Town of Kilmarnock
Water and Sewer Master Plan

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Water & Sewer Master Plan Report Summary

WATER & SEWER MASTER PLAN REPORT SUMMARY

Project Background

Waste Water Management (WWM) was engaged by the Town of Kilmarnock to develop a Water and Sewer Master Plan with the objective of identifying problem spots and trouble areas within the water distribution and the sewer collection systems. The purpose of this report is to provide the Town with a solid understanding of the strengths and weaknesses of its water supply, distribution and storage system and its sewage collection and pumping system and to provide a framework and basis upon which to make informed budgeting, planning and utility management decisions to maintain existing infrastructure and plan for future growth in and around town.

Over the course of the past year WWM engineers worked extensively with the Town staff to locate, gather and assemble old data, maps, plans and reports to then create the Town's first electronic comprehensive map data base. Once the map base had been created WWM engineers utilized hydraulic modeling tools to evaluate the water distribution and the sewer collection systems under the existing use conditions and projected future use conditions.

Figure 1 – Map of Lancaster County

In addition to its work with the Town, WWM met with representatives of Lancaster County, the Town of White Stone, Rappahannock Westminster-Canterbury assisted living facility, and the Tides Inn and with the Virginia Department of Environmental Quality (DEQ) and discussed their needs and concerns for public water and sewer service in the "Golden Triangle" area of the County, shown in Figure 1. It was clear from all the meetings that everyone recognized the Town of Kilmarnock is the primary utility service provider in the area and that whatever planning decisions may be made by the Town on its own behalf will also have major impacts on the County's ability to manage zoning and growth in the Golden Triangle and the surrounding areas. Figure 2 is a current satellite photograph of the Town with the property lines and roads superimposed and Map G-1 is a current AutoCad map of the Town showing buildings, property lines roads and is enclosed in Appendix 1.

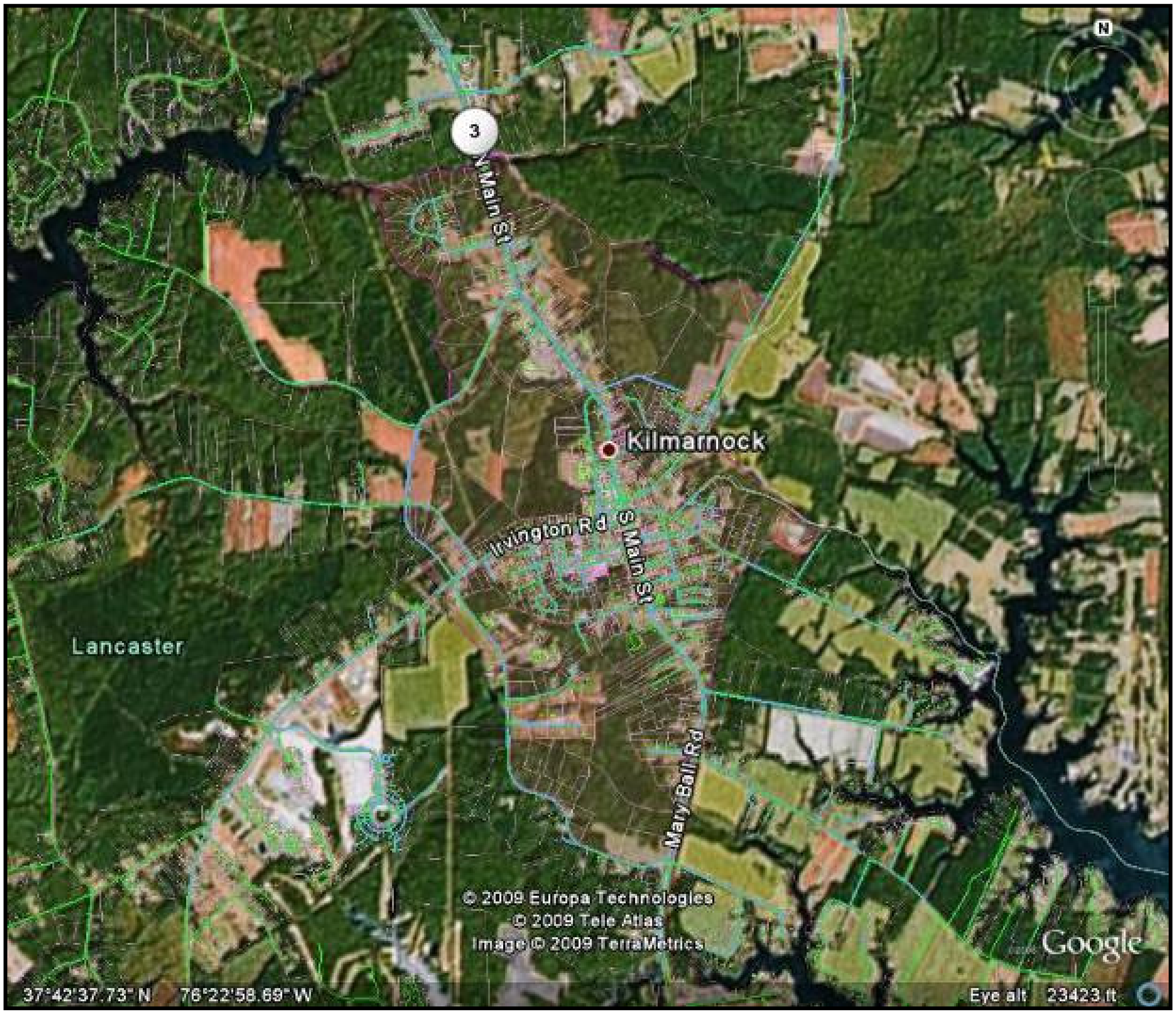

Figure 2 – Satellite Map of Town with GIS Property Data

WWM collected actual water production and wastewater treatment records, the number of current water and sewer connections, and available data on planned and ongoing development to establish the basis for detailed water and sewer system modeling efforts. As WWM progressed with this initial data collection, it became clear that the existing systems have limited capacity to serve even the in-town customer needs and at such time in the future as the in-town undeveloped properties become developed the capacity in both the water and sewer systems will be expended.

A detailed discussion of data collection efforts, meetings held, and the calculations for existing and projected future water and sewer use is included in Appendix 1

Description of the Existing Water System

The Town of Kilmarnock's water system was originally constructed in the middle of the last century and consists of a network of small pipes between 2 ½" and 8" in diameter, three deep wells and three elevated water storage tanks located at the three well sites. However, the Hospital Well collapsed in 2006 and a new well to replace it has not yet been completed, so the Town currently relies on only two wells. The water system serves a total of 1,057 residential and commercial customers both in-town and outside town and provides fire flow service throughout its service area. Map W-1 is a map of the existing Town water system and is included in Appendix 2.

The Virginia Department of Health, Office of Water Programs requires public water systems to provide a minimum of two wells and a minimum of 0.5 gallons per minute per connection. The combined production rate of the two wells currently in use is 715 gallons per minute, which is enough to support a total of 1,430 connections. So the existing system has sufficient supply for an additional 373 connections. However, with only two functional wells, the Town does not have a back up source if operation is interrupted on either of the existing wells.

WWM engineers assessed the physical conditions of the Town's three wells and elevated storage tanks. The engineering assessments then led to developing a list of short term priority needs which identified that the number one priority should be reestablishing the Hospital well as soon as possible. After the Hospital well urgent improvements are needed at the Radio well where new piping is needed and a new chemical room should be built. A detailed discussion of the existing wells and storage tanks is included in Appendix 2.

