

2.0 BACKGROUND

2.1 Existing Water Service

The Spotsylvania County water system, serving about 28,100 customers with drinking water in both Spotsylvania County and the City of Fredericksburg, has undergone dramatic changes since the acceptance of the original 1994 Water/Sewer Master Plan. Over the course of the past eight years Spotsylvania County, in partnership with the City of Fredericksburg, has developed a regional water supply, treatment and distribution system to serve the five pressure zones in Spotsylvania County and three zones in the City of Fredericksburg. This action represents a fundamental shift in water production and delivery within both municipalities.

The Spotsylvania County water distribution system has seen significant growth in recent years, especially with the installation and operation of the Motts Run Water Treatment Plant (WTP). This plant, owned by Spotsylvania County, serves both Spotsylvania County and the City of Fredericksburg, and significantly altered the operation of both water systems.

Prior to the opening of the Motts Run WTP, Spotsylvania County operated only the Ni Water Treatment Facility. To augment water supply and distribution, Spotsylvania County maintained a purchase of water agreement with the City of Fredericksburg and received delivery of water at three separate connections: Route 3 pump station, the Lafayette Boulevard pressure reducing valve (PRV), and the Route 1 interconnection.

In 2000, Spotsylvania County placed the Motts Run WTP into service and the City of Fredericksburg decommissioning the Kenmore WTP located along the Rappahannock River. The City currently receives its primary water supply from the Motts Run WTP through a connection at Falls Hill Avenue and continues to maintain two emergency connections to Stafford County. Spotsylvania County currently manages water production and distribution at both the Ni and Motts Run water treatment facilities.

Spotsylvania County water system consists of the following principal features:

Ni Reservoir

The Ni Reservoir, the raw water supply to the adjacent Ni Water Treatment Plant, was constructed in 1974 by the U.S. Department of Agriculture, Soil and Conservation Service. The reservoir has a volume of 750 million gallons covering approximately 417 acres. The safe yield, as defined by the Virginia Water Control Board, is 4.0 mgd annual average withdrawal. Safe yield was re-calculated in 1999 during the 1998-1999 drought at 4.3 mgd; however, the 1998-1999 drought was not confirmed to be the drought of record.

The class 2 earth-fill dam at the Ni Reservoir is 45 feet high and 1440 feet long. The dam principle spillway is at an elevation of 237.5 feet, while the emergency spillway is at 247.7 feet.

Ni Water Treatment Plant

The Ni WTP was initially constructed in 1974 with a 1.0 mgd capacity; expanded in 1977 to 2.0 mgd; expanded again in 1981 to 4.0 mgd, and in 1993 underwent final expansion to its current capacity of 6.0 mgd.

The Ni WTP includes a rapid mix facility, three parallel up flow clarification processes (1.0 – mgd Suburban, 2.0-mgd Crane-Cochran, and 3.0-mgd Superpulsator), mixed media filtration, and clearwell storage. Carbon can be added to the raw water by a carbon feeder. All raw water is treated with lime and potassium permanganate, and polymer and liquid alum are added to the rapid mix basin as a coagulant aid. Fluoride, chlorine and corrosion inhibitor are added at the clearwell.

The clearwell storage consists of three separate underground structures containing a total volume of 358,000 gallons. Raw water pumping consists of four 2- mgd raw water pumps, with one used as a backup. The finished water pumping consists of four pumps - at 1300 gpm. An additional 1400-gpm pump is stored and maintained at the plant, to be utilized if one of the installed pumps goes out of service for a prolonged period. Wastewater sludge generated at this facility is pumped to the Massaponax WWTP; backwash water decant can be pumped to the sewerage system or can be dechlorinated and returned to the Ni River below the dam.

Before the Motts Run Water Treatment Plant was placed into service in 2000, the Ni WTP served as the primary water supply to Spotsylvania County through a 16-inch main in the Five Mile Fork pressure zone along Gordon Road.

Motts Run Reservoir

The Motts Run Reservoir was built in 1971, and is currently undergoing modifications and improvements expected to be completed in 2002. The reservoir is located adjacent to the Rappahannock River; prior to 1995 it was owned and maintained solely by the City of Fredericksburg. Currently, the reservoir is owned by the City of Fredericksburg, but is jointly operated by the City of Fredericksburg and Spotsylvania County. The total reservoir volume, prior to modifications, is 1.3 billion gallons.

