Suggestions from SAIF Water Wells, Inc. in green and pink.
Lancaster County Comprehensive Plan, For Chapter 3,

B. GROUNDWATER

1. Groundwater Structure

As stated previously, Lancaster County residents are 100% dependent on groundwater for their drinking water supplies. Lancaster County's groundwater resources come from an underground system of aquifers that reflect the geology of the Coastal Plain Region of Virginia. Underground, the coastal plain is made up of unconsolidated gravels, sands, silts, and clays in addition to variable amounts of shells. This mixture of deposits rest on an underground rock surface called the basement, which slopes gently eastward. The basement rocks actually come out of the earth's surface at the fall line of the rivers, which is the dividing line between the Piedmont and Coastal Plain Regions of Virginia. As a point of reference the fall line of the Rappahannock River is at *space* Fredericksburg, the fall line of the James River is at Richmond, and the fall line of the Potomac River is at Washington, DC. At the fall line the thickness of the coastal plain sediments is zero; however, going east from the fall line the basement rock slopes down and the coastal plain sediments become thick. ~~By the time the downward slope stops at the coast,~~ At the coastline, the coastal plain sediments are over 6,000 feet thick. (The basement continues to deepen under the continental shelf - the downward slope does not stop at the coast line.])

Contained in the Coastal Plain sediments are a system of underground aquifers ~~These a Aquifers~~, or water-bearing units. ~~can be pictured as underground rivers that travel through sand. These rivers also come to the surface near the fall line, then they slope downward to the east. At the fall line the aquifers are recharged, meaning this is the point where water enters them.~~

Aquifers are recharged at the fall line, except for the Brightseat-Upper Potomac which is not recharged directly from the land surface. The Brightseat-Upper Potomac are the aquifers that offer the best sources of potable water.

~~Additionally, E~~ach aquifer is separated from those above and below by clay confining beds, from which they get the name confined aquifers. These confining beds act to trap the water in between, allowing water to escape up and down only at very slow rates. ~~The confining beds also act to add pressure to the water, therefore,~~ When the aquifers are tapped by a well the pressure enhances the flow of the water upward.

Throughout the Coastal Plain there is also an unconfined, water table aquifer. The water table aquifer is found between the ground surface and the top of the first confining bed. This aquifer is not pressurized and is the one used by shallow wells. This aquifer is recharged at ground surface level by rainwater and below the ground surface by water bodies such as creeks and rivers. Because this aquifer is unconfined and recharges from
the surface, it is very susceptible to contamination. Anything that permeates the ground surface can quickly reach the water table aquifer.
Wells in Lancaster County tap four underground aquifers. Shallow wells utilize the Columbia and Yorktown-Eastover Aquifers, which are the water table aquifers. Deep wells, or artesians, tap the Chickahominy-Piney Point Aquifer and the deeper Brightest-Upper Potomac Aquifer. Detail on each of these aquifers is given below.

a. Columbia Aquifer (Water Table)

The water table aquifer in the higher elevated parts of the western and central, and throughout the entire eastern section of Lancaster County is actually an aquifer named the Columbia. The Columbia Aquifer is moderately used as a drinking water supply by the residents and businesses utilizing shallow wells in Lancaster County (See Shallow Well Chart on Page 3-15). This aquifer is unconfined and made up of sand and sediment deposits found underground from an elevation approximately at sea level, to about 100 feet above sea level. However, clayey sediments can produce localized confined or semi-confined conditions (Pg. C52, USGS Professional Paper 1404-C).
The saturated thickness of the Columbia Aquifer ranges from 15 feet at the aquifer's western limit to about 80 feet in the southeastern part of the Coastal Plain (Pg. F5, USGS Professional Paper 1404-F). The local recharge area for the Columbia Aquifer is the ground surface of LancasterCounty. ~~The~~ ~~major~~ Sources ~~of~~ recharge are rain, ice, and snow. ~~storms on the ground level and underwater surface water body flows below the ground surface.~~ **MOVED FROM BELOW and corrected to accurately reflect the USGS SOURCE):** ~~Contamination in T~~his aquifer also affects lower aquifers, because the Columbia is also a source of recharge for the underlying confined aquifers (Pg. F5, USGS Professional Paper 1404-F). However, recharge by cross-formational flow is exceedingly slow—requiring hundreds and thousands of years. Contamination through this process is essentially negligible.)

Local conditions including topography, drainage patterns, and land cover influence where the most important recharge areas in the county are located. However, because the aquifer recharges primarily from the surface, it is very susceptible to contamination. Septic system discharge, agricultural and lawn fertilizers, leaking underground storage tanks, and improper disposal of hazardous home waste can cause contamination of this aquifer.

The groundwater supplies of the Columbia Aquifer usually fluctuate according to the seasons of the year, with lowest supplies present during local drought conditions. Lastly, localized high chloride concentrations in wells utilizing the Columbia are due to local intrusion of water from thespaceChesapeake Bay and its major estuaries (Pg. 11, USGS WRI Report 92-4175). This condition is reported to be present in shallow wells in some parts of Lancaster County which are very close to large surface water bodies.

ADDITIONAL PARAGRAPH

Water samples from some wells in this aquifer have elevated levels of nitrate, above the Maximum Contaminant Level recommended by the U.S. Environmental Protection Agency. High nitrate concentrations in groundwater are the result of human activities, especially agricultural fertilization practices and septic systems

b. Yorktown-Eastover (Unconfined, Water Table and Confined)

The Yorktown-Eastover Aquifer is unconfined in its western limits, but becomes confined as the aquifer slopes eastward (Pg. F7, USGS Professional Paper 1404-F). The western limit of the Yorktown-Eastover is in the western part of Lancaster County. In this part of the County, the Yorktown-Eastover acts as the water table aquifer. This area also serves as the recharge area for the confined part of the aquifer (Pg. F7, USGS Professional Paper 1404-F). The unconfined, water table recharge areas of the Yorktown-Eastover are important because it is where contaminants can quickly reach the aquifer through the ground surface. This is of further concern because the Yorktown-Eastover Aquifer is a primary source of drinking water for the Eastern Shore of Virginia (Pg. C51, USGS Professional Paper 1404-C).