Water System Hydraulic Analysis

WWM created a computerized hydraulic model of the water distribution system using Haestad Methods WaterCAD software, the water system maps and data collected, and used it to simulate four scenarios to assess the performance of the existing system. The results indicate that the existing system generally performs well under average and peak flow situations. However, under fire fighting scenarios, pressures in the system fall below acceptable levels and in some cases, negative pressures develop in certain areas. Low or negative pressures in water distribution systems create the potential for infiltration of contamination into the system, or insufficient flows for fire fighting, creating a serious public health and safety problem. A full description of the development of the model, the scenarios modeled, and the results including maps is presented in Appendix 3.

Description of the Existing Sewer System

The Town of Kilmarnock's sewer system was originally constructed in the middle of the last century and consists of a network of small diameter gravity sewer lines, five main sewage pump stations with force mains, two small minor pump stations and force mains and a wastewater treatment plant with a permit to discharge 500,000 gallons per day of treated effluent. The sewer system serves a total of 1,010 residential and commercial customers both in-town and outside town and provides service to the distant Hills Quarter golf course development. The average total volume of wastewater treated at the wastewater treatment plant is 193,000 gallons per day. Map S-1 is a map of the existing Town sewer system and is enclosed in Appendix 4.

WWM engineers assessed the physical conditions of the Town's five large sewage pumping stations. Major deficiencies were noted at four of the five stations. The Harvey Lane, the

Wiggins, and the School Street stations all have conditions that pose serious risks and safety hazards to the utility maintenance personnel, requiring almost immediate attention. In all three cases the sewage pumping stations are operating beyond their useful lives and the risk of imminent collapse or failure of several key components is great. Further, the site access to the Wiggins pumping station severely restricts the ability of emergency service personnel to respond in case of a spill, fire, accident or personal emergency. Finally, the existing generator at the Norris Pond station is undersized and not capable of providing sufficient power to the station in the event of a power outage. A complete discussion of the sewer system and the pumping stations is included in Appendix 4.

Sewer System Hydraulic Analysis

WWM created a computerized hydraulic model of the gravity sewer collection system using EPA SWMM 5.0 source code and AutoCAD, the data recorded in all the old sewer plan drawings, information on the elevations of the tops and inverts of the manholes, and an overall field survey and used it to simulate four scenarios to assess the performance of the existing system. The results indicate that surcharging of pipe sections occurs downstream of pumping station force main connections to the gravity sewer system. Gravity sewer systems are designed such that sewage flows through the pipes with the pipes only partially filled, which allows the sewage to flow freely. A surcharged pipe section is one that is flowing full, causing a back up in the system, and creating the potential for overflows to the environment or back ups into residences and commercial establishments. This is a serious environmental and public health and safety concern.

Cost Estimates for Priority Needs

After reviewing deficiencies identified in the water and sewer systems by the hydraulic modeling and field investigations, WWM created a prioritized list of recommended improvements and prepared engineering cost estimates to complete each. Highest priority was placed on the problems which are currently affecting the Town and its ability to properly manage its water and sewer systems. The less urgent problems are those that will become manifested as future development occurs. A detailed discussion is presented in Appendix 6, but a summary of the recommendations and costs is presented below.

Priority Improvements	Cost
1. Hospital Well	$ 265,000
2. Radio Well	$ 100,000
3. Harvey Lane Sewage Pump Station	$ 340,000
4. Wiggins Sewage Pump Station	$ 365,000
5. School Street Sewage Pump Station	$ 270,000
6. Norris Pond Sewage Pump Station	$ 75,000
7. Church Street Well	$ 20,000
8. Facility Operation and Maintenance Manuals	$25,000

Policy Issues for Consideration

Although a study of the existing wastewater treatment plant was not included in the scope of this project, the plant is severely limited in capacity with the ability to only serve the existing customers plus the projected build-out of the undeveloped in-town properties and Hills Quarter. The plant does not have capacity to serve additional out-of-town customers without sacrificing capacity for future in-town customers. In a brief visit to the plant by WWM engineers, it appears that the plant could be modified and upgraded to provide greater treatment capacity without having to construct additional tanks and major equipment. It is recommended that this potential be studied more thoroughly to develop budgetary cost estimates and schedules that the Town can use for planning and budgeting purposes in the coming years.

As development in and around the Town continues, the Town should consider innovative ways of funding infrastructure improvements and expansions. Other municipalities in the region have begun working with developers and neighboring municipalities to create agreements that allow for equitable sharing of costs depending on the particular circumstances. For example, some municipalities have agreements with developers paying for the upgraded facilities sized to serve an entire planning area and then being partially reimbursed by the municipality with future connection fees outside their properties. An example of a reimbursement agreement between the Prince William County Service Authority and two developers and an example of a capacity purchase agreement between Fairfax County Water Authority and Prince William Counties are provided in Appendix 7.

All well run and managed municipal water and sewer utilities have developed and rely on highly detailed and rigid standards for design, pipe materials, equipment and construction. The enforcement of rigid standards provides many important benefits including reducing the number of spare parts the operation and maintenance staff must have on hand, consistency in delivery of service and minimization of infiltration. Many municipal water and sewer utilities have adopted detailed design, material, equipment and construction standards and the Town of Kilmarnock would benefit from having its own set of adopted standards.

It has been WWM's experience that most small municipalities fail to capture all the true costs of owning and operating their water and sewer utilities and often resort to receiving subsidies from a General Fund to balance the water and sewer budgets. The most commonly overlooked budget item is a capital replacement allowance which is always necessary from time to time to make major repairs, upgrade equipment, reach higher levels of treatment and otherwise provide for system longevity. A proper utility budget should include all cost items including operating and maintenance labor and fringe benefits, administrative labor, a share of the rent, electricity, chemicals, sludge hauling analytical testing and reporting, permit fees, vehicles, insurance, legal, engineering and accounting fees, capital recovery, depreciation of equipment, and a capital replacement fund.

Appendix 1 – Project Background

Appendix I – Project Background

A. Introduction and Scope of Work

Waste Water Management, Inc. (WWM) was retained by the Town of Kilmarnock to prepare this Master Plan report for the Town's water and sewer utilities systems exclusive of the wastewater treatment plant. Specific tasks and objectives of the Master Plan "scope of work" included the following:

- Assemble and review the existing hand drawn water and sewer maps collected, gathered and delivered to WWM by the Town.
- Collect Lancaster County's base real estate and digital topographic map data and conduct field surveying to tie old Town map data into the County digital framework.
- Develop new comprehensive water and sewer system maps in digital formats.
- Assess the conditions of the existing water and sewer systems.
- Assess the capacities of the existing water and sewer systems.
- Identify specific problems within the existing water and sewer systems.
- Project and assess the impacts of future residential and commercial development on the existing water and sewer systems.
- Develop of a list of priority needs for improving the existing water and sewer systems.
- Evaluate the existing utility management policies which relate to the future use and development of the water and sewer systems.

During the performance of its work WWM was assisted by the civil engineering firm, The Engineering Groupe, which provided field data collection and surveying of most of the base horizontal and vertical control data from which the digital utility maps have been developed. The Town administrative and utility personnel were instrumental in locating and collecting many old maps and drawings. Their work was very exhaustive and time consuming and invaluable in the development of the base utility maps. The efforts of all project participants were akin to creating a mosaic puzzle which included both the old and new geographic information published within this report.

B. Initial Work

Waste Water Management's initial work, which lasted through the spring and summer of 2008, consisted of meetings with Town staff and meeting various local public officials, state regulatory officials and various private and interested parties. In all the discussions there seemed to be a general consensus that the Town of Kilmarnock would by default become the primary provider for sewer service in the southern portion of Lancaster County. There also seemed to be a strong belief that the Town could adequately supply water or provide sewer to many nearby undeveloped properties outside the Town simply for the asking without any serious concerns for system capacity. A summary of the various meetings is as follows.

