwater Design Manual. MDE's specific performance standards address four main categories to address water quality:

- standards requiring recharge to the water table
- flood protection
- stream channel erosion protection
- water quality improvement

COUNTY REGULATION OF STORMWATER

In 2001 Queen Anne's County adopted a Stormwater Management Ordinance (Chapter 14, Section 4) whose purpose is to protect, maintain and enhance the public, health, safety, and general welfare by establishing minimum requirements and procedures to control the adverse impacts associated with increased stormwater runoff. The ordinance seeks to minimize damage to property, reduce the effects of development on land, control stream channel erosion, reduce local flooding, and maintain after development, as nearly as possible, the predevelopment runoff characteristics. The coordination and enforcement of the ordinance are under the Queen Anne's County Department of Public Works. Within the ordinance are articles requiring stormwater management plans, erosion and sediment controls, water recharge, flooding controls and application of Best Management Practices (BMPs).

Queen Anne's County in its Stormwater Management Ordinance has also identified the 2000 Maryland Stormwater Design Manual (Volumes I & II), to serve as the official guide for stormwater principles, methods and practices; which was supplemented, in December 2007, with a Queen Anne's County Environmental Site Design Manual. The County has routinely adopted the State Standards for Stormwater and adopted the latest standards in 2010. The State is mandated to address climate change precipitation amounts that dictate stormwater BMP size thresholds for design. Their initial report is due in November 2021. This mandate includes incorporating precipitation and climate change in updated stormwater design regulations. This State effort is something that the County is actively tracking.

STORMWATER FACILITIES

Queen Anne's County has been proactive in addressing stormwater. The County adopted an Environmental Site Design (ESD) before it was required, and there are demonstration projects within the County including permeable concrete and rain gardens. The Queen Anne's County Department of Public Works recently completed a Geographic Information Systems (GIS) inventory of stormwater facilities and can utilize the recently completed impervious surface coverage to augment stormwater practices, programs, and activities. Within the County there are over 1,000 stormwater facilities with inspection status reports provided to the State. Although Queen Anne's County does not have a Stormwater Utility it has been considered in the past.

BEST MANAGEMENT PRACTICES

A Best Management Practices matrix is provided in **Table 1-20**. The matrix includes information associated with a comprehensive planning and site design approaches that aims to minimize stormwater impacts associated with water quality volume and peak flows, and water supply. This

approach relates to a number of growth management initiatives such as Smart Growth, Low Impact Design (LID), conservation-by-Design and Environmental Site Design (ESD). The matrix contains a variety of Best Management Practices (BMPs) and land management techniques and strategies that can be used as a toolkit to reduce impacts on water resources.

LANDSCAPES TYPOLOGY

The following landscapes typologies are used to describe both natural and man-made environments across the County as well as used in the assessment of each watershed and associated Best Management Practices matrix tools and techniques.

- Agricultural Landscapes – Areas that are predominantly used and preserved (permanently or temporarily) for agricultural use with minimal intrusions by residential, commercial, industrial and institutional uses.
- Natural Landscapes – Areas that are predominantly undeveloped containing natural features such as waterways, riparian buffers, wetlands, floodplains, forests, wildlife habitats and other natural features.
- Rural Residential Landscapes – Areas within agricultural landscapes where historical or recent residential development and/or clusters have occurred.
- Suburban Landscapes – Areas in and around the Towns and Growth Areas where medium to low density residential, commercial and employment centers have developed or are permitted to expand in the future.
- Town/Village Landscapes – Incorporated Towns and Villages where historically development has occurred and has been supported by infrastructure improvements (e.g., water, sewer, roadways).