The Yorktown-Eastover Aquifer is not used heavily in Lancaster County (See Shallow Well Chart Below). Use in Lancaster County would be by people with shallow wells in the western part of the County, and with wells reaching 75-85 feet in depth in the eastern parts of the County. Lastly, localized high chloride concentrations in wells utilizing the Yorktown-Eastover, like the Columbia, are due to local intrusion of water from thespaceChesapeake Bay and its major estuaries. This condition is reported to be present in shallow wells in some parts of Lancaster County which are very close to large surface water bodies.

Dug (Shallow) Well for Source of Water Supply

Lancaster County, VA - 1990

Towns	27	3% of Housing Units in Towns
County	1652	34% of Housing Units in County
Total	1679	28% of all Housing Units

Source: 1990 United States Census

This and other charts are using statistics from the 1990 census. They should be checked against the more recent census. Data is available from the Northern Neck Planning District.

c. Chickahominy-Piney Point Aquifer (Confined)

This confined aquifer is located approximately 200-425 feet below the ground surface in Lancaster County and averages 50 to 100 feet in thickness throughout its reach, with a maximum thickness of 140 feet in Lancaster County (Pg. C46, USGS Professional Paper 1404-C). The Chickahominy-Piney Point starts at outcrop areas near the major stream valleys in Stafford and King George Counties, on down through Caroline, Hanover, and Henrico Counties, just east of the fall line (Pg. C46, USGS Professional Paper 1404-C). The major recharge area for this aquifer is also found at the outcrop location. Water entering from the recharge area flows down and eastward to reach Lancaster County. Lesser recharge of the aquifer also occurs in smaller amounts from vertical seepage between the confining beds of the other aquifers and along existing well conduits. This aquifer is not as prone to contamination as the water table aquifer due to its limited recharge potential in Lancaster County. Furthermore, supply in this aquifer is not as susceptible to decreases due to local drought conditions. This aquifer is moderately used as a deep/artesian well supply by many light industrial, small municipal, and domestic users in Lancaster County(See Individual Drilled Well Chart on Page 3-18. Furthermore, the aquifer is thought to be capable of supplying large quantities of water suitable for most uses (Pg. C47, USGS Professional Paper 1404-C). However, there have been scattered reports of odor and other water quality problems in wells dug in this aquifer. Water in this aquifer contains concentrations of sodium, dissolved solids, and fluoride, which decrease while moving west in the aquifer. Specifically, sodium concentrations exceed 20mg/L throughout most of the aquifer, fluoride concentrations exceed 2mg/L in the south-central part of the aquifer, and concentrations of sulfate, chloride, and dissolved solids exceed the U.S. EPA Secondary Maximum Contaminant Level in the eastern part of the aquifer (Pgs. 13, 14, and 15, USGS WRI Report 92-4175).

d. Brightseat-Upper Potomac Aquifer (Confined)

This aquifer is located approximately 525-725 (should be changed to 820 since they are talking about both aquifers here) feet below the ground surface in Lancaster County. The aquifer is actually two aquifers located very close together, and separated by a thin confining bed. The Brightseat is the smaller aquifer and is located above the Upper Potomac Aquifer. The Upper Potomac Aquifer is located further below the surface at depths of 750 feet to 820 feet. These aquifers start from "subsurface pinchouts" east of the fall line and build to almost 400 feet in thickness to the east (Pg. C42, USGS Professional Paper 1404-C). **These aquifers have no significant source of surface recharge.** ~~**Recharge areas for these aquifers are located at the start of the "pinchouts" east of the fall line.**~~ Recharge also occurs in much smaller amounts from vertical seepage between aquifers and along existing well conduits. These aquifers are not as prone to contamination as the

water table aquifer due to its limited recharge potential in Lancaster County. Furthermore, supply of these aquifers is not susceptible to decreases due to local drought conditions.
Most deep wells in Lancaster County tap the Brightseat Aquifer, not the Upper-Potomac. Water in the Brightseat Aquifer is of the sodium bicarbonate type in the central part of the aquifer, and becomes of the sodium chloride to the east and southeast of Lancaster County under the Bay. ~~type when moving east~~. Additionally, groundwater in this aquifer becomes more mineralized the further one moves **south**east. For Lancaster County this means that certain parts of the county utilizing this aquifer have higher concentrations of sodium, and fluoride ~~and chloride~~ [not in any of the analyses of wells conducted by VDH] in their drinking water. Specifically, dissolved-solid concentrations exceed the 500 mg/L U.S. EPA SMCL in the eastern part of the aquifer, fluoride concentrations exceed the 4mg/L U.S. EPA MCL in the south-central part of the aquifer and the 2mg/L U.S. EPA SMCL in the rest of the aquifer. ~~and~~ Chloride ~~concentrations~~ exceed the 250 mg/L U.S. EPA SMCL in the southeastern part of the aquifer (Pg. 15, USGS WRI Report 92-4175). But Virginia Department of Health records do not show chloride concentrations exceeding 132ppm in Lancaster County. The highest chloride concentration is 132 ppm at Foxwells and the next highest is 71 at Mosquito Point. Locally, there are elevated concentrations of sodium, fluoride, and chloride in water drawn from this aquifer. These levels are particularly high in areas from White Stone east including Palmer, Foxwells, and Windmill Point. Sodium levels are approximately 230 mg/L in White Stone, 300 mg/L in Palmer, 400 mg/L in Foxwells, and as high as 500 mg/L at Windmill Point. **Sodium levels in the artesian aquifers in the entire county exceed the USEPA advisory limits for persons with health conditions requiring limitation of sodium intake.**