The existing dam is of earth-fill construction is approximately 100 feet high and 700 feet long. Recent modifications to the dam include replacement of two 10-inch intake tower gates with two 24-inch sluice gates, slip-lining the existing 48-inch conduit with 700 feet of 36-inch polyethylene pipe, upgrading the emergency spillway, reshaping the dam, armoring the dam side to reduce erosion, raising the crest of the dam 3.5 feet, and installing a blanket drain system on the downstream side. Upon completion of the dam modifications, the reservoir will be capable of supplying raw water to the Motts Run WTP or receiving water to be stored from the Rappahannock River raw water pump station and intake. Safe yield of this reservoir varies based on natural inflow assumptions, inflow pumping rates, and sedimentation and recreational storage requirements. Applying conservative criteria and assumptions the safe yield has been estimated to be between 3.5 and 4.0 mgd. The past safe yield studies of this reservoir are discussed in Section 7 of this report.

Motts Run Water Treatment Plant and Intake on the Rappahannock River

The Motts Run water treatment facility and Rappahannock River raw water pumping station were completed in the spring of 2000. The current water treatment plant capacity is 12 mgd and is expandable to 24 mgd.

The Rappahannock River Intake facilities consist of a 36-inch diameter raw water conduit from a header system of three (expandable to 4) cylindrical shoreline well screens to the raw water pumping station. The riverbank inlet includes both de-icing and automatic air bursting systems to maintain consistent intake flows. The raw water pumping station, located adjacent to the intake has a Rappahannock River withdrawal capacity of 28 mgd. Raw water can either be pumped to the Motts Run WTP via vertical turbine pumps or to the Motts Run Reservoir through two 10-mgd vertical turbine pumps. As an alternative, water can also be released from the Motts Run Reservoir into the Rappahannock River upstream of the intake structure or can be piped directly to the raw water pumping station to be treated at the plant.

The Motts Run water treatment facility includes two contact basins and rapid mixers where potassium permanganate, lime, carbon, polymer, and alum can be added. Clarification occurs through four Actiflo flocculation and high rate settling systems. Five mixed media filters are topped with granular activated carbon. The plant has 2.3-mg clearwell storage. Additional chemical feed systems include chlorine for disinfection, caustic soda for pH adjustment, fluoridation, and corrosion inhibitor. Wastewater sludge generated at this facility is pumped to the City of Fredericksburg sanitary sewer system; supernatant from the sediment basins can be pumped to the sewerage system or can be dechlorinated with sulfur dioxide and returned to the Motts Run Reservoir. The finished water high service pumping station, on top of the clearwell, houses six vertical turbine pumps. Three 3-mgd pumps provide water to the City of Fredericksburg, and three pumps (two at 3 mgd and one at 6 mgd) provide water to Spotsylvania County.

The Motts Run WTP serves Spotsylvania County through 7,500 feet of 30-inch transmission main and the City of Fredericksburg through 10,000 feet of 24-inch main. The Motts Run WTP Spotsylvania County finished water supply ties into the Five Mile Fork Zone at Route 3 and the Battlefield Zone through a 24-inch transmission main. The City of Fredericksburg finished water supply enters the Courtland Zone at the Falls Hill Avenue PRV vault.

Hunting Run Side-Stream Storage Reservoir and Intake on the Rapidan River

The Hunting Run water supply dam and side-stream reservoir will be completed in 2002 and will have a total volume at normal pool of 3.053 billion gallon and a safe yield estimated at 8 mgd.

The Rapidan River intake facility consists of three screens and a 36-inch raw water conduit to the raw water pumping station. The riverbank inlet includes both de-icing and automatic air bursting systems. Raw water is pumped to the Hunting Run reservoir by three 8-mgd pumps. The intake is fully automated and controlled from both the Ni WTP and the Motts Run WTP. During water release from the reservoir, water travels through the same 36-inch water conduit back into the

Rapidan River, which drains to the Rappahannock River, and is then used as source water for the Motts Run WTP through the Rappahannock River intake.