Table 1-19. Evaluation of Land Use Management Tools & Techniques

Key Tool/Technique	Key Advantages	Implementation	Key Disadvantages
Preserve & Repair Riparian Buffers	▪ Reduction of peak storm flow. ▪ Filtering pollutants. ▪ Reduction of nutrients in waterways. ▪ Streambank stabilization. ▪ Stream temperature control.	▪ Establish buffers, greenways, open space, and recreational areas through comprehensive planning. ▪ Support local watershed groups. ▪ Riparian Corridor Conservation District zoning overlay. ▪ Consistency between land development ordinances. ▪ Best Management Practices should be implemented by landowners in natural and rural landscapes.	▪ Establishments of buffers must be clearly tied to health, safety and welfare issues and environmental protection. ▪ A strong buffer awareness program may be required to educate development community and property owners.
Stormwater Management Best Management Practices	▪ Refer to Section 10.3 for examples of BMPs and other relevant information.	▪ Part of subdivision/development plans and required by stormwater management ordinances. ▪ Construct stormwater facilities on lands previously developed without such facilities. ▪ Conversion of dry ponds for stormwater management to extended detention or retention facilities which are more effective at nutrient removal. ▪ Requirements of various County and State permits.	▪ Lack of education/understanding of importance by the public. ▪ Initial cost of some practices may exceed traditional methods to address SWM.
Agricultural Best Management Practices ▪ Animal Waste Management Systems ▪ Cover Crops ▪ Nutrient Management Plan Implementation ▪ Runoff Control ▪ Retirement of Highly Erodible Land ▪ Stream Protection with and without Fencing ▪ Conservation Tillage	▪ Animal waste management systems are designed to properly handle, store and use waste generated by confined animal facilities. ▪ Cover crops reduce nitrate leaching losses during the winter and also reduces erosion. ▪ Nutrient management plan implementation reduces impacts of nutrients due to management practices. ▪ Runoff control reduces nutrient impacts on waterways. ▪ Retirement of highly erodible land reduces potential for soil loss. ▪ Stream protection discourages animals from entering streams. ▪ Conservation tillage minimal soil disturbance.	▪ Animal waste management systems include ponds, lagoons and tanks for liquid waste, and sheds or pits for solid waste. ▪ Cover crops are small grains planted in September or early October on land otherwise fallow with no fertilizer applied. ▪ Nutrient management plan implementation comprehensive plan to manage the amount, placement, timing and application of animal waste, fertilizer, sludge or other plant nutrients. ▪ Runoff control systems include ponds, lagoons and tanks for liquid waste and sheds or pits for solid waste. ▪ Retirement of erodible lands ▪ Stream protection provides troughs or other watering devices in remote locations away from streams to discourage animals from entering the stream and use of fencing adjacent to stream crossing to limit access points. ▪ Conservation tillage is a process that uses tillage equipment to seed the crop directly into the vegetative cover or crop residue on the surface.	▪ Cost associated with use of new equipment and procedures.
Conservation Subdivision or Cluster Development Standards	▪ Alternative to conventional development patterns that allow for preservation/conservation. ▪ Fewer environmental impacts. ▪ Potential reduction in infrastructure costs. ▪ Ability to create walkable neighborhoods and sense of community. ▪ On-lot systems can be used if designed and maintained properly.	▪ Amendment of zoning ordinance and subdivision/ development ordinance. ▪ Sketch plan process. ▪ Use of Map of Potential Conservation. ▪ Can be applied to all landscapes.	▪ May result in the need for community sewer systems. ▪ Continued use of agricultural uses in open spaces of cluster development creates conflict. ▪ Transportation and air quality impacts are the same as conventional development. ▪ Poor design can result in greater visual impacts than conventional design. ▪ May require more site inspections.
Natural Features Conservation Standards or Conservation Zoning	▪ Protection of floodplains, forests and vegetation. ▪ Preserve the Upper Delaware National Scenic and Recreational River Corridor. ▪ Protect groundwater and maintain groundwater recharge areas. ▪ Protect wellheads, riparian buffers, and steep slopes and manage stormwater. ▪ Protect and maintain water supply and reduce erosion and sedimentation. ▪ Protection of environmentally sensitive areas.	▪ Delineation of water resource features should be done by a professional hydro-geologist or engineer. ▪ Coordination with update of Natural Areas Inventory. ▪ Use of Map of Potential Conservation. ▪ Can be applied to all landscapes.	▪ Assessments can be costly.
Floodplain Regulations	▪ Protection of floodplain and water quality. ▪ Protection from flood damage. ▪ Creates riparian buffers to support wildlife habitats, greenways and access for recreation. ▪ Allowable and unallowable uses are defined in the ordinance.	▪ Map and ordinance regulations. ▪ Implemented as part of zoning ordinance. ▪ Land Development Plans subject to requirements and floodways, floodplain, flood areas and/or riparian buffers must be shown on plans.	▪ Cost associated with development of floodplain map and ordinance. ▪ Requires establishment of ordinance. ▪ Limitations on allowable uses may be too restrictive.
Tree Planting	▪ Reduces runoff.	▪ Includes any tree planting on any site except those along rivers and streams.	▪ Cost to private property owners.