(1) Effects of Drawdown in the Brightseat-Upper Potomac

The Brightseat-Upper Potomac Aquifers are heavily tapped for deep/artesian well supplies in Lancaster County and regionally (See Individual Drilled Well Chart on Page 3-18). The aquifers are a principal source of groundwater for municipal, industrial, and agricultural use in the York-James, Middle, and Northern Neck Peninsulas of Virginia (Pg. F9, USGS Professional Paper 1404-F). **In 2004 the Maryland Geological Survey released a report on the need to assess the sustainability of the Ground-Water Resources in the Atlantic Coastal Plain and in 2006 began a cooperative effort with the U.S. Geological Survey. (Development in Maryland draws from aquifers shared with the Northern Neck of Virginia.)** Due to this heavy use there has been some regional drawdown in the aquifer throughout the Coastal Plain Region.

Drawdown is caused by the withdrawal of large amounts of groundwater from the confined aquifers. The result of drawdown is that water levels in the confined aquifers have declined and the underground flow of water has changed. These resulting situations ~~could~~ present future problems for Lancaster Countyspacedeep well users. Several United States Geological Survey reports have studied the Coastal Plain groundwater aquifers, as well as the effect of drawdown caused by heavy pumping. According to one report, the decline in the level of water in the aquifers has changed the direction of ground-water flow toward the major pumping centers. When considering the Brightseat-Upper Potomac Aquifers, these centers are located near the cities of Franklin, Williamsburg, Suffolk, and Alexandria and the towns of West Point and Smithfield. Total withdrawal from these centers is estimated to have been 65 MGD in 1980. Franklin alone had withdrawals over 40 MGD in 1980 (Pg. F83, USGS Professional Paper 1404-F). Industry, suburban development and golf courses are among the major users.

(Corrections in the following paragraph have been made to accurately reflect the USGS source.)

Furthermore, this report states **a general principle** that ~~the~~ heavy withdrawals ~~have~~ increase~~d~~ vertical leakage through confining units, reduce~~d~~ the volume of water stored in the ground-water flow system, increase~~d~~ flow from the water-table aquifer into the confined flow system, and decrease~~d~~ local ground-water discharge to streams and regional discharge to coastal water. Basically the natural balance between recharge and discharge that existed prior to periods of heavy pumping has been disturbed. Areas of heavy pumping now capture a large part of the water previously discharged from the ground-water flow system to surface water, such as the Chesapeake Bay and the Rappahannock River (Pgs. F10, F11, and F12, USGS Professional Paper 1404-F).
~~For Lancaster County this means that contaminants in the water table aquifer can now more easily reach the confined aquifers.~~
Furthermore,
future underground water supplies are decreasing at faster rates than before periods of heavy pumping. Lastly, groundwater supplies ~~which used to travel all the way to the coast to recharge surface water bodies with fresh water get~~ are detoured before they reach the surface water bodies. Impacts of this situation on the water quality of the Chesapeake Bay and its tributaries is unknown. (Specific data on water levels in wells monitored in Lancaster and surrounding counties by the United States Geological Survey, **documentation of artesian aquifer recharge areas and declining water supplies**, as well as a list of major water use areas can be seen in Appendix VII.)

~~Despite all the problems surrounding regional drawdown, it is believed that ample groundwater supplies exist for the foreseeable~~

~~future.~~ The Brightseat-Upper Potomac Aquifer**s** ~~is~~were documented in 1988 as capable of producing large quantities of high-quality water suitable for most uses (Pg. C42, USGS Professional Paper 1404-C). However, more recent activities of the USGS suggest a serious concern for issues surrounding declining artesian water supplies.

* Public Supply Well for Source of Water Supply Lancaster County, VA – 1990		
Towns	951	92% of Housing Units in Towns
County	1,200	25% of Housing Units in County
Total	2,151	36% of all Housing Units

* Individual Drilled Well for Source of Water Supply Lancaster County, VA – 1990		
Towns	51	5% of Housing Units in Towns
County	1,982	41% of Housing Units in County
Total	2,033	34% of all Housing Units
Source: **1990** United States Census Statistics		

* The large majority of the wells utilize the Brightseat-Upper Potomac aquifers for groundwater supplies. A smaller but significant number use the Chickahominy-Piney Point Aquifer **with mixed results in water quality.**

2. Existing And Projected Demand For Groundwater in Lancaster County, VA

In 1990 there were 10,896 people in Lancaster County, including approximately 1,100 people in the Town of Kilmarnock. (1,053 in Lancaster, and 56 in Northumberland) The 1,100 people in Kilmarnock used a total of .129 MGD (million gallons daily) of groundwater in 1990. The 9,769 people in the remainder of Lancaster County used a total of .88 MGD of groundwater in 1990. This comes to a County-wide total of 1.01 MGD for 1990. These figures were approximating a 117 gallons used per customer per day (GPCD) in the Town of Kilmarnock and 90 gallons used per customer per day in the remainder of Lancaster County. These averages were obtained from the 1988. Rappahannock Water Supply Plan prepared by the State Water Control Board. These figures can further be used to predict future demand for groundwater in Lancaster County.

These figures should be recalculated using a more recent data base and distinguish between major users such as the gold courses.