The Hunting Run reservoir dam is a composite roller-compacted-concrete and earth-fill dam. The dam is 2,300 feet long and 90 feet high with the top elevation of the earth-fill at 259 feet, and the top elevation of the RCC at 259.8 feet. The spillway is 100 feet long with a 110-foot excavation height.

Five Mile Fork Pressure Zone

The Five Mile Fork pressure zone is supplied by the Motts Run WTP in the north, and by the Ni WTP in the southeast. The Five Mile Fork zone is served by the 100,000 gallon Five Mile Fork elevated storage tank (overflow elevation 465.24 feet) and the 2.0 mg Route 627 ground storage tank (overflow elevation 348.00 feet) and booster station. The hydraulic grade line (HGL) in this pressure zone is controlled by the Five Mile Fork Tank at 465.24 feet. Refer to Figure 1. Prior to the Motts Run WTP construction, the Route 627 facility was originally built to aid in the distribution of water from the Ni WTP, north to the Route 3 area.

American Central Pressure Zone

The Fawn Lake development receives finished water through the American Central booster pump station, along the 12-inch American Central water line, which is part of the Five Mile Fork pressure zone. Currently there is no storage in the Fawn Lake area; therefore, the hydraulic grade varies with demand and pumping.

Battlefield Pressure Zone

The Battlefield pressure zone is supplied from the Five Mile Fork zone by three pressure reducing valves (PRV). This zone normally operates at approximately 430 feet in the northern part of the zone and 420 feet in the southern part of the zone. This pressure zone is served by the 250,000 gallon Battlefield Tank (overflow elevation 431.25 feet), the 100,000 gallon Courthouse Tank (overflow elevation 429 feet), the 250,000 gallon Onduline Tank (overflow elevation 431.25), and the 250,000 gallon Thornburg Tank (overflow elevation 431.25). These tanks float off the demands in this zone. The Mine Road booster pumping station and ground storage tank also provide water to this zone. Upon completion of the 24-inch main along Cherry, Harrison, and Leavells Roads, the Motts Run WTP will be capable of supplying water directly to the Battlefield pressure zone.

City Pressure Zone

The City pressure zone is owned and operated by Spotsylvania County, but is supplied through two connections with the City of Fredericksburg Courtland pressure zone. The first connection is located along Lafayette Boulevard (control grade 395 feet). The second connection is through an 8-inch line on Dunning Mills Lane in the City. There are currently no storage facilities within in the City pressure zone.

Figure 1 – Water Pressure Zone Hydraulic Grade Lines

Mine Road Pressure Zone

Water enters the Mine Road Zone from a PRV off the Battlefield Zone at Route 635 (control grade 270 feet). In the past, the Mine Road Zone was served by the Landsdown connection to the City of Fredericksburg, but that connection is currently configured to supplement the City's downtown system should local pressures in the City system drop. The Mine Road pressure zone contains a 2.0-mg Mine Road ground storage tank (overflow elevation 267.33). When the tank fills, overflow can be pumped to the Battlefield Zone. During the summer of 1999, an emergency 6-inch connection was made to the City of Fredericksburg zone at Artillery Ridge, which can supply approximately 800 gpm to the Mine Road tank for pumping to the Battlefield Zone.

Water Distribution System

The Spotsylvania County water distribution system consists of approximately 120 miles of piping ranging in size up to 30 inches. Piping materials are typically polyvinyl chloride for 6- and 8-inch pipes and ductile iron pipe for pipes greater than 8-inches in diameter. Also, pipes installed between 1960 and 1979 are mostly cast iron, while pipes installed after 1980 are mostly ductile iron.

The water distribution system is mapped on the Spotsylvania County GIS system. The Spotsylvania County and City of Fredericksburg water distribution systems are combined for the purposes of hydraulic modeling using Cybernet software.