- **Town of Kilmarnock** – Immediately following award of the project WWM met with Lara Burleson, Town Manager; Marshall Sebra, Town Planner, several members of the Town administrative staff; Pat Chenoweth the head wastewater treatment plant operator, and James Seagle, the head utility system operator to discuss the scope of work and review the existing utility records. During these early meetings it became clear there was no central and organized record keeping program and no geographic mapping system. The data consisting of old utility drawings, property development plats, engineering reports and miscellaneous correspondence and documents was collected by the Town staff between February 2008 and February 2009 and forwarded to WWM for processing.

- **Lancaster County General Services** – One of WWM's first local meetings was with Mr. Glenn Rowe, Director of General Services for Lancaster County. Mr. Rowe had been responsible for coordinating the development of an aerial mapping program in 2007 wherein the entire County was flown and digital aerial maps were produced. At the time of the meeting in February 2008 with Mr. Rowe he was waiting on a final edit of the digital map data. In May 2008 Mr. Rowe provided WWM with the digital base map information. That digital information then became the structural basis for the digital maps upon which this report is based.
- **Lancaster County Administration and Planning** – In June 2008 WWM met with Mr. Bill Pennell, County Administrator and Mr. Don Gill, Director of Planning for Lancaster County at the Kilmarnock Town office. Mr. Pennell and Mr. Gill presented the southern area of the County as being the "Golden Triangle" with the Towns of Kilmarnock, White Stone and Irvington being the points of the triangle. They said it was expected this area of the County would receive the majority of interest and growth over the next decade or two and reported the County has no water or sewer utilities of its own in this area. They said the County has taken a "hands off" position with property owners and developers in the Golden Triangle area when they have requested water or sewer service from the Town of Kilmarnock or other utility providers. They said they expected the Town of Kilmarnock wastewater treatment plant to become the regional treatment plant to serve

the future growth within the Golden Triangle and the Town's water system to become the primary water utility in the area.

- **Town of White Stone –** In addition to meeting with Lancaster County WWM visited Mr. Garey Conrad, Town Manager of the Town of White Stone. Mr. Conrad stated the town has a small water system which is operated by Aqua Virginia out of Richmond. Mr. Conrad said the residences and small businesses in White Stone all rely on individual septic systems for disposal of sewage. He said "it would be nice to have public sewer" but he said the cost of installing a sewer collection system and then connecting it to the Town of Kilmarnock and then paying the individual connection fees would be too great for the residents of White Stone to bear. Mr. Conrad said the only way the Town of White Stone could have a public sewer system is if it received a CDBG (Community Development Block Grant) from the State.
- **Rappahannock Westminster-Canterbury** – WWM also met with Mr. Stuart Bunting, President of Rappahannock Westminster-Canterbury and discussed its water and sewer needs. Rappahannock Westminster-Canterbury is an assisted living facility located in the middle of the Golden Triangle which has 151 individual residential housing units, 38 assisted living units, a 42 bed nursing facility and a dining facility. It operates its own water and sewer systems. The water system includes 2 wells which produce 77,600 gallons per day. The sewer system is a lagoon system with a permit to spray discharge 50,000 gallons per day. They have applied for and received a permit to construct a new wastewater treatment plant with a discharge to Carters Creek in the amount of 80,000 gallons per day to allow for the development of 52 vacant acres surrounding the main campus. Mr. Bunting said he has been approached by the Golden Eagle golf course and

cottage development across the road from Rappahannock Westminster-Canterbury, to possibly provide that project with sewer service. The Golden Eagle project is owned by the Tides Inn. Mr. Bunting said he would "be delighted to be out of the sewer business".

- **Tides Inn** – WWM met with Mr. Gordon Slatford, General Manager of the Tides Inn to discuss their sewer needs. The Tides Inn owns and operates two wastewater treatment plants, one on each side of Carters Creek and has plans to construct a new single 100,000 gallon per day wastewater treatment plant. Once complete the Tides Inn will cooperate with Lancaster County to implement a CDBG housing grant to provide sewage service for a new 38-unit, low income housing project. The Tides Inn also plans to sell sewer service to other homes as a means of generating revenue to pay for the new wastewater plant. The Tides Inn also owns the Golden Eagle golf course and cottages across from the entrance to Rappahannock Westminster-Canterbury. Mr. Slatford said the Tides Inn considered working with the Town of Kilmarnock to provide sewage treatment in lieu of upgrading its two treatment plants but the costs of the pumping stations and force mains and the connection fees were prohibitively expensive.

As WWM's work progressed it became clear there was no consolidated data base relating to any water or sewer utilities in either Lancaster County or in the Towns of Kilmarnock, White Stone and Irvington. In addition, it was immediately recognized both the water and sewer systems were in need of serious repair simply to maintain service viability. More serious however was the fact that even if the systems were refurbished their capacity was seriously limited to serve even the in-town needs, much less any future demands from outside town. In order to provide water and sewer service to areas outside town significant improvements in both capacity and delivery will be necessary.

C. Basis of Design for Capacity Analysis

In order to properly assess the existing utility systems it was necessary to review the water production and wastewater treatment records and analyze the number of residential and commercial connections. Ms. Chenoweth provided WWM with both the water production and the wastewater treatment plant records for the following periods; May through December 2002, January through December 2003, October through December 2006 for wastewater only, January through December 2007 and January 2008 for a total of 33 months of data. At the time no water data was available for the 2006 calendar year. Table 1 lists the monthly average water produced and the volume of wastewater treated during the period.

Table 1
Monthly Average Water Produced / Wastewater Treated 2002 - 2007

Year (# of Months of Records W/WW)	Water Produced (Gallons / Month)	Wastewater Treated (Gallons / Month)
2002 (8/8)	5,849,390	6,485,000
2003 (12/12)*	5,750,580	5,899,580
2005 (12/11)**	6,678,500	5,352,360
2006 (1/4)	6,886,000	6,431,000
2007 (0/12)***		5,722,580
Average Monthly Flow	6,146,400	5,871,200
Average Daily Flow	**202,000 GPD**	**193,000 GPD**

* The highest average monthly wastewater flow was recorded in February 2003 in the amount of 7,071,000 gallons which equates to a daily average of 252,500 gallons.
** No wastewater data provided for February 2005
*** No water production data was provided for 2007.

It can be seen from review of the table there has been a slight but steady increase in the amount of water produced during the five year period from 2002 through 2007. There has been a corresponding slight decrease in the average monthly flow through the wastewater treatment plant during the same period. Ms. Chenoweth believes the reduction in flow through the treatment plant is a result of the Town's ongoing efforts to identify and eliminate sources of infiltration and inflow into the sewer collection lines. She said the average dry weather flow is now 170,000 gallons per day. However, it should be noted in October 2006 during a two day period of heavy rain when 4.0 inches fell, the average daily flow through the wastewater treatment plant was 677,500 gallons per day. In February 2009 the Town provided WWM with a current list of the residential and commercial, in-town and out of town water and sewer connections. Table 2 lists the breakdown and the total number of the residential and commercial, in-town and out of town water and sewer connections.

Table 2
Water and Sewer Connections (as of 1/31/09)

	Water		**Sewer**	
	Residential	*Commercial*	*Residential*	*Commercial*
In-Town	609	276	579	268
Out-of-Town	168	6	161	2
Total	1,059		1,010	

Dividing the total daily water production by the total number of connections to the water and sewer systems the average daily flow per connection can be determined. In both cases the water system and the sewer system average connection use is approximately 190 gallons per day.