		▪ Applicable to all landscapes.	
Urban Nutrient Management	▪ Reduction of excess lawn fertilizer use.	▪ Education program targeted at suburban residents and businesses.	▪ Voluntary compliance through education.
Resource Management Plan	▪ Protection of natural environment. ▪ Preservation of open space. ▪ Ability to create greenways or connections. ▪ Provides proper context for environmental regulations, pre-emptive statutes and forest management techniques.	▪ MDE Funding available to prepare plan. ▪ Plan can build upon Comprehensive Plan and Land Preservation, Parks and Recreation Plan (LPPRP). ▪ Utilizes map of Potential Conservation. ▪ Applicable to all landscapes.	▪ Cost associated with development of the plan. ▪ Cost associated with implementation (management of resources) of the plan. ▪ May result in development of additional local land use regulations and environmental regulations. ▪ Forest succession may not be attractive to all residents.
Resiliency and Hazard Planning	▪ Protection of life and limb ▪ Protection of resources and infrastructure	▪ During new development project review, contemplate the *2016 Sea Level Rise and Coastal Vulnerability Assessment Plan*, which identified key vulnerable resources ▪ Finalize the *2019 County Climate Resilience Planning and Financing Study* and contemplate the prioritization of resiliency projects and capital improvements.	▪ Cost to County and property owners
Resource Management Practices ▪ Forest Harvesting Practices ▪ Marine Pump-outs ▪ Structural Shore Erosion Control ▪ Nonstructural Shore Erosion Control	▪ Forest harvesting with appropriate controls in management zones will reduce erosion and impacts of runoff. ▪ Marine pump-outs will improve water quality. ▪ Structural shore erosion controls will stabilize eroding shorelines. ▪ Nonstructural shore erosion controls will stabilize eroding shorelines. Contributes to creating wetland habitats.	▪ Forest harvesting is the application of regulatory and voluntary best management practices applied to timber harvesting including erosion and sediment control and streamside management zones. ▪ Marine pump-outs are facilities sited at marinas for pumping sewage from boat holding tanks to dockside storage facility. Regulatory requirements are contained in ordinances. ▪ Structural shore erosion controls is a practice of stabilizing eroding shorelines using stone riprap or timber bulkheads. Suitable for sites with high wave energy. ▪ Nonstructural shore erosion controls a practice for stabilizing eroding shorelines by establishing marsh grasses. Suitable for sites with lower wave energy.	▪ Costs to property owners.
Use of Nitrate Levels to Restrict Development (Develop a Nitrates Map)	▪ Guides development supported by on-lot systems to appropriate areas. ▪ Contributes to public health, safety and welfare. ▪ Identifies areas for expansion of public water and sewer systems or restriction of development.	▪ Development of a Nitrates Map. ▪ Identification of appropriate site analysis and testing. ▪ Part of plan review and permitting. ▪ Applicable to all landscapes.	▪ Cost associated with development of a nitrates map. ▪ Additional cost to developer/property owner.
Priority Preservation Areas (PPAs) and Other Land Preservation Programs	▪ Targeted to natural or other environmentally sensitive resources such as wetlands, buffers along waterways, or forested areas that provide habitat for flora and fauna and wildlife habitats. ▪ Assist with maintaining functioning soil resources. ▪ If areas selected properly can contribute to wellhead protection and protection of other water resources. ▪ Funding may be associated with designations to assist with preservation and growth management.	▪ Designation of PPA as part of the comprehensive planning process. ▪ Designation of areas based upon specific programs.	▪ Potential for program to change or program to be augmented with a set of unknown regulations at the time of designation.
Planned Residential Development	▪ Development standards are specified prior to development approval and applicable to all phases of development through agreement. ▪ Allows for provision of adequate public facilities as part of development.	▪ Adequate planning and implementation of public facilities is part of the development. ▪ Applicable to rural residential landscapes.	▪ All phases of development are defined by a legal instrument and must develop in that manner regardless of change in economic market and/or changes in desired land use patterns. ▪ Legal agreements and extensive Solicitor involvement.
Traditional Neighborhood Development (TND)	▪ Development pattern emulates smaller, older communities. ▪ Pedestrian oriented community. ▪ Streets are laid out in a grid pattern. ▪ More community open space is provided. ▪ Variety of housing types with small or no front yards are provided. ▪ Mixed use neighborhood. ▪ Environment where residents can walk from home to jobs and commercial establishments. ▪ Minimize environmental impacts due to less use of automobile and close proximity of uses.	▪ Standards are typical of villages or small urbanized areas. ▪ Established through zoning ordinance and zoning map. ▪ Applicable for village landscapes (existing and proposed villages).	▪ Perception of public in rural areas results in hesitation to apply technique to residential communities that may require some level of mix use due to remote locations or lack of access to goods and services within existing community. ▪ Regulation of impacts and site design of non-residential uses must be addressed.

