Greene County

Sanitary Engineering Department

Northwest Regional Water Master Plan

May 2005

Executive Summary

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Northwest Regional Water Master Plan

Section 1 - Introduction

This Executive Summary provides an overview of the Greene County Northwest Regional Water System (GCNRWS) Master Plan. The GCNRWS has grown significantly beyond the service area envisioned when the last comprehensive Master Plan was completed in the 1970s. The Board of County Commissioners authorized this project on April 1, 2003; it was subsequently amended on November 18, 2004, December 28, 2004, and May 19, 2005, when Greene County authorized a final revision to the Scope of Services. These amendments were in response to significant changes in land use and water demand for several large parcels within the South High Service Area (SHSA). This summary includes evaluation of alternatives to serve this rapidly changing area.

Data from prior reports and technical memoranda are incorporated in this document to provide a condensed summary for the convenience of the reader. Supporting technical documents referenced in this summary include the following:

- *Addendum to North Regional Water Treatment Plant Site Master Plan Report, June 2003,* was prepared to document improvements to the North Regional Water Treatment Plant (NRWTP) and to support re-rating of this facility by OEPA to over 5 million gallons per day (mgd).

- *Technical Memorandum No. 1 - Data Collection and Evaluation Summary, August 2003,* summarized existing facilities, prior studies, and land use plans to establish a basis for future planning.

- *Technical Memorandum No. 2 - Assessment of Water Supply and Treatment Facilities to Meet Future Demands, September 2004 (revised March 2005),* identified alternative means of obtaining water supply and developing treatment for meeting growth demands for a 20-year horizon.

- *Technical Memorandum No. 3 - Model Assessment and Recommended System Improvements, October 2004 (revised March 2005)*, identified piping system improvements necessary to distribute water to future customers.

- *Filter Re-Rating Study, January 30, 2004,* was submitted to OEPA to document findings of the first re-rating study. This was supplemented by an addendum dated January 6, 2005, to document results of a second re-rating study.

GCNRWS serves approximately 30,000 people in the City of Beavercreek; a small portion of the City of Kettering; and portions of Beavercreek, Sugarcreek, Bath, and Xenia Townships. Greene County Sanitary Engineering Department (GCSED) staff prepared and maintained a distribution system hydraulic model for planning system improvements between 1980 and 1990. That model is obsolete, and a new model is

needed to support future growth planning. Previously, Greene County commissioned a study by another consultant to address the development needs in the SHSA.

This current study is intended to:

- identify existing conditions;
- project future needs;
- consolidate prior water distribution and supply studies; and
- provide a sound basis for developing capital improvements plans for water supply, treatment and distribution needs within the Northwest Regional Water System.

Section 2 - Existing Conditions

The Northwest Regional Water System includes two water treatment plants and three well fields to provide customers with potable water. A schematic of the entire GCNRWS is presented in **Figure ES-1**. The Northwest Regional Water System includes ten elevated water storage towers and five booster pump stations. The NRWTP is supplied with water from the North Beavercreek well field and the Valley Springs well field. The South Water Treatment Plant (SWTP) is supplied with water from the South Beavercreek well field. In 1981, the SWTP was purchased from the original private developer and combined with the NRWTP to form the Northwest Regional Water System. The general operations for the two facilities are described below.