First, recent population projections were obtained for Lancaster County from the Virginia Employment Commission (VA Population Projections, 2010. VEC, June 1993). The projected annualized growth rate for the County was then applied to the Town's 1990 population to calculate projections. Lastly, the previous water use average for each customer per day was multiplied by the appropriate population for the Town or County to calculated projected groundwater demand. This is detailed in the following chart.

Year	Town Population	Town GPCD	Town MGD	County Population	County GPCD	County MGD	Total Population	Total MGD
1990	1,100	117	.129	9,796	90	.88	10,896	1.01
1995	1,141	117	.133	10,162	90	.91	11,303	1.04
2000	1,183	117	.138	10,508	90	.95	11,691	1.09
2010	1,250	117	.146	11,140	90	1.00	12,390	1.15

As is evidenced in the above chart, Lancaster County's projected groundwater supply needs are not expected to grow significantly. This projection would be in line with the 1988 Rappahannock Water Supply Plan which stated that the present groundwater system should be adequate to meet the needs of Kilmarnock's water supply through the 50-year planning period.

(This 50-year planning period would end in 2038. It is important to start from a more recent baseline if possible.)

These projections would indicate that despite the negative impacts of drawdown, the amount of the water supply is not the immediate problem. Instead the problems with the quality of the supply, as discussed under the individual aquifer sections, appear to be of more immediate concern.

3. Threats to Groundwater Supply

a. Septic Systems/Sewage Disposal

As discussed previously in the "Surface Water Section," individual homeowners sewage disposal means can act to negatively impact groundwater supplies local waterways and Chesapeake Bay. The aquifers most susceptible to contamination from individual sewage disposal systems are the Columbia and the unconfined water table part of the Yorktown-Eastover. Localized soil conditions such as high water tables and highly permeable soils in conjunction with large concentrations of septic systems can threaten the quality of the water table aquifers. The charts below detail the number of housing units in Lancaster County utilizing septic systems for sewage disposal, as well as the number of housing units lacking complete plumbing and kitchen facilities.

Suggested addition: In recent years a number of experimental types of wastewater treatment have been allowed by the Health Department. There needs to be some plan or county ordinance for monitoring their effectiveness and potential impacts on the environment.

A means should be developed to insure that septic tanks are pumped every 5 years in accordance with state regulations.

Septic/Cesspool for Sewage Disposal, Lancaster County, VA - 1990		
Towns	534	52% of Housing Units in Towns
County	4,370	89% of Housing Units in County
Total	4,904	83% of all Housing Units

Housing Units Lacking Complete Plumbing Facilities Lancaster County, VA - 1990		
Towns	8	< 1% of Housing Units in Towns
County	324	7% of Housing Units in County
Total	332	6% of all Housing Units

Housing Units Lacking Complete Kitchen Facilities, Lancaster County, VA - 1990		
Towns	6	< 1% of Housing Units in Towns
County	201	4% of Housing Units in County
Total	207	3.5% of all Housing Units

Source: **1990** United States Census Statistics

The 2000 census shows 7 white and 106 African American households lacking complete plumbing facilities.

b. Underground Storage Tanks

According to the Department of Environmental Quality's Underground Storage Tank database there are approximately 326 regulated underground storage tanks in Lancaster County (Local Inventory of Regulated Underground Storage Tanks can be viewed at the Lancaster County Planning and Land Use Office). Additionally, many people in the county have unregulated storage tanks which contain fuel for the home heating source or their personal vehicles. These underground storage tanks can be a possible source of contamination for groundwater in Lancaster County.

Regulated storage tanks in the county are all tanks over 110 gallons, except for residential/non-commercial tanks less than 1,100 gallons, farm tanks less than 1,100 gallons, and residential/commercial heating fuel tanks less than 5,000 gallons. Therefore, regulated tanks are generally the tanks found at most gas stations, convenience stores, and automobile distributors in the county. Current state regulations have strict requirements for the operation of regulated underground storage tanks. First, these tanks must be protected from corrosion if they are to be placed underground. Second, owners and operators of new and existing tanks must provide a method, or combination of methods for release detection. Additionally, these tanks are required to be monitored periodically by the owners for leaks. Lastly, the owner and operator must report, investigate, and clean up any spills and overfills in accordance with state regulations. Residential underground storage tanks are not regulated by the Department of Environmental Quality. Most leaks are discovered and taken care of by the owners of the tanks. Information available from local oil companies suggests that problems with leaks are only found in areas with low groundwater tables. In areas with high water tables, water leaks into leaking tanks instead of fuel leaking

out. Leaks in these cases will often be detected when water levels in the tank cause the
owner's furnace or heating source not to light. However, in areas with low water tables fuel will often leak out and down when a leak occurs. Leaks in these cases will be detected only by noticing a drop in tank levels, or an increase in the usage of the fuel. The chart below indicates the number of housing units in the county which utilize fuel oil, kerosene, propane, etc. for the home heating fuel. It is assumed that these individual heating supplies are stored in either above or underground storage tanks. However, the percentage of these tanks located underground is undetermined.

Above ground storage tanks for home heating oil have proved to be a serious hazard to water wells drawing from the surficial aquifer. Even when the tank itself is secure, leaks around the valve and oil line have contaminated water wells beyond repair. Currently a program exists under the Department of Environmental Quality to replace shallow wells contaminated by fuel oil with artesian wells.

Fuel Oil, Kerosene, etc., for House Heating Fuel, Lancaster County, VA - 1990		
Towns	402	46.5% of Housing Units in Towns
County	1,491	40.3% of Housing Units in County
Total	1,893	41.5% of all Housing Units
Source: 1990 United States Census Statistics.		

c. Uncapped/Abandoned Wells

Note: The expression "uncapped wells" is used to refer to wells that have not been "capped off" or properly abandoned. However, Lancaster County has a large number of wells which are in use, but do not have adequate well caps or lids.