	▪ Can be used in existing villages, boroughs and mixed use neighborhoods to preserve historic resources and architectural integrity.		
Land Preservation Programs: ▪ Program Open Space ▪ Maryland Agricultural Land Preservation Program (MALPF) ▪ Rural Legacy ▪ GreenPrint ▪ Maryland Environmental Trust ▪ Conservation Reserve Enhancement Program	▪ Preservation of natural resources, environmentally sensitive lands and agricultural lands. ▪ Some programs provide financial benefits or tax incentives. ▪ Promotes effective land management of natural environment.	▪ Coordination with the County and state for application/designation and eligibility requirements.	▪ Limitations on type, amount and intensity of development.

STORMWATER MANAGEMENT TOOLS

There are several innovative tools and technologies or Best Management Practices (BMPs) available to reduce stormwater problems. The following matrix provides a brief description of various stormwater management tools applicable to all landscapes that contribute to:

- Providing acceptable practices for compliance with regulation of stormwater management.
- Minimizing the increase of surface volumes, rates and frequencies resulting from development.
- Minimizing increases to downstream flooding.
- Increasing recharge to groundwater.
- Increasing treatment and pollutant removal for groundwater recharge and surface water discharge.
- Decreasing erosion and sedimentation.
- Offering aesthetic amenities for new development.
- Reducing infrastructure requirements, space requirements and maintenance costs for stormwater handling facilities.
- Enhancing stream and riparian corridor management.