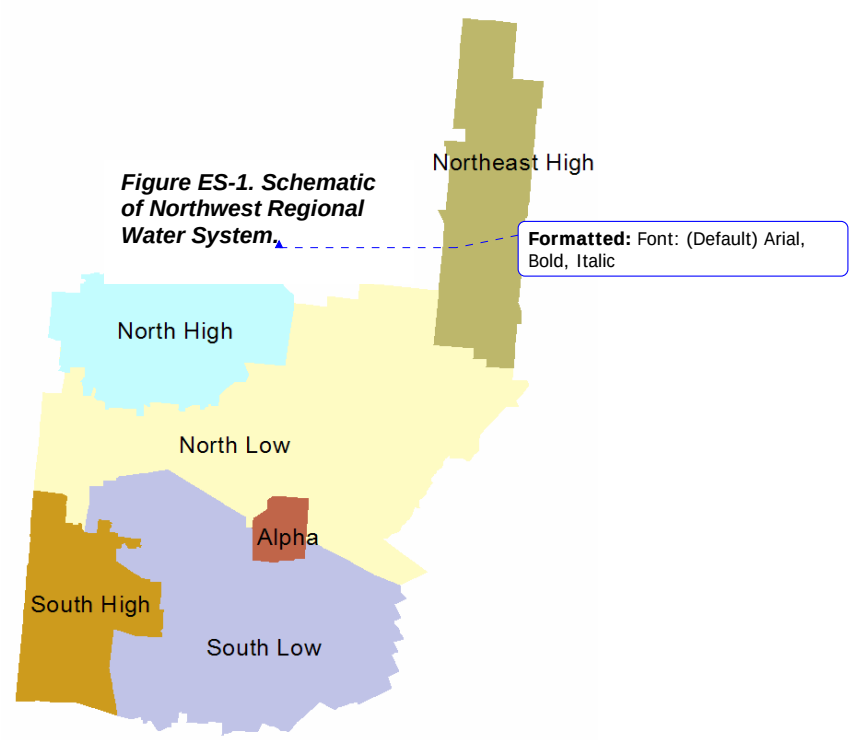

Figure ES-1. Schematic of Northwest Regional Water System.

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- NRWTP—Water is pumped from the North Beavercreek and Valley Springs well fields to the NRWTP, where it undergoes aeration, filtration, fluoridation, and disinfection. The water is then held in two clearwells at the plant before being pumped into the distribution system. The rated capacity of this facility is approximately 5.08 mgd.
- SWTP—Water is pumped from the South Beavercreek well field to the SWTP, where it undergoes aeration, filtration, fluoridation, and disinfection. The water is then held in a single clearwell at the plant before being pumped into the distribution system. The OEPA rated capacity of this facility is 0.86 mgd.

Due to the widely varying topography in the service area, it is not possible to serve all customers in a single pressure zone. GCSED has established the following pressure zones (shown with overflow elevations) within the Northwest Regional Water System to supply customers with water at appropriate pressures:

- The North High Pressure Zone (elevation 1140)
- The North Low Pressure Zone (elevation 1075)
- The South High Pressure Zone (elevation 1160)
- The South Low Pressure Zone (elevation 1075)
- The Alpha (Low-Low) Pressure Zone (elevation 941)
- The Northeast High Pressure Zone (served by Routzong Road pump station and West Enon Road elevated storage tower at elevation 1170)

The GCNRWS includes a total of approximately 1,431,300 feet (271 miles) of transmission and distribution piping. The distribution system transmission piping is comprised of mostly 8-inch and 12-inch water mains. The backbone of the system is the water main along Dayton-Xenia Road, which originates in Beaver Valley Road and proceeds west to the Summerfield elevated water storage tower (east side of I-675). This main starts as a 24-inch and gradually reduces to a 12-in diameter at Grange Hall Road. The majority of the interior water mains are 6-inch and 8-inch.

Contracts have been executed by Greene County with other suppliers of water to serve areas where GCSED has previously been unable to provide service. It should be noted that these sequential water systems require separate water quality monitoring on a regular basis by GCSED staff to comply with OEPA requirements. These contracts provide for varying terms and conditions as follows:

City of Bellbrook: Serves several areas of Sugarcreek Township outside the City, and more specifically, the areas south of Feedwire Road east of Possum Run Road. Since 1995, the water lines, meters, and hydrants within this area are owned by the City and customers are billed at the same rate as City residents. This arrangement is permanent unless further modified by both parties. A small area outside this boundary is temporarily being served by Bellbrook, until service can be extended from other Greene County service area mains.