As an integral part of the water and sewer system analysis it was necessary to meet with Acting Town Manager, Marshall Sebra to discuss the plans for proposed growth within the Town and within the water and sewer service areas outside of Town. During this analysis WWM relied on the zoning and land use criteria identified in both the Kilmarnock and Lancaster County adopted Comprehensive Plans. During the meetings with Mr. Sebra data was collected on several proposed development plans for undeveloped in-town properties. In addition there were several large areas and tracts without current development plans and it was noted that the approved and connected Hills Quarter project is only 20 percent developed at this time. The data listed in Table 3 were collected from Mr. Sebra and correlated with the Kilmarnock Comprehensive Plan. Where there were no current proposals for undeveloped and in-fill properties WWM used the approved density listed in the Comprehensive Plans and subtracted out known resource protection area and open space requirements to estimate future unit development in those areas. In Table 3 the new water and sewer flows were calculated based on 250 gallons per day per unit. It should be noted that even if the measured average daily flow in the existing water and sewer systems is 190 gallons per day per unit neither the Virginia Department of Environmental Quality (DEQ) nor the Virginia Department of Health (VDH) accept design flows less than 250 gallons per day per unit since lower flows do not account for peak daily usage.

Table 3 **Proposed New Units from Future In-Town Development** (Based on 250 gallons per day per unit)		
Property Description	**# of Units**	**Additional Water and Sewer Flow (GPD)**
Direct Connection to Gravity Sewer		
Sea Star Apartments	19	4,750
In-fill northeast of town center and east of Rte 200 (1)	15	3,750
New CDBG Pump Station		0
CDBG project south of town	30	7,500
Properties east of Main St conntacting to CDBG project	4	1,000
Wiggins Pump Station		0
Tartan Village Phase II by gravity	19	4,750
Grace Hill PUD from Grace Hill pump station	65	16,250
C-2 in-fill between Grace Hill and Industrial Park by gravity (1)	10	2,500
Hills Quarter future homes by Hills Quarter Pump Station	400	100,000
Hills Quarter future shops and activity center (1)	20	5,000
New Kilmarnock Glen Pump Station		0
Kilmarnock Glen	423	105,750
Spring Wood	40	10,000
Crossroads of Chesapeake	120	30,000
R-1 and R-3 properties north and west of Kilmarnock Glen (1)	60	15,000
Harvey Lane Pump Station		0
Rolling Hills in-fill by gravity	20	5,000
In-fill north of town and west of Rte 200 by gravity (1)	100	25,000
Commercial in-fill in new town center / bowling alley area (1)	25	6,250
Norris Pond Pump Station		0
C-1 properties below Harvey Lane and behind Wal-Mart (1)	50	12,500
Total	**1,420**	**355,000**
1. Number of units is estimated		

A quick review of Table 3 reveals the fact that the currently proposed in-town and Hills Quarter development projects will require significantly more water and sewer capacity than is now being delivered and treated to the existing customers. By adding the proposed peak demand flow of 340,000 gallons per day to the existing water and sewer flows it can be seen the future capacity needs at full in-town build out are 542,000 gallons per day of water and 533,000 gallons per day of sewer.

Appendix 2 - Description of the Existing Water System

Appendix 2 – Description of the Existing Water System

A. General Description of the Existing Water System

The Town of Kilmarnock's water system was originally constructed in the middle of the last century and consists of a network of small pipes between 2 ½" and 8" in diameter, three deep wells and three elevated water storage tanks located at the three well sites. The water system serves a total of 1,057 residential and commercial customers both in-town and outside town and provides fire flow service throughout its service area. The average total volume of water pumped from the wells is 202,000 gallons per day. Map W-1 is a map of the existing Town water system. Table 4 lists information on the existing wells and Table 5 lists information on the elevated storage tanks.

Table 4
Existing Well Production

Location	Production Rate (GPM)	Maximum Possible Connections (1)
Current		
Radio Well	425	850
Church Street Well	290	580
Total =	**715**	**1,430**
Future		
Hospital Well (2)	350	700
Total Future Production =	**1,065**	**2,130**

1. The Virginia Department of Health, Office of Water Programs requires public water systems to provide a minimum of two wells and a minimum of 0.5 gallons per minute per connection

2. The Hospital Well collapsed in 2006 and a new well adjacent to the old well has been under development for the past two years. No capacity data has yet to be confirmed, but it has been estimated that the sustained yield will be approximately 350 gallons per minute.

As can be seen from review of Table 4 with only two wells running the Town only has production capacity to serve its existing 1,057 connected unit customer base plus an additional 373 customers. At such time as the Hills Quarter project begins to build the additional 400 approved homes, the existing Radio and Church Street wells will ultimately fall short of meeting the Health Department production standards. It can also be seen from review of Table 4 that once the Hospital well has been re-developed the Town will have a total capacity to serve 2,013 customers. Based on a projected in-town build out of 1,360 new customers plus the existing 1,057 customers for a total of 2,417 customers, the well capacity will fall short of meeting its needs by approximately 200 gallons per minute. In addition to reestablishing the Hospital well, it will be necessary to drill at least one new well prior to completing the build out of the proposed in-town development and in the event any of the then four wells would be off line for any reason the system would again fall short of meeting the Health Department standards. A second new well for a total of five production wells is strongly recommended to complete the future comprehensive water system. Figures 3, 4 and 5 show the well houses and elevated water storage tanks at the Radio Well, the Church Street Well and the Hospital Well respectively.

Figure 3 – Radio Well Elevated Tank and Well Pump House Interior

Figure 4 – Church Street Well Pump House Exterior and Elevated Tank

Figure 5 – Hospital Well Elevated Tanks and Well Pump House Interior

B. Field Investigations

During the field evaluation and investigation phase of WWM's work visits were made to the three well sites. As part of the work WWM noted major deficiencies at all three well sites and prepared estimates of the costs for repair and upgrade. The estimated repair and upgrade costs are reported in Appendix 6. The observed deficiencies at the three well sites are as follows.

- **Radio Well**. All the iron pump discharge piping inside the Radio Well pump house is severely corroded due to the long term exposure to chlorine gas and humidity. It is only a matter of time before a piping system rupture will occur. Should this well fail before the Hospital Well has been redeveloped the Town will not have sufficient capacity from the Church Street well alone to supply its existing customer needs. To prevent future corrosion a new chlorine room should be constructed outside the main pump room. In addition the existing building should be properly insulated and ventilated and the well site should be protected with a security fence.
- **Church Street Well.** The Church Street well has been recently provided with a new pump. The well house is in a poor condition and would benefit by refurbishing the main door, related items and the fence. Should this well fail before the Hospital Well has been redeveloped the Town will not have sufficient capacity from the Radio well alone to supply its existing customer needs.
- **Hospital Well.** The Hospital well has been off line for more than two years. The reduced supply capacity has placed the Town in a critical situation where it is dependent on its old Church Street well which at times has experienced both equipment failures and capacity reduction and on the Radio well which has a severely deteriorated well discharge piping system that is on the verge of failure. It is imperative the Hospital Well be redeveloped and placed back on line as soon as possible. Due to contractual agreements between the Town and a third party engineering firm, WWM’s scope of work did not include a detailed review of the Hospital well.

In addition to owning three wells the Town owns three elevated water storage tanks. The storage capacity of the three elevated tanks is shown in Table 5.

Table 5
Existing Elevated Storage Tank Capacity

Elevated Tank	Size (Gallons)	Customers Served*
Radio Well Tank	250,000	1,250
Church Street Well Tank	60,000	300
Hospital Well Tank	250,000	1,250
Total	**560,000**	**2,800**
Fire Storage Reserve**	120,000	600
Total Available for Customers	**440,000**	**2,200**

* The Virginia Department of Health, Office of Water Programs requires public water systems to provide a minimum of 200 gallons of storage per connection.
** It is customary to subtract fire storage volumes from the total storage volume to determine water available to the customers during a fire event. Fire storage volumes are calculated at the estimated pumping rate (1,000 gallons per minute minimum) for two hours duration (120 minutes).