Table 1-20. Stormwater Best Management Practices

Tool	Description	Benefit
Rain Gardens	Rain gardens are gardens containing flowering plants and grasses that can survive in soil soaked with water from rainstorms. However, they are not gardens that have standing water.	Rain gardens collect and slow stormwater runoff and increase its infiltration into the soil.
Grassed Swales	Grassed swales are vegetated channels designed to treat and attenuate stormwater runoff for a specified water quality volume.	As stormwater flows through the channels, it is treated through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils.
Pervious Pavement	Pervious pavement is designed to allow percolation or infiltration of stormwater through the surface into the soil.	The water is naturally filtered and pollutants are removed.
Parking Lot Filter Strips	Filter strips are gently sloping, vegetated areas adjacent to impervious surfaces. These strips are typically referred to as vegetated filter strips, grassed filter strips, grassed filters or buffer strips.	They are intended to reduce impacts of sheet flow and velocity of stormwater and help improve its water quality. They help remove sediments, other pollutants and increase infiltration.
Bioretention Basins	Bioretention basins are landscaped depressions or shallow basins used to slow and treat on-site stormwater runoff.	Stormwater is directed to the basin and then percolates through the system. The slowed, cleaned water is allowed to infiltrate native soils or directed to nearby stormwater drains or receiving waters.
Underground Storage	On-site, underground stormwater retention/detention captures and stores stormwater collection from surrounding impervious areas.	The facility stores stormwater and then releases it directly through an outlet pipe back into natural waters at rates designed to reduce peak flows and mimic waters at rates designed to reduce peak flows and mimic pre-development conditions. In some cases, stored water can be allowed to infiltrate to recharge groundwater.
Green Roofs	Green roofs or vegetated roof covers (also referred to as living roofs, nature roofs and eco-roofs) are a thin layer of living plants growing on top of a roof.	A green roof is not a collection of potted plants to decorate a roof space, but rather an extension of a conventional roof which involves installation of a layered system of membranes, substrate and plants.
Stream and Shoreline Buffer Zones	Floodway areas consisting of natural vegetation such as grasses, shrubs and/or forests between 50 to 100 feet used as water quality buffer areas.	These zones can be effective in preventing runoff impacts and also in enhancing fish and wildlife by filtering pollutants and slowing runoff entering the waterway. These areas protect riparian and aquatic ecosystems and improve water quality.
Conservation of Natural Areas	Conservation of pervious natural areas and drainage pathways as well as avoiding disturbance of soils and native vegetation, especially on steep slopes.	Natural vegetation is used to minimize stormwater runoff and pollutant loads from the site.

FARM CONSERVATION BMPs

Conservation practices (or BMPs) are tools that farms can use to reduce soil and fertilizer runoff, properly manage animal waste, and protect water and air quality. Often, these tools also can help improve a farmer's bottom line by reducing operational costs. According to the Chesapeake Bay Foundation, the five most cost-effective conservation practices include:

- **Streamside Buffers.** Streamside buffers are areas bordering stream banks that get taken out of crop production or pasture use and instead planted with native trees, shrubs, or grasses. These buffers filter and absorb runoff pollution before it can reach streams. The buffers also help shade streams and provide food and homes for wildlife.
- **Streamside Fencing.** Streamside fencing keeps livestock and their waste out of farm streams, thereby reducing pollution and erosion and helping prevent the spread of waterborne disease.
- **Nutrient Management Plans.** Nutrient Management Plans help farmers know how much and when fertilizers should be used on crops. By developing and using the NMP, farmers can minimize fertilizer costs and reduce nutrient runoff into local waterways.
- **Conservation Tillage.** Conservation tillage reduces erosion and runoff by minimizing soil disturbances. This practice also builds the soil's health and its ability to hold moisture. Conversely, traditional plowing and tilling disturbs the soil and leaves it unprotected, allowing more erosion to occur.
- **Cover Crops.** Cover crops are planted to absorb excess fertilizer left in fields after the main crop is harvested. Cover crops help reduce runoff and erosion, while enriching the soil with organic matter. According to the Queen Anne's Soil Conservation District, the County has consistently been the first in the State for cover crops planted, averaging approximately 60,000 acres per year.

These practices reduce the greatest amounts of nitrogen and phosphorus per dollar spent. It is estimated that widespread use of these five BMPs on local farms could reduce the amount of nitrogen pollution going into the Bay from nonpoint sources by as much as 60%.

The Maryland Department of Agriculture (MDA) tracks BMPs installed in the County. **Table 1-21, Installed Farm Conservation BMPs** shows those installed from September 2016-September 2021. MDA also highlighted the value of developing soil and water quality conservation plans.