Uncapped**, AND** abandoned wells are potential sources for groundwater contamination. These wells, ~~particularly shallow/dug wells~~, act as direct conduits to the groundwater supply**. (Contamination of shallow wells is normally confined to a small, localized area.)** ~~Furthermore,~~ **A**bandoned **artesian wells may allow direct access to deep aquifers.** ~~deep wells provide direct access to lower confined aquifers. that are usually somewhat protected from vertical leakage.~~ Census figures for Lancaster County*space*indicate that there are possibly several hundred of ~~these~~ wells in the county **which are no longer used, but have not been properly abandoned. Procedures for abandoning a well are stipulated by the Health Department and can be costly.**

In a 1995 survey of shallow wells in Lancaster County conducted by SAIF Water with the assistance of Virginia Tech the major cause of bacterial contamination in shallow wells was the homeowners' lack of knowledge of how to properly care for a well.

d. Improper Disposal of Household Hazardous Waste

Due to tightened regulations and prohibitive costs, many rural counties no longer operate their own landfills to dispose of solid waste. In the Northern Neck each of the four counties have switched to waste transfer types of waste collection and disposal. In Lancaster County, waste and recyclable material are collected at three transfer sites. Waste collected at these sites is then carried by a waste carrier to a large regional landfill inspaceKing & Queen County. Furthermore, marketable recyclable materials such as cardboard, paper, aluminum, and glass collected at these sites are sold by the county to generate revenue to support the costs of operating the collection centers.

However, due to limitations on the type of waste accepted by the regional landfill and the high costs of collection and proper disposal of household hazardous waste, Lancaster County has no system in place for citizens to dispose of this type of waste. Household hazardous waste can include used motor oil, paint thinners, solvents, antifreeze, etc. Therefore, limited options can lead homeowners to choose improper means for disposing of this type of waste, which in turn becomes a threat to groundwater supplies.

II. ASSESSMENT OF EXISTING CONDITIONS

A. A. SURFACE WATER

Lancaster County is fortunate to have large areas of surface water within its boundaries. Overall, the condition of these surface waters is good; however, there are some areas for concern. Non-point source pollution has caused some degradation of water quality in the E25 (Corrotoman River) and C01 (Chesapeake Bay) watersheds. The E25 watershed was cited as having significant levels of urban use impacts due to urban erosion and nutrient loadings, and the amount of disturbed land. This type of pollution would be attributed to new home or business construction, particularly on the water. The C01 watershed was cited as having a large number of shellfish condemnations due to urban non-point source influences. This type of pollution would be attributed to high densities of septic systems, or a number of failing septic systems located close to surface water. The C01 watershed also was negatively impacted from agricultural non-point source pollution. However, despite being mentioned for these specific non-point source pollution impacts, none of the three watersheds were cited as having violations of state water quality standards. Lancaster County's surface water resources also have potential, although limited, for use as a future potable water supply. In the County, there are no smaller fresh water streams that have suitable flow to allow for raw intake for drinking water purposes. Furthermore, saline conditions in the larger tidal portions of the County's surface water bodies would make them unsuitable as a supply for drinking water. However, the County does have a large number of existing millponds, as well as other possible locations for impoundment of fresh surface water supplies.

The existing millponds already serve an important function, since they act as areas of recharge for water table aquifer**S**. Furthermore, the existing millponds are generally located at the headwaters of streams or creeks, and many have sparsely populated areas surrounding them. With enlarged impoundment structures, these millponds could be potential surface water supplies for drinking water. Lastly, all the millponds are located upstream of permitted discharges. This situation would prevent discharges from affecting millpond or reservoir waters.

B. GROUNDWATER

Lancaster County's citizens get their water from four aquifers; the Columbia, the Yorktown-Eastover, the Chickahominy-Piney Point, and the Brightseat/Upper Potomac. The Chickahominy-Piney Point and the Brightseat/Upper Potomac are the deeper, confined aquifers. The two deeper confined aquifers also supply other regions of Virginia with water, as well as parts of Maryland. Quality problems exist in the Chickahominy-Piney Point and Brightseat-Upper Potomac aquifers, mainly due to elevated levels of chloride, sodium, and fluoride. Levels of sodium and fluoride are of particular concern in LancasterCounty. Sodium levels **in the artesian aquifers are elevated in the entire county with the highest levels near White Stone and** ~~**get higher**~~ going towards Windmill Point. Patterns of fluoride levels are more random, but tend to be high throughout the County.

Each of the four aquifers has a particular recharge area. The Columbia Aquifer recharges from the ground surface in Lancaster County. The County has some influence through land use controls on protecting these areas. The Yorktown-Eastover Aquifer recharges at the outcrop of this aquifer in the western part of Lancaster County. Again, the County has some control over the protection of these areas through land use ordinances. This area is of particular importance because the Yorktown-Eastover Aquifer is the primary supply of drinking water for the Eastern Shore of Virginia. Lastly, the two deeper aquifers, the Chickahominy-Piney Point and the Brightseat-Upper Potomac, primarily recharge at their outcrop areas just east of the fall line. They also recharge to a lesser degree through vertical leakage from the water table aquifers. However, the outcrop recharge areas are located near Westmoreland, King George, and Stafford Counties, and the City of Fredericksburg. The Groundwater Management Study Committee, under the direction of the Northern Neck Planning District is developing methods to protect the recharge areas.
Locally, Lancaster County can act to protect the two water table aquifers. The Columbia is the principal water table aquifer, and the Yorktown-Eastover is the secondary aquifer. The main users of the water table aquifers are owners of shallow wells. The water table aquifers are the most susceptible to pollution, and the recharge area is the land above the aquifers in Lancaster County. Direct threats include septic systems, underground storage tanks, improper disposal of hazardous home waste (oil, gas, etc.), and abandoned, uncapped wells. Additionally, recharge areas can be affected by large areas of impervious cover, local drainage patterns, vegetation, and drought conditions. Lastly, the highest concentrations of shallow well, water table aquifer users are most likely found in the older developed areas of the county.
On the surface there appears to be an adequate supply of groundwater for the : IMMEDIATE future. However, recent studies conclude that regional drawdowns due to heavy pumping of deeper, confined aquifers should cause concern and warrant further study.