It can also be seen from a review of Table 5 that once a minimum fire storage volume of 120,000 gallons has been subtracted from the total elevated storage tank volume of 560,000 gallons there remains only 440,000 gallons available for the water system customers in the event of a fire. In order to meet the Health Department standard of 200 gallons per customer the system has the capacity of serve 2,200 customers. Based on a projected in-town build out of 1,360 new customers plus the existing 1,057 customers for a total of 2,417 customers, the tank capacity will fall short of meeting its needs by approximately 43,400 gallons.

Appendix 3 - Water System Hydraulic Analysis

Appendix 3 – Water System Hydraulic Analysis

A. Hydraulic Model

WWM created a computerized hydraulic model of the water distribution system using Haestad Methods WaterCAD software. This software utilizes the gradient method to solve the HQ equations for the network. Once WWM completed the water distribution system CAD file it then created the water distribution system model. Generally all crosses, tees, and 90 degree fittings of the distribution system piping were represented as nodes. In a residential area, the demand of houses along a pipe segment can be distributed at pipe endpoint nodes and adequate modeling results can still be achieved. However, the Town of Kilmarnock has a wide range of connection types so nodes were provided at intermediate points in the pipes to represent the taps to serve each building.

B. Background Theory and Calibration

Calibration of a network model is a highly complex process. Generally, the process includes a macro-calibration step, in which large discrepancies between predicted and observed flows are analyzed to identify data entry errors or physical problems with the system, such as a closed valve. This is followed by a micro-calibration step, in which the assumed node outflows and the assumed pipe roughness coefficients are adjusted to bring the computed flows and pressures closer to the observed flows and pressures. Micro-calibration typically requires extensive flow and pressure data obtained by data logging devices installed in the network. While precise calibration of the network model was not included in the scope of work, the flow test data was compared to the modeled results. The following discussion provides general background information that can be used during future calibration efforts.

Loss of energy of a flowing fluid is called headloss. In a distribution system network headloss is due to 1) the frictional resistance of the pipe wall on the fluid and 2) the shape drag resistance of pipe fittings on the fluid. The headloss due to the frictional resistance of the pipe wall can be determined by the following equation which is commonly known as the *Hazen-Williams* equation of friction,

$$h_f = 10.44 \cdot L \cdot Q^{1.85} / (C^{1.85} \cdot D^{4.87})$$

where "h_f" is the headloss in feet, "L" is the length of the pipeline in feet, "Q" is the fluid volumetric flow rate in gallons per minute, "D" is the pipe diameter in inches, and "C" is a frictional resistance coefficient known as the *Hazen-Williams* C factor. The C factor is an empirical constant and as such the calculated headloss in a design is generally not identical to an observed headloss value. The viscosity of water is also affected by temperature and that is not taken into account by this equation. Additionally, the age of a pipe will affect its C factor with the build up of residues on the pipe walls. A C factor of 120 was used for the Town of Kilmarnock water system hydraulic analysis.

In addition to the energy lost due to pipe friction is the energy lost at the fittings and bends in the pipes. The headloss due to the water flowing through the bends and fittings is called minor losses and can be determined by the following equation

$$h_m = K \cdot (V^2/2 \cdot g)$$

where "K" is a coefficient based on fitting geometry, "V" is the fluid velocity in feet per second, and "g" is the gravitational constant 32.2 feet per second squared. Pipe materials of construction do not affect the minor headloss, so the K value for a fitting would be the same whether the fitting was manufactured from ductile iron, asbestos cement, or PVC, etc.

The total head available at any point in a water distribution system is determined by the following *Bernoulli* equation which is commonly referred to as the Energy equation

$$H = P/Y + z + V^2/2 \cdot g$$

where “H” is a measurement of energy in feet, “P” is the pressure of the water in pounds per square foot, “Y” (gamma) is the unit weight of water (62.4 pounds per cubic foot), “z” is the elevation of the point above an arbitrary datum in feet, “V” is the velocity of the water in feet per second, and “g” is the gravitational constant (32.2 feet per second squared). The laws of fluid mechanics state that the energy in a pipe network system can be related in accordance with the following equation

$$H_1 = H_2 + h_{L1\text{-}2}$$

where the subscripts 1 and 2 indicate two points and $h_{L1\text{-}2}$ is the headloss from point 1 to point 2 due to frictional resistance and minor losses. Generally, H_1 can be taken as a static point exposed to atmospheric pressure (i.e. the low water elevation in a water storage tank, or the low hydraulic grade provided by a municipal utility, etc.).

Similar to the sewer system map the water system map was developed from old paper copy plans. The existing water system map W-1 shows the water lines, wells, tanks and fire hydrants and is attached in Appendix 1 of this report. The static water system pressures were developed by overlaying the Lancaster County aerial topographic map on top of the water system map with the assumption that all water lines are 3’ below grade. Once the water pressures were developed then the model was initially calibrated and the modeling work began.

C. Hydraulic Modeling Scenarios

Following the importation of all the data and selecting the existing fire hydrants as the “nodes” for the hydraulic model WWM selected four basic modeling scenarios. In each of the four scenarios WWM calculated the flows within each pipe section and identified specific areas where pipe flows and pressures are restricted. The four basic modeling scenarios are as follows.

- **Scenario W-1 - Average Flow.** The first scenario was the basic system model using a normal daily flow of 191 gallons per day per customer. As one should expect no flow or pressure problems were found with this scenario. Scenario 1 is shown in map W-2 and is attached in Appendix B at the back of this report.
- **Scenario W-2 – Peak Daily Flow.** The second scenario was the basic system usage on a peak day and again no flow or pressure problems were identified. Scenario 2 is shown in map W-3 which is found in Appendix B.
- **Scenario W-3 – Peak Daily Flow + 500 GPM Fire Flows.** The third scenario was an array of models which systematically superimposed a 500 gallon per minute fire demand at each fire hydrant over top of the peak daily demand. Low pressure problems were identified at 8 fire hydrants. The problem points with low pressure are shown in maps W-4 through W-11.
- **Scenario W-4 - Peak Daily Flow + 1,000 GPM Fire Flows.** The third scenario was an array of models which systematically superimposed a 1,000 gallon per minute fire demand at each fire hydrant over top of the peak daily demand. Low pressure problems were identified at 13 fire hydrants. The problem points with low pressure are shown in maps W-12 through W-24.
- **Critical Analysis.** In addition to the hydraulic models which demonstrated the system pressures problems WWM also identified specific buildings within Town that will be impacted with **negative** (less than 0 psi) pressures during a 1,000 gallon per minute fire. The critical buildings are shown in map W-5.

Appendix 4 - Description of the Existing Sewer System

Appendix 4 – Description of Existing Sewer System

A. General Description of the Existing Sewer System

The Town of Kilmarnock's sewer system was originally constructed in the middle of the last century and consists of a network of small diameter gravity sewer lines, five main sewage pump stations with force mains, two small minor pump stations and force mains and a wastewater treatment plant with a permit to discharge 500,000 gallons per day of treated effluent. The sewer system serves a total of 1,010 residential and commercial customers both in-town and outside town and provides service to the distant Hills Quarter golf course development. The average total volume of wastewater treated at the wastewater treatment plant is 193,000 gallons per day. Map S-1 is a map of the existing Town sewer system. Table 6 lists information on the existing main sewage pump stations.

Table 6
Existing Main Sewage Pumping Stations

Pumping Station	Pumping Rate (GPM)
Wiggins	278
Harvey Lane	400
Norris Pond	300
School Street	200
Hills Quarter	220

Unlike the water system which was evaluated for its existing capacity and its ability to serve additional projected flows from the in-town service area the nature of the sewer system does not lend itself to an overall analysis until such time as specific development plans can be presented for detailed technical analysis. However, WWM met twice with Marshall Sebra and discussed the potential in-town development plans. The total number of estimated future in-town connections was used to prepare the sewer hydraulic analysis described in Appendix 5.