Table 1-21. Installed Farm Conservation BMPs

BMP	Description	Extent
Animal Mortality Facility	On-farm facility for the treatment/disposal of livestock and poultry carcasses for routine and catastrophic mortality events.	12
Conservation Cover	Establishing and maintaining perennial vegetative cover to protect soil and water resources on lands needing permanent protective cover that will not be used for forage production.	346.2 ac
Cover Crop	Growing a crop of grass, small grain, or legumes primarily for seasonal protection and soil improvement.	60,000 ac/yr
Critical Area Planting	Establishes permanent vegetation on sites that have (or are expected to have) high erosion rates and on sites that have conditions that prevent the establishment of vegetation with normal practices.	2.9 ac
Diversion	An earthen channel that is installed across a slope with a supporting ridge on the downhill side.	1,157 ft

Fence	A constructed barrier to animals or people.	52,456 ft
Field Border	Strips of permanent vegetation (grasses, legumes, forbs, shrubs) established on one or more sides of a field.	10.8 ac
Filter Strip	An area of vegetation established for removing sediment, organic material, and other pollutants from runoff and wastewater.	40.0 ac
Grade Stabilization Structure	A structure used to control the grade in natural or constructed channels.	23
Grassed Waterway	A shaped or graded channel that is established with suitable vegetation to convey surface water at a nonerosive velocity using a broad and shallow cross section to a stable outlet.	24.5 ac
Heavy Use Area Protection	A way to stabilize a ground surface that is frequently and intensively used by people, animals, or vehicles.	6.4 ac
Hedgerow Planting	Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.	39,298 ft
Lined Waterway or Outlet	A structure having an erosion resistant lining of concrete, stone, or other permanent material.	1,2770 ft
Livestock Pipeline	A pipeline installed to convey water for livestock or wildlife.	2,550 ft
Pasture & Hay Planting	Establishing adapted and compatible species, varieties, or cultivars of perennial herbaceous plants suitable for pasture or hay production.	73.7 ac
Prescribed Grazing	Managing the harvest of vegetation with grazing or browsing animals with the intent to achieve specific ecological, economic, and management objectives.	40.7 ac
Riparian Forest Buffer	An area predominantly covered by trees or shrubs located adjacent to and upgradient from a watercourse or water body.	80.3 ac
Riparian Herbaceous Cover	Establishment and maintenance of grasses, grass-like plants, and forbs that are tolerant of intermittent flooding or saturated soils and that are established or managed in the transitional zone between terrestrial and aquatic habitats.	1,613.3 ac
Roof Runoff Structure	A structure or system of structures to collect, control, and convey precipitation runoff from a roof.	6
Roofs & Covers	A system of rigid, semirigid, or flexible manufactured membrane; composite material; or roof structure placed over a waste management facility or an agrichemical handling facility.	11
Saturated Buffer	A vegetated, riparian buffer in which the water table is artificially raised by diverting much of the water from a subsurface drainage system along the buffer to reduce nitrate loading to surface water through enhanced denitrification.	600 ft
Sediment Control Pond	A pond or basin constructed with an engineered outlet, formed by constructing an embankment, excavating a dugout, or a combination of both.	1
Shallow Water Development & Management	The inundation of lands to provide habitat for fish or wildlife.	61.7 ac
Structure for Water Control	A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation, or measures water.	10

Subsurface Drain	A conduit such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and convey drainage water.	2,720 ft
Tree/Shrub Establishment	Planting seedlings or cuttings, seeding, or creating conditions that promote natural regeneration.	8.3 ac
Underground Outlet—Riser	A conduit or system of conduits installed beneath the ground surface to convey surface water to a suitable outlet.	3,688 ft
Waste Storage Facility	An agricultural waste storage impoundment or containment made by constructing an embankment, excavating a pit or dugout, or by fabricating a structure.	25
Water Well	A hole drilled, dug, driven, bored, jetted, or otherwise constructed into an aquifer for agricultural water supply.	4
Watering Facility	A means of providing drinking water to livestock or wildlife.	13
Wetland Creation	Establishment of a wetland on a site that was historically non-wetland.	95.2 ac
Wetland Restoration	A way to return a former or degraded wetland to a condition that is a close approximation of its original condition.	286.4 ac
Windbreak/Shelterbelt Establishment or Renovation	Single to multiple rows of trees and possibly shrubs planted in a linear fashion, established upwind of areas to be protected. Renovating a windbreak may involve removing, releasing, or replacing selected trees and shrubs or rows of trees or shrubs.	3,621.0 ft

Source: Queen Anne's County Soil Conservation District