City of Fredericksburg Distribution System

The City of Fredericksburg water distribution system is supplied by a 24-inch transmission main from the Motts Run Water Treatment Plant to a PRV (control grade 425 feet) located along Falls Hill Avenue. The Courtland Zone is the first to receive water, with a zone HGL of 395 feet. The Courtland Zone has a 500,000-gallon tank with an overflow elevation of approximately 395 feet. As previously discussed, the Courtland Zone supplies the Spotsylvania County City pressure zone through connections located on Lafayette Boulevard and Dunning Mills Lane. The College pressure zone is fed from the Courtland Zone through two PRV that reduce the pressure to approximately 268 feet. Water from the Courtland system flows to the City's Downtown pressure zone via a PRV station at the Powhatan Street Reservoir and from the 4.0-mg Powhatan Reservoir with an overflow elevation of 195 feet. The 4.0 mg reservoir is also supplied from the Courtland zone via an altitude valve at the reservoir. The Downtown pressure zone is also supplied through the newly installed Lafayette PRV (control grade 195 feet) located adjacent to the Lafayette pump station that remains in a stand-by mode. The City maintains two emergency connections with Stafford County. One is an 8-inch connection just south of the Falmouth Bridge and the second is a 16-inch connection near Charlotte Street. The combined capacity of these interconnections is 2 to 2.5 mgd and is limited by distribution problems in Stafford County.

2.2 Existing Sewer Service

Spotsylvania County sewerage system consists of the following principal features:

Massaponax Wastewater Treatment Plant

The Massaponax WWTP was constructed in 1975 with 3.0 mgd capacity. It was expanded in 1991 to 6.0 mgd capacity. Expansion to 8-mgd capacity is scheduled for completion in November 2002. The Massaponax wastewater treatment facilities consist of flow equalization, influent screening, pH adjustment, pumping, grit removal, activated sludge, coagulant addition, clarification, sand filtration, ultraviolet disinfection and post aeration. Scum, septic sludge and waste activated sludge are stabilized with a chlorine-oxidation system, followed by thickening in a decant tank and dewatering on a belt filter press.

The wastewater treatment plant serves the Massaponax Creek drainage basin and includes the pump-over from the American Central sewage collection system and a small part of the upper Hazel Run drainage basin that is also pumped into the Massaponax Creek basin. Facilities are in place to enable sewage from the Deep Run drainage basin to be pumped to the Massaponax Creek drainage basin. Deep Run wastewater may also be treated at the FMC Wastewater Treatment Plant. A Courthouse Area Sewage Pumping Station, expected to be on line in 2003 will convey sewage from the Courthouse Area to the Massaponax Creek interceptor. When this pump station is completed, the Wishner Wastewater Treatment Plant will be abandoned.

FMC Wastewater Treatment Plant

The original FMC industrial WWTP began operation in 1967 to treat up to 8 mgd of process wastewater from the production of cellophane. In 1978, the FMC Corporation viscose plant ceased production and the industrial WWTP shut down and was abandoned. The plant was purchased by Spotsylvania County in 1980 and in 1985 the plant was upgraded for municipal wastewater treatment service for a design flow of 2.619 mgd. Sand filters were added in 1992, to increase WWTP capacity to 4 mgd. In 1995 the FMC WWTP was further upgraded to enable the plant to achieve new TKN limits at a 4 mgd capacity.

The FMC WWTP consists of preliminary treatment with screening and grit removal, lime addition, biological treatment with extended aeration activated sludge, followed by clarification, alum or polymer addition, tertiary filters, chlorination/dechlorination, and post aeration prior to discharge. The solids handling includes aerobic digestion, gravity thickening, belt filter press, and final removal to the landfill.

The FMC WWTP has no gravity service area. Sewage from the City of Fredericksburg is pumped to the plant. This includes a flow equal to that from the Spotsylvania County Hazel Run drainage basin that flows by gravity into the City of Fredericksburg wastewater collection system. In addition, the City has an option to pump an additional 1.5- mgd flow to the FMC Wastewater Treatment Plant. In addition, the FMC plant receives flow from the Bowman Industrial Park and can receive discharge from the Deep Run sewage pumping station.

Thornburg Wastewater Treatment Plant

The Thornburg WWTP was constructed in 1972 with 60,000-gpd capacity. The WWTP was expanded in 1990 to 345,000 gpd capacity. The Thornburg sewage collection system consists of approximately 12,000 feet of 8" and 10" gravity sewer and 2000 feet of 6" force main. Service area includes travel-trade along the west side of the Thornburg Interchange of I-95 at Route 606 and residential and commercial customers along US Route 1, Route 606, and Route 632 near the intersection of Route 1 and Route 606. Additionally, an industrial site on the southeast corner of the interchange is served by an 8" gravity sewer, 200-gpm pumping station, and 6" force main that passes westward under I-95.