B. Field Investigations

During the field investigation phase of WWM's work, the gravity sewer system was observed and brief visits were made to the wastewater treatment plant. Because the Town was under contract with a third party engineer for the upgrade of the wastewater treatment plant and because the Town has for several years been involved in an ongoing program of infiltration and inflow (I/I) reduction in the gravity sewer system WWM concentrated its efforts on the existing, large pumping stations. During the field investigations WWM noted major deficiencies at four of the five pumping stations and prepared estimates of the costs for repair and upgrade. The estimated repair and upgrade costs are reported in Appendix 6. The observed deficiencies at the four pumping stations are as follows.

- **Harvey Lane Sewage Pump Station.** The Harvey Lane sewage pump station is beyond its useful life, is non-OSHA compliant and is an operation and maintenance hazard. The pump station should be virtually replaced. In the past the original pumps included top mounted motors with long shafts to the pumps. Those motors were replaced with close coupled motors located deep inside the station. The metal cross bracing and minimal ladder access renders the pump station "extremely hazardous". Employee safety is at great risk during maintenance work due to the physical inability to extract a person from the station in the even of an accident. The generator is also past its useful life and the building, the controls and the fence need to be substantially replaced. Further this pump station will be receiving a large share of the future flows projected from undeveloped commercial growth areas within the Town. Figure 6 shows the condition of the Harvey Lane sewage pumping station.

Figure 6 – Harvey Lane Sewage Pumping Station

- **Wiggins Sewage Pump Station.** The Wiggins sewage pump station is also at the end of its useful life. It is the pump station that serves the largest sewer shed area including the hospital and the out of town Hills Quarter development. At present the majority of the planned homes in Hills Quarter have yet to be built. The Wiggins pump station is also the pump station that will receive all the future flows from the yet to be occupied Grace Hill development and the undeveloped residential growth areas in the western sector of the town. The pump station will need to be completely replaced since its capacity is limited to its existing connections. Similar to the Harvey Lane sewage pump station the Wiggins pump station was converted in the past to become an non-OSHA compliant facility. The building, the controls, the fencing and the pump station access are in need of substantial repair or replacement. One significant problem with this pump station is it lies at the end of a dilapidated long one lane access driveway which has no provisions for emergency vehicle turn around. In the event of an accident or fire this facility is virtually inaccessible to the emergency responders. It is patently unsafe. Figure 7 shows the condition of the Wiggins sewage pumping station.

Figure 7 – Wiggins Sewage Pumping Station

- **School Street Sewage Pump Station.** At some time in the past the School Street sewage pump station was converted from extended shaft pumps to close coupled pumps similar to the Harvey Lane and Wiggins sewage pump stations. Fortunately this station appears not to be located in the path of future development and should not be faced with a capacity problem. However, the pump station is in need of a significant upgrade to restore its useful life. Figure 8 shows the condition of the School Street station. Such items as the reconstruction of the pump chamber, new piping and valves, new controls, a new generator, building improvements and a new fence and minor site work are needed.
- **Norris Pond Sewage Pump Station.** The Norris Pond sewage pump station is a much newer facility. However, it has an undersized generator which does not have the ability to provide power to the station in the event of a power outage. The existing generator

should be replaced with a new properly sized generator. Figure 9 shows the condition of the Norris Pond sewage pumping station with a rusted propane tank and chain hoist.

Figure 8 – School Street Sewage Pumping Station

Figure 9 – Norris Pond Sewage Pumping Station

- **Hills Quarter Sewage Pump Station.** The Hills Quarter pumping station is relatively new and was designed for a capacity to serve approximately 505 homes, the golf course clubhouse and a number of unspecified commercial shops planned within the project. The specified pumping rate is 220 gallons per minute and no upgrades are needed at this time. Figure 10 shows the Hills Quarter sewage pumping station.

Figure 10 – Hills Quarter Sewage Pumping Station

C. Gravity Sewer System

The Town's gravity sewer collection system contains approximately 9 miles of gravity sewer pipe ranging in size from 6"-12". Historically the system has experienced excessive infiltration and inflow and over the years the Town has worked to identify and correct obvious problems and reduce the amount of extraneous water entering the system. The existing sewer system is shown in map S-1. Appendix 5, Sewer System Hydraulic Analysis discusses the gravity sewer system in greater detail and identifies specific problems within the existing system where the capacity is either limited now or will become limited following the connection of new customers from future development projects.

D. Wastewater Treatment Plant

The Town operates an activated sludge treatment plant which utilizes a process known as the Schreiber process. The plant is rated for 500,000 gallons per day and has recently undergone an upgrade. The current average daily flow is approximately 200,000 gallons per day. Due to the fact the Town has engaged a third party engineer to assist with the work at the wastewater treatment plant this report excluded any work in this area.

Appendix 5 - Sewer System Hydraulic Analysis

Appendix 5 – Sewer System Hydraulic Analysis

A. Theory of Hydraulic Sewer System Modeling

Sanitary sewer systems are typically designed to flow partially full and are thus analyzed using the theory of open channel flow. Conventional gravity sewer systems are analyzed using the *Manning* equation with the assumption the flow is uniform throughout each sewer run between manholes. The *Manning* equation expresses the flow rate "Q" (measured in cubic feet per second), as a function of the roughness of the pipe wall "n" (dimensionless empirically developed coefficient), the cross sectional area of the pipe "A" (square feet), the hydraulic radius "R" (the cross section of the flowing water within the sewer by the wetted perimeter of the pipe) and the slope of the channel pipe "S" (the drop between manholes divided by the length of the pipe and expressed as a decimal).

$$Q=1.49/n \cdot A \cdot R^{2/3} \cdot S^{1/2}$$

The cross sectional area of flow and hydraulic radius are both functions of the uniform flow depth. The Virginia Department of Environmental Quality's Sewage Collection and Treatment (SCAT) Regulation 9VAC25-790-320 requires the use of a *Manning* n coefficient of .014 for design and analysis of sewers in Virginia regardless of the type of pipe material.

It is generally a valid assumption that the flow in gravity sewer pipes will be uniform over most of the length. At manholes however, the transitions often result in unsteady flow and variable water levels. Hydraulic jumps can occur when the influent and effluent sewers either change direction or change slope. If hydraulic jumps are not present the flow is considered as being gradually varied and is therefore analyzed by numerically integrating the one dimensional *Bernoulli* (or energy) equation. If hydraulic jumps do occur the conservation of momentum principal is applied to determine the upstream and downstream depths. Both uniform and gradually varied flows are steady, meaning that the flow rate does not vary with time. Most if not all sanitary sewer systems are subject to changes in flow rate due to the variation in use throughout the day. To analyze the unsteady flow caused by the varying rate of flow, the one dimensional *St. Venant* equations are used. These are the partial differential forms of the conservation of mass and the conservation of momentum equations. These can be solved numerically using explicit or implicit finite difference schemes to determine the flow rate and depth at specific points along the channel. Algorithms can be incorporated to consider hydraulic jumps and full conduit flow. Descriptions of these algorithms are beyond the scope of this report but can be found in textbooks on computational river hydraulics.

B. The Hydraulic Model

WWM created a computerized hydraulic model of the gravity sewer collection system water distribution system. The first step was to manually import all the data recorded in all the old sewer plan drawings obtained from the Town into AutoCAD to generate a map of the system. The manually imported sewer data also included information on the elevations of the tops and inverts of the manholes. An overall field survey by The Engineering Groupe was used to horizontally tie the plan drawing information into the Lancaster County GIS mapping system.

The next step was the development of a custom hydraulic analysis routine to run in the AutoCAD environment. This was developed using EPA SWMM 5.0 source code incorporated into a VisualBasic for Applications program. Simulations were then run using the dynamic wave routing option which solves the one dimensional *St. Venant* equations previously described for various development scenarios to identify specific pipe and manhole sewer system elements of insufficient hydraulic capacity. Finally, the map and capacity data were translated to ArcGIS 9.2

for delivery to the Town. The basic ArcGIS map of the existing sewer system, S-1 is a skeleton map showing the manholes and pipes. In the model, manholes are represented as nodes, sewer pipes are represented as links, and lateral lines (not shown in the skeleton map) between buildings and the system are data objects shown as lines intersecting a sewer pipe.