City of Fairborn: Serves a small area north of New Germany-Trebein Road. Greene County owns and operates the wastewater collection and water distribution systems in this area and reads the meters. Payment to Fairborn is at the same rate as City of Fairborn residents. The original agreement was developed in 1976 and amended in 1986 as an agreement among Fairborn, Beavercreek and Greene County. The agreement is to run continuously but can be terminated at any time with mutual consent of the parties. Adjustments to the service area boundary have been discussed with Fairborn and it is expected that all but several parcels along National Road will be connected to the GCNRWS with improvements to be recommended by this study.

City of Dayton/Montgomery County: Serves a portion of the system commonly known as Grange View. This area is generally located between the Greene-Montgomery County line and I-675, north of Dayton-Xenia Road and south of Kemp Road. This area is part of an overall service area defined by Agreement of 1969, with a stated expiration date of December 31, 1979. No documentation has been located that the agreement has been formally re-negotiated or extended since the time of its origination.

Montgomery County: Serves additional areas under a general agreement that was negotiated in 1974, with a termination date of December 31, 1997. No indication of whether this agreement has been extended or modified was available. Montgomery County Sanitary Engineering Department (MCSED) purchases water from the City of Dayton through master meters. It is considered that all of the other areas currently served by MCSED, exclusive of the Grange View area, are served under this agreement.

Section 3 - Flow Analysis and Projections

Based on 2002 billing data, the Northwest Regional Water System currently supplies water to approximately 11,900 customers, of which 11,100 (93 percent) are residential/apartment customers. The residential/apartment customers account for 76 percent of the water consumption, while the 538 commercial/food service/restaurant customers represent 5 percent of total users and 17 percent of the water consumption. The remaining 2 percent of the customers consists of construction/government/institution/ industrial users that combine for the remaining 7 percent of water consumption.

Comparing the production and billing data provides an indication of the unaccounted for water that the distribution system may be losing. Over the past 3 years, the percentage of unaccounted water has decreased from 23.83 percent to 15.34 percent. The typical range for unaccounted water is up to 15 percent, depending on the system size, age, and other factors. Greene County has previously taken some positive action to reduce water loss. The County has an ongoing water meter replacement program that began in 1999. Replacement of old (and possibly inaccurate) meters with new meters could partially explain the decline in the percentage of unaccounted water usage over the past few years.

Future demand projections are based on the service area as revised by Greene County, GIS Land Use data from the 2020 Land Use Plan, and Greene County water billing records for 2000 through 2002. Land use categories within the service area were reviewed to develop a listing of the types of land uses in the service area and the respective total acreage for each. The service area contains approximately 80 different land use types, which were grouped together into 16 different general descriptions.

The GCSED water billing records were linked to the land use data by the parcel identifier to establish the unit demands for each land use description. To develop the future demand projections, only parcels within the service area boundary that are not currently linked to the billing records were considered. These parcels were considered

future developable areas that GCSED desired to service. The unit demands for each land use type were then applied to the future areas to develop the future demand projections.

Table ES-1 displays the various demands that GCSED will need to service, or contract with another entity to serve, for the 2020 Land Use conditions within the defined service area. Based on these original projections, GCSED would need to produce an average daily supply of 7.8 mgd for current (excluding currently served areas west of I-675) and future demands within the service boundary.

Recent requests for water service by developers of three large tracts within the SHSA west of I-675 have altered the original estimates prepared for the service area. These three major developments impact the future water demand needs because some of the parcels were projected to remain agricultural and others were projected to be developed at a lower density. The SHSA analysis performed as a supplemental service resulted in two scenarios for higher water demand, Scenario A provides for a higher demand of 8.9 mgd ADF resulting from changed land use and Scenario B includes the higher demands from Scenario A and also provides for serving areas south of Feedwire Road currently served by MCSED. As a result, the revised service area demand at buildout is approximately 9.3 mgd.

Table ES-1. 2020 and Beyond Service Scenarios