Wishner (Stoneybrook) Wastewater Treatment Plant

The Wishner WWTP was constructed in 1974 with 150,000-gpd capacity. The WWTP was expanded in 1988 to 225,000 gpd capacity. The Wishner WWTP serves the Courthouse Area by gravity sewer and two small sewage pumping stations. The Courthouse Area is mostly residential, but has the potential for commercial growth following the implementation of the Courthouse Area Master Plan.

Under the Courthouse area Master Plan, the Wishner WWTP will be removed from service and replaced with a sewage pumping station that will pump Courthouse Area sewage to the Massaponax Creek interceptor. This sewage pumping station is scheduled for completion in 2003. Several sub-basin pumping stations may be installed as the Courthouse area develops. These small pump stations would pump into the new Courthouse area pumping station.

Sewers and Interceptors

The sewer system is broken into collection sewers and 4 major interceptors. The interceptors are defined by the drainage basins that they serve - Massaponax Creek, Hazel Run, Deep Run, and Long Branch (which is a part of the Hazel Run drainage basin).

All Spotsylvania County sewers and interceptors are mapped on the County GIS system.

2.3 Master Planning Resources and References

The following references and resources were utilized to prepare the Water/Sewer Master Plan Revisions:

1. Planimetric Data (as of March 1999) for all of Spotsylvania County including roads, water bodies, buildings, tree lines, and other major geographical features. This data was provided by the Spotsylvania County Planning Department and is broken into 90 quadrants covering all of Spotsylvania County. The 35 quadrants which make up the primary settlement area, the secondary settlement area, and the American Central region were assembled for background for the GIS maps used in the Water/Sewer Master Plan Revisions.
2. Property Line Data (as of March 1999) for all of Spotsylvania County including all currently platted properties. This data was provided by the Spotsylvania County Planning Department and is broken into 90 quadrants covering all of Spotsylvania County. The 35 quadrants that make up the primary settlement area, the secondary settlement area, and the American Central (Fawn Lake) region were assembled for use in the master planning process. The property line data was then placed over the planimetric data in AutoCAD to create one drawing showing all the features. Sub-basins were defined to follow topographic features and property lines.
3. Topographic Mapping (last revised circa 1985) for the primary settlement area, secondary settlement area, and the American Central (Fawn Lake) region. Raster images of the USGS topographic sheets were obtained and layered on the AutoCAD drawing to provide contour information. Contours were used to define drainage areas and sub-basin boundaries.
4. Existing Sewage Pump Stations. Data locating up to 60 existing pump stations was taken from a Spotsylvania County sewer map index and from an AutoCAD drawing provided by the Spotsylvania County Utilities Department. A sub-basin was defined for each sewage pump station. Subsequent corrections to the sub-basin boundaries were made at the direction of the Spotsylvania County Utilities Department, to account for sewage pump station installations that do not actually serve a sub-basin defined by contours.
5. Emergency 911 Street Addresses for all of Spotsylvania County. Addresses were provided by the Spotsylvania County Planning Department and are attributed to the County GIS system. Addresses were provided with physical location attributes, enabling use of ArcView to physically locate each property on the County planimetric map.
6. Water Service Records provided by Spotsylvania County Information Services Department. These records provided water meter readings for 18,880 Spotsylvania County customers from June 1998 to May 1999 in spreadsheet format and included a physical address for each water meter. The water service record addresses were matched and reconciled with the E911 addresses to facilitate GIS location of all metered water consumption in the County.
7. County of Spotsylvania Residential Build-out Analysis provided by the Spotsylvania County Planning Department. The planning department analyzed the residential portion of the

County and defined a unit density for each of the residential and agricultural zoning designations. The development densities thus defined were used, in lieu of the Spotsylvania County zoning regulations, to estimate unit densities. The build-out analysis also defined the number of people per residential unit at 3.01 persons/unit.

8. VPDES permits for Ni Water Plant, Motts Run Water Plant, Thornburg Wastewater Treatment Plant, FMC Wastewater Treatment Plant, and Massaponax Wastewater Treatment Plant were obtained from the County.
9. Estimated capital and O&M costs and the preliminary engineering report for the Massaponax Wastewater Treatment Plant expansion were provided by O'Brien & Gere, engineers for the wastewater treatment plant expansion.