C. Hydraulic Analysis

Wastewater Treatment Plant Influent Flow Data. Wastewater treatment plant influent data from January 2002 through December 2007 was analyzed to determine actual influent flow rates to the wastewater treatment plant. Predicted model flows to the treatment plant should match existing records, and in a fashion similar to the calibration of water distribution networks by the adjustment of nodal demands, appropriate values of lateral inflows from residential and commercial connections were determined as further described below.

Dry Weather Flow Determination. The first step in determining appropriate lateral inflows was to determine the typical dry weather base flow entering the wastewater treatment plant. A general observation of the combined influent flow and daily rainfall vs. time led to the following general conclusions.

- Storms of intensities of 0.5”-1.0” per day following periods of dry weather had little or no effect on wastewater treatment plant flow.
- Storms of intensities greater than 1.0” per day following periods of wet weather could result in a wastewater treatment plant flows of between 0.3 MGD – 0.4 MGD.
- Storms of intensities of greater than 1.5” per day could result in wastewater treatment plant flows of between 0.5 MGD – 0.7 MGD.

Infiltration and Inflow. To apply infiltration and inflow to a hydraulic model one of several numeric techniques can be safely used. Often a unit flow in gallons per day per inch diameter per mile of pipe can be used when a complete inventory of existing pipe diameters and lengths is available and rainfall and flow data is not. In the case of the Town of Kilmarnock the existing wastewater treatment plant flow records along with the recorded rainfall was used to calculate total average dry and wet weather flows from which average unit flows per connection (both residential and commercial alike) were calculated. Then using those average unit dry and wet weather flows, projected flows from new developments were calculated and imported into the hydraulic model. In this model WWM used a dry weather unit flow of 175 gallons per day per customer and a wet weather unit flow of 189 gallons per day per customer. As part of the unit flow validation process WWM considered the following points.

- The average wet weather flow of 189 gallons per day per customer was an extremely close match to the average water usage of 191 gallons per day per customer.
- The average flows of 175 and 189 gallons per day respectively for dry and wet weather flows corresponded closely with measured average unit flows from other municipalities of similar size and similar sewer characteristics.
- The average flows closely aligned with published unit flow design data (Metcalf & Eddy, Inc. *"Wastewater Engineering: Collection and Pumping of Wastewater*", 1981).
- In the model there was no attempt to differentiate between the unit flows from the various residential, commercial or institutional users.

Hydraulic Modeling Scenarios. After collecting the data WWM built the AutoCad maps of the sewer system which included manhole and pipe locations, pipe sizes and invert elevations and pump station and force main locations. WWM also developed and calculated anticipated future flows from the individual development parcels and selected probable sites for new sewage pumping stations and force mains in order to determine the impacts the future flows will have on the existing sewer system. Sewer map S-1 shows the existing sewer system and sewer map S-2 shows the probable future pumping station and force main locations.

Following the importation of all the data WWM selected four basic modeling scenarios. In each of the four scenarios WWM calculated the flows within each pipe section and identified specific areas where pipe capacities are restricted. The four basic modeling scenarios are as follows.

- **Scenario S-1 - Average Flow.** The first scenario was the basic system model using a per unit dry weather flow of 175 gallons per day per customer. This scenario depicts what the Town now experiences on a typical day. As one would expect very few problems were found with this model with the exception of a short stretch of line immediately downstream from the discharge of the Harvey Lane force main. The model determined there is frequent surcharging in that stretch of line. Scenario 1 is shown on map S-3.
- **Scenario S-2 - Average Flow x 2.5.** The second scenario was to superimpose a diurnal peak factor of 2.5 on the average daily flow to determine the instantaneous system flows on a typical dry weather day. Scenario 1 is shown in map S-4 and shows additional problems with short term surcharging in the system. In addition to the line down stream from the Harvey Lane force main the sewer line down stream from the Wiggins pumping station all the way to the treatment plant experiences short term surcharging.
- **Scenario S-3 - Average Flow x 2.5 + I&I.** The third scenario was similar to the second scenario S-2 with the addition of the infiltration and inflow to model the system on a wet weather day. In this scenario a per unit wet weather flow of 189 gallons per day per customer and a diurnal peak factor of 2.5 were used to develop the model. This scenario showed a greater degree of surcharging and is shown in map S-5.

- **Scenario S-4 - Average Flow x 2.5 + I&I + Future Development Flows.** The fourth scenario used the third scenario as a base and then added the future development flows. The model determined there will be significant system capacity failures in all the main gravity lines downstream from the Harvey Lane, the Wiggins and the School Street force mains where the additional pumped flows will be connected. The fourth scenario is shown in map S-6.
- **Preliminary Recommendations for Future Improvements.** In addition to the hydraulic modeling work WWM identified specific areas where future upgrades will be necessary to serve the future development flows. The specific recommendations include the replacement of several existing gravity sewer line with larger gravity sewer lines to eliminate the surcharging and to provide the additional capacity.

Appendix 6 – Cost Estimates for Priority Needs

Appendix 6 – Cost Estimates for Priority Needs

As discussed in the body of the report the problems with the water and sewer systems are numerous and widespread. The most serious problems are those which are currently affecting the Town and its ability to properly manage its water and sewer systems. The less urgent problems are those that will become manifested as future development occurs within the Town however over time they may become significantly greater in magnitude and much more costly to resolve.

In regards to the water system the most urgent need is to complete the redevelopment of the Hospital well as quickly as possible. With this well off line the current situation is critical in that should either the Radio well or the Church Street wells go down for any reason neither well has the capacity on its own to supply the current daily needs. Addressing this serious deficiency should be the Town's top priority. In addition, repairs are needed at the Radio well to replace the damaged piping system which is in a state of near failure due to corrosion from the chlorine chemicals stored and used within the pump room. The most practical solution to preventing the corrosion from becoming an ongoing problem is to construct a separate chemical feed room adjacent to the main pump room and then protect the well site with a secure fence. The priority needs with estimated associated costs are shown in Table 7.

Table 7 **Water and Sewer System Priority Improvements**		
Priority Improvements	Tasks	Costs
1. Hospital Well. The Hospital Well has been off line for more than two years. The reduced supply capacity has placed the Town in a critical situation where if either the Radio well or the Church Street well should go down it would not be able to supply the Town. It is imperative the Hospital Well be redeveloped and placed back on line as soon as possible.	Engineering 48 Hour Pump Test New Pump Piping and Controls Building Upgrade New Generator Electrical Site Work Contingency **Total**	20,000 15,000 25,000 60,000 20,000 40,000 30,000 30,000 25,000 **$ 265,000**
2. Radio Well. All the pump discharge piping inside the Radio Well pump house is severely corroded due to the long term exposure to chlorine gas and humidity. To prevent future corrosion a new chlorine room should be constructed adjacent to the main pump room. Once the new chlorine room has been constructed and new piping installed the site should be fenced.	Engineering Surveying Repiping New Chlorine Room Electrical Building Upgrade Site Work Contingency **Total**	5,000 5,000 15,000 15,000 10,000 10,000 30,000 10,000 **$ 100,000**
3. Harvey Lane Sewage Pump Station. The Harvey Lane sewage pump station is beyond its useful life and is non-OSHA compliant and a serious operation and maintenance hazard to the employees. The pump station should be virtually replaced. The generator is also past its useful life and the building, the controls and the fence need to be substantially replaced. This pump station is will receive a large share of the future flows projected from undeveloped commercial growth areas within the Town.	Engineering Surveying Pumps / Controls Convert Wet Well New Valve Vault New Station Piping New Generator Electrical Building Upgrade Site Work Contingency **Total**	35,000 5,000 20,000 40,000 50,000 30,000 40,000 30,000 20,000 40,000 30,000 **$ 340,000**