A local hydrogeologist, Dr. Frank Fletcher, has summarized the situation as follows: "The continued reliance on groundwater drawn from the artesian aquifers will lead to the impairment the aquifer system by mid-century and to the eventual loss of the aquifers as a productive source of water."

During the time frame covered by this Comprehensive Plan, Lancaster County should be developing plans for a diverse water supply and begin the political process necessary to preserve land for potential reservoirs.

III. POTABLE WATER SUPPLY PLAN
A. GROUNDWATER

1. Water Table Aquifers

In Lancaster County, the water table aquifers are those most susceptible to contamination. Failing septic systems, agricultural fertilizers, hazardous home wastes, etc. can act to pollute water table aquifer resources. Furthermore, no regular water quality testing is done on these shallow wells to determine present areas of contamination. Therefore, it is strongly recommended that a parcel specific inventory be taken of homeowners utilizing shallow wells for their drinking water supply. After the inventory is completed, parcels with shallow wells in high septic system and agricultural areas will be targeted for water sampling. (It is not feasible to test for agricultural chemicals as everything used in the last 30 years is often still in the soil. You would have to have a specific 30-year history of every chemical used in order to determine what to tests to use.) SAIF Water and some Health Department officials do not recommend the use of shallow wells near agricultural operations for this reason.) Available outside resources for water quality testing will be explored and pursued. (Good luck! The General Assembly has not allocated funds for the Indoor Plumbing Program for the last two years.) When funds are obtained, **a series of** water samples will be taken to see if these shallow wells are contaminated by fecal coliform, organic and inorganic chemicals, and nitrates or some other foreign matter. ~~Well samples~~ ~~Determine~~ **Determination of** contamination of water **will be** based on MCL's, as specified in the Waterworks Regulation. Areas with large numbers of contaminated wells will be targeted for local water system improvements **and homeowner education.**

> **Note: A single water sample for bacteria is not adequate to judge the condition of a well. The Centers for Disease Control recommend a series of 3 samples spanning two to three months. Water samples are easily contaminated by the manner in which they are handled. The source of the contamination may not be in the well at all, but rather in the plumbing. Inadequate maintenance of the well structure and inadequate disinfection by the homeowner are causes of contamination that can be corrected.**

If there are existing clusters of contaminated wells, it is recommended that outside funds again be pursued for improvements to these wells or replacement with shared artesian systems. ~~Specifically, if there are enough affected shallow wells in an area, the possibility of drilling a shared artesian well should be explored. After the well is in place, houses that were previously on shallow wells should **may** be hooked up to the new deep well. The contaminated shallow wells would then be permanently abandoned in accordance with the Waterworks Regulations to prevent them from becoming new sources of groundwater contamination.~~

> NOTE: Public water systems are allowed to fail many lab tests for bacteria without being shut down. We expect filtering, disinfecting and regular testing of public systems. But the National

Drinking Water Standards are not applied to private wells. Many of our shallow wells could function quite adequately with a treatment device for bacteria. They will be increasingly needed as the artesian aquifers decline. They are an important resource during times of emergency when there is no electric power. (Water cannot be obtained from artesian wells without electricity.) In addition, the high sodium content of artesian wells makes them undesirable for many persons with health conditions.

Until the economic circumstances for the county's low income residents are improved, the addition of a monthly water bill is questionable. Current government programs for installing artesian wells are loan funds which add another financial burden to the low income families who most commonly depend upon shallow wells.

There are alternatives to abandonment such as the Center for Disease Control's directions for cleaning up flooded wells, and repairing leaks in the well structure.

The following paragraph recommends a way of avoiding what the Health Department considers to be the best protocol for maintaining a safe water supply. It is not appropriate to include it as a part of county policy.

It is further recommended that as these new community systems are established, care be taken to keep the total number of hook-ups to each system to a maximum of 10. The reason is that at 15 hook-ups a well becomes an official public supply well which must be monitored and regulated by the State Department of Environmental Quality (DEQ). Public Supply wells must be regularly tested with samples submitted to DEQ. The result is that the well requires careful monitoring and costs more money to operate due to required sampling. Keeping the number of hook-ups below 10 will keep the new well from becoming designated public supply system, while still leaving a small number of hook-ups available for future development.

Furthermore, it is recommended that a blanket well user agreement be established for users wanting to switch to the new well. This agreement will be a legally binding document that each homeowner signs. ~~The agreement will assure that homeowners are fully responsible for their fair share of maintenance or repair costs for the new well system.~~ (You can't insure this if people don't have money coming in.) This will hopefully reduce any future disagreements over who is financially responsible for any well maintenance or repairs.

The experience of SAIF Water with homes that have received artesian wells through the state Indoor Plumbing Program shows that low-income families often do not have the resources needed for repairs such as pump replacements.

2. Abandoned Wells

~~As part of the effort to control threats to the county's groundwater supply,~~ It is recommended that the county undertake a parcel specific inventory of all abandoned wells in the county. After wells are identified an informative mailing will be prepared to send to each property owner with an abandoned well. The mailing will caution owners to protect the well area and not to use it for disposal of solid or liquid waste. Furthermore, it will ask the owners if they would be interested in participating in a countywide permanent well abandonment.

The county will launch an intensive educational campaign on well care and pursue grants for upgrading wells. Wells which were constructed after 1992 when the Health Department upgraded well construction standards should be fitted with a seal under the well cap.

An ordinance shall be enacted to provide penalties for contamination of a water well.

~~The abandoned well capping project~~ A project to properly cap existing wells or abandon wells would utilize available outside funding offered. ~~for protection of groundwater supplies.~~ The county would explore sources of such funding and apply for any available amounts.

3. Household Hazardous Waste Collection Day

To provide further protection to the County's groundwater resources it is recommended that Lancaster County establish a semi-annual Household Hazardous Waste Collection Day. This event could be held at the existing solid waste refuse sites. To sponsor such an event, the County would have to hire a certified waste disposal contractor who would have proper authorization to handle and dispose of this type of waste. The event would be widely marketed to the public and on this particular day, Lancaster County residents would be allowed to properly dispose of household hazardous waste. This type of event is offered by other localities and provides an alternative disposal option for residents with this type of waste.

4. Groundwater Management ~~District~~ Area

~~As a way to gain influence over the protection of groundwater resources found outside the County's boundaries, it is recommended that Lancaster County support any future proposals in the region for the creation of a State (substitute: extension of the Groundwater Management District through Middlesex County and the Northern Neck.. Groundwater Management Districts are found in other areas of the state such as Hampton Roads and the City of Richmond. However, there is presently no such District to coordinate management and protection of groundwater resources in the Middle Peninsula and the Northern Neck. Participation in a Groundwater Management District would enable Lancaster County to expand its ability to protect the supply and quality of ground- water resources.~~

Suggested rewrite of above paragraph:

It is recommended that Lancaster County actively support efforts to have the Eastern Virginia Groundwater Management Area extended through Middlesex County and the Northern Neck. This would insure that future entities who wish to withdraw large amounts of water would be required to seek a permit and report to the Department of Environmental Quality. (See Appendix ___ for map.)
Note: This is a very limited step which will not solve the over pumping of the aquifer nor effect existing large users.

The County will encourage conservation efforts on the part of current and future users within the county. Any future golf courses will be asked to develop plans to include surface water sources for their needs rather than being totally dependent on groundwater withdrawals.

5. Drilling Test MONITORING Wells

To expand existing knowledge of the groundwater resources of Lancaster County and the Northern Neck, it is proposed that the County endorse previous recommendations made by the Department of Environmental Quality (then the State Water Control Board) to establish monitoring wells in Lancaster County*space*and the Northern Neck. Specifically, it is recommended that a monitoring well be developed to track the possible inland migration of elevated sodium, chloride, and fluoride levels in the White Stone, Palmer, Foxwells, Windmill Point area. There is no current evidence for saline intrusion, or an increase in chloride, TDS or any other measured parameter, based on analysis of Virginia Department of Health data. However, that may no longer be true by the time the Comprehensive Plan is revised again. Understanding water quality problems in the southeastern part of the County is vital to assure protection of less affected supplies located nearby in the more densely populated areas in and around Kilmarnock.
Additional monitoring wells may be desirable to provide a more adequate information base on the decline of water in the artesian aquifers and the possible tapping of deeper aquifers.

6. Regional Water System Plan

To prepare for the coordination and efficient use of the future water supply in Lancaster County, it is recommended that the County support the preparation of a regional water system plan. The State Water Control Board made the original proposal for such a plan in the 1988 Rappahannock Water Supply Plan. The goal was to develop a plan that would encompass the County as well as the Towns of Irvington, Kilmarnock, and White Stone. The plan would emphasize the cost savings of using a coordinated, regional approach to address the future water supply needs, and water quality problems of LancasterCounty. ~~This plan could also provide the opportunity to explore possible water impoundment sites for future potable surface water supplies.~~

B. B. SURFACE WATER

1. Inventory Septic Systems

As part of the effort to assure continued protection of Lancaster County's Surface and Groundwater Resources, it is proposed that the County inventory and map existing septic systems in the County. This effort would help to pinpoint high concentrations of septic systems in the County, which could act cumulatively to deteriorate the quality of Lancaster's surface and groundwater supplies. Information obtained from this inventory would be valuable in developing a future land use map for Lancaster County. Additionally, once compiled this information would aid in any future efforts to identify and prioritize areas for efficient placement of a wastewater treatment plant.

Note: Much of the county is already mapped by the Shellfish Division of the Health Department and regularly checked for signs of failing systems or lack of proper facilities.

2. Identify Possible Impoundment Areas

~~This recommendation can be carried out in conjunction with the proposal to support creation of a Regional Water System Plan.~~ **Lancaster County shall undertake rezoning of areas identified as potential reservoir sites in accordance with documents on file at the Northern Neck Planning District Commission. This step shall receive priority in its own right without waiting for any further coordinated efforts.**

3. Continue Present Enforcement Levels

To assure continued protection of the quality of Lancaster County's surface water bodies, it is recommended that the County continue its present, active enforcement of the Chesapeake Bay Preservation Act and the Erosion and Sediment Control Acts.

IV. GOALS AND OBJECTIVES FOR LANCASTER COUNTY POTABLE WATER SUPPLY PLAN

GOAL #1: **Protect and improve quality of surface waters of Lancaster County to assure their continued benefit to the economy, recreation, and health of the County.**

Objective: Continue strict enforcement of the Chesapeake Bay Preservation Act and Erosion and Sediment Control Act Regulations to assure protection of the water quality of the Chesapeake Bay and its tributaries.