4. Wiggins Sewage Pump Station. The Wiggins sewage pump station is at the end of its useful life. It is the pump station that serves the largest sewer shed area including the hospital and the Hills Quarter development in which the majority of the planned homes have yet to be built. The Wiggins pump station will also be receiving all the future flows from the undeveloped residential growth areas in the western sector of the Town. The pump station will need to be completely replaced since its capacity is limited to its existing connections. The Wiggins pump station is also non-OSHA compliant and an operation and maintenance hazard. Further, this pump station lies at the end of a long one lane driveway which has no provisions for emergency vehicle turn around. In the event of an accident or fire this facility is virtually inaccessible to the emergency responders.	Engineering Surveying Pumps / Controls Convert Wet Well New Valve Vault New Station Piping New Generator Electrical Building Upgrade Site Work Contingency **Total**	45,000 10,000 20,000 40,000 50,000 30,000 40,000 30,000 20,000 50,000 30,000 **$ 365,000**
5. School Street Sewage Pump Station. The School Street sewage pump station is at the end of its useful life and in need of replacement. The School Street pump station is non-OSHA compliant and a serious operation and maintenance hazard to the employees.	Engineering Surveying Pumps / Controls Convert Wet Well New Valve Vault New Station Piping New Generator Electrical Building Upgrade Site Work Contingency **Total**	25,000 5,000 20,000 30,000 40,000 25,000 35,000 25,000 20,000 20,000 25,000 **$ 270,000**
6. Norris Pond Sewage Pump Station. The Norris Pond sewage pump station is a relatively new facility. However, it was constructed with an undersized generator which does not have the ability to power the station in the event of a power outage. The existing generator should be replaced with a new properly sized generator.	Engineering Surveying New Generator Electrical Site Work Contingency **Total**	5,000 5,000 35,000 15,000 5,000 10,000 **$ 75,000**
7. Church Street Well. The Church Street well is in need of some minor improvements to the building door and the fence, etc.	General Repairs Contingency **Total**	15,000 5,000 **$ 20,000**

8. Facility Operation and Maintenance Manuals. All existing sewage pump stations and wells should have Operation and Maintenance manuals prepared to satisfy the DEQ and VDH requirements and for use by the employees.	Engineering **Total**	25,000 **$25,000**
9. Infiltration and Inflow. The Town should continue to pursue its ongoing Infiltration and Inflow (I/I) flow identification and reduction program.		

In regards to the sewage pump stations the most urgent needs are the rehabilitations of the Harvey Lane, the Wiggins and the Church Street pumping stations. Those facilities have reached the end of their useful lives and are in need of urgent attention. In addition all three pumping stations are non-OSHA compliant and are defined as "confined spaces" due to their lack of adequate access and structural configurations which severely restrict the ability to extract a person from the pump chambers in the event of an emergency. In addition, all three pumping stations will be receiving additional flow from the future development of undeveloped propertied in town and will need to be expanded in capacity. In such instances all three pumping stations plus the Norris Pond pump station will need larger standby emergency power generators.

Appendix 7 – Policy Issues for Consideration

Appendix 7 – Policy Issues for Consideration

A. Wastewater Treatment Plant Expansion

As demonstrated in the body of this report the existing wastewater treatment plant is severely limited in capacity with the ability to only serve the existing customers plus the projected build-out of the undeveloped in-town properties and Hills Quarter. The existing wastewater treatment plant does not have capacity to serve additional out-of-town customers without sacrificing capacity for future in-town customers. It is a fact that the expansion of any wastewater treatment plant is never made in small increments but is made in large volumes. For example, the existing wastewater treatment plant is sized for 500,000 gallons per day and a practical increase in capacity would be 250,000 gallon per day, or fifty percent of the existing capacity. Conversely, it would not be practical to increase the plant capacity a small incremental amount such as by 50,000 gallons per day. The purpose of making this point is that at such time as the treatment plant capacity has been reached or "used up" it will be impractical to expect a small property to be able to afford to pay for the expanded capacity. It would also be impractical to expect the existing customers to pay for a large plant expansion thereby subsidizing future developers.

With that being said however, the existing wastewater treatment plant could be modified and upgraded to provide greater treatment capacity without having to construct additional tanks and major equipment. The existing Schreiber bioreactor units are almost impossible to upgrade or convert to an improved process due to the constantly rotating aeration arm. However, those reactors were installed to replace the original extended aeration tanks which are still in use as equalization basins. It would be possible to combine the capacity of both the Schreiber and the extended aeration reactors to achieve additional capacity providing the ongoing infiltration and inflow reduction program continues to achieve substantive results in the overall reduction of flow through the treatment plant. The details of such an upgrade are outside and beyond the scope of this report.

B. Developer Responsibilities

In the past 25 years since the end of the federally funded water and sewer program era municipalities that have been faced with pressure from developers to provide capacity for their projects have come to realize it is the developers who should be paying for the upgrades and not the municipalities themselves. This have been particularly true with smaller utilities which have often struggled to maintain financial viability and balanced budgets. In many instances the municipalities have even taken the approach that the upgrade of their utility systems should be made on a planning area basis and not just on a project by project basis. In those cases some municipalities have relied on "oversizing" and / or "reimbursement" agreements with the leading developers paying for the larger facilities sized to serve the entire planning area and then being partially reimbursed by the municipality with future connection fees outside their properties. An example of a reimbursement agreement between the Prince William County Service Authority and two developers and an example of a capacity purchase agreement between Fairfax County Water Authority and Prince William Counties are provided in Appendix 7.

C. Sewer Standards and Ordinances

All well run and managed municipal water and sewer utilities have developed and rely on highly detailed and rigid standards for design, pipe materials, equipment and construction. The enforcement of rigid standards provides many important benefits including reducing the number of spare parts the operation and maintenance staff must have on hand, consistency in delivery of service and minimization of infiltration. Many municipal water and sewer utilities have adopted detailed design, material, equipment and construction standards and the Town of Kilmarnock would benefit from having its own set of adopted standards.

D. User Fee Structure

As part of WWM's overall project work the issue of water and sewer user fees came up on several occasions. Several questions were posed asking what should be included in the user fees and is it common for a municipality to use money from the "General Fund" to support or subsidize the "Water and Sewer Fund." It has been WWM's experience that most small municipalities fail to capture all the true costs of owning and operating their water and sewer utilities and often resort to receiving subsidies from the General Fund to balance the water and sewer budgets. The most commonly overlooked budget item is a capital replacement allowance which is always necessary from time to time to make major repairs, upgrade equipment, reach higher levels of treatment and otherwise provide for system longevity. During the era of federal funding for water and sewer systems the federal agencies always required the fund recipients to develop and adopt comprehensive user ordinances and fee structures that ensured balanced budgets over the life of the project. However, as often was the case, as time went by and the federal agency scrutiny stopped the user fees became fodder for the local politicians where mayors or council persons would include "low water and sewer rates" as platform planks. Invariably thereafter the operating and maintenance budgets would be cut and the replacement funds would be eliminated. Then in the future would come the day of reckoning when a major incident or failure would require a significant amount of funds for mitigation or repair and the money wouldn't be there placing the municipality in a difficult position.

A proper utility budget should include all cost items including operating and maintenance labor and fringe benefits, administrative labor, a share of the rent, electricity, chemicals, sludge hauling analytical testing and reporting, permit fees, vehicles, insurance, legal, engineering and accounting fees, capital recovery, depreciation of equipment, and a capital replacement fund.

Appendix 8 – References

Appendix 8 – References

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