Objective: Explore possible water impoundment areas presented in plan for Lancaster County.

Objective: Support strengthened county ordinances to assure protection of proposed impoundment areas.

GOAL #2: **Develop methods to prevent groundwater pollution in order to protect the supply of groundwater in Lancaster County and to assure that an adequate future supply exists for the continued growth of the County.**

Objective: Organize a hazardous home waste collection day to give residents an opportunity to safely dispose of their waste.

Objective: Inventory and map uncapped, **and** inactive deep wells in the county and identify procedures to encourage property owners to properly abandon such (Delete:cap off) wells. (There is no reason to abandon a well simply because it is not currently in use. The question should be whether it reasonably presents a threat of contaminating the aquifer.)

Suggested rewrite for above objective: Inventory all wells in the county for environmental hazards and structural defects. Encourage the upgrading of well structure and removal of environmental hazards near wells--encouraging well head protection measures for private wells and regular laboratory analyses of water samples..

Objective: Seek state and federal funding to ~~initiate~~ **Substitute**: assist in upgrading wells or installing purification systems. ~~an Inactive Well Capping Project.~~

Objective: Develop a method of collecting waste oil in the county to give residents a safe disposal option.

Objective: Discourage the use of shallow wells near agricultural operations because it is not possible to test for all the chemicals that can remain in the groundwater for many years.

GOAL #3: **Develop methods to improve and protect groundwater quality in Lancaster County to assure the continued safe health of the local people and the economy.**

Objective: Work in coordination with existing community organizations and the health department in efficiently utilizing existing local resources to improve drinking water quality.

Objective: Prepare an ordinance requiring plumbers and others installing water well pumps to seal the curbs around the piping and inside the sleeve which holds the water line.

Objective: Endorse regulations by Virginia's Department of Professional and Occupational Regulations which take effect July 2007 limiting all work on wells to qualified professionals.

Objective: Require by ordinance the sealing of all well caps, both artesian and shallow. Seals are required on newer artesian wells by state regulation. However, currently shallow well caps are only placed on top of the well curb. They are often chipped and are easy entry points for infestation by insects, animals, snakes, and other contaminants.

Objective: Inventory and map active shallow wells in the county to lay groundwork for identification of concentrations of contaminated shallow wells, investigate the causes, and recommend appropriate action by homeowners. ~~and, if feasible, prioritize for upgrading to small community deep well systems.)~~
Note: It is very difficult to determine whether contamination is due to the well or the plumbing or the manner in which the water sample was handled.. The well water may be as good as any of our town systems. Treatment alternatives should be explored as an option where the water fails bacteria tests.
Shallow wells near farm fields, where it is impossible to test for all the potential chemical contaminants, should be replaced with deep wells.

Objective: Identify possible funding for community well improvements.

Objective: Strongly support Department of Environmental Quality proposals to drill test wells in the eastern half of the county to monitor water quality problems. (Track inland movement of dissolved solids; chloride, sodium, and fluoride in groundwater aquifers.)

Objective: Support future regional efforts to establish a groundwater management district for the Northern Neck and Middle Peninsula areas of Virginia.

Objective: Support preparation of a regional water system plan for the County. The plan would encompass the county, as well as the towns of Irvington, Kilmarnock, and White Stone. The plan would
emphasize cost savings of using a coordinated, regional approach to address future water supply.
Planning for diverse sources of water supply is in order for the entire county because of over pumping of the principal artesian aquifers.
Cooperation with other counties and the Planning District is warranted.

GLOSSARY OF TERMS

Terms and measurements used to further understanding of groundwater quality descriptions are listed and detailed. They have been obtained from the following United States Geological Survey Report:

Water-Resources Investigations Report 92-4175, "Quality of Groundwater in the Coastal Plain Physiographic Province of Virginia." Focazio, Michael J.; Speiran, Gary K.; and Rowan, M. Eileen; U.S. Geological Survey; Richmond, VA: 1993.

Chloride - The U.S. EPA has established a SMCL for chloride of 250 mg/L. (U.S. Environmental Protection Agency, 1990c;) Furthermore, the State of Virginiamaintains an antidegradation standard for chloride in groundwater in the Coastal Plain of 50 mg/L (Commonwealth of Virginia, 1988)

Dissolved Solids - This refers to the measure of the concentration of all dissolved material in the water. The U.S. EPA SMCL for dissolved solids is 500 mg.L (U.S. EPA, 1990c). The State of Virginia's antidegradation standard for dissolved solids in groundwater in the Coastal Plain is 1,000 mg/L. (Commonwealth of Virginia, 1988)

Fluoride - The U.S. EPA has established both an MCL of 4.0 mg/L and an SMCL of 2.0 mg/L for fluoride. The State of Virginia enforces a standard of 1.8 mg/L. (Commonwealth of Virginia, 1982)

MCL - This refers to Maximum Contaminant Levels, which is a U.S. Environmental Protection Agency (1990a) designation. Reported MCL's are set for health concerns. This is the maximum permissible level of a contaminant in water that is delivered to any user of a public-water system. These levels are enforceable.

SMCL - This refers to Secondary Maximum Contaminant Levels, which is a U.S. Environmental Protection Agency (1990a) designation. Reported SMCL's are set for aesthetics (such as taste or odor) or for limits on properties that affect use of the water (such as chemical aggressiveness, or potential for the water to deposit solid chemicals). These levels are not enforceable.

Sodium - Presently, there are no Federal drinking water regulations concerning sodium; however, the State of Virginia maintains an antidegradation standard for sodium in groundwater in the Coastal Plain of 100 mg/L. The State also advises that persons on sodium-restricted diets avoid drinking water with sodium concentrations greater than 20mg/L, if the restriction is se.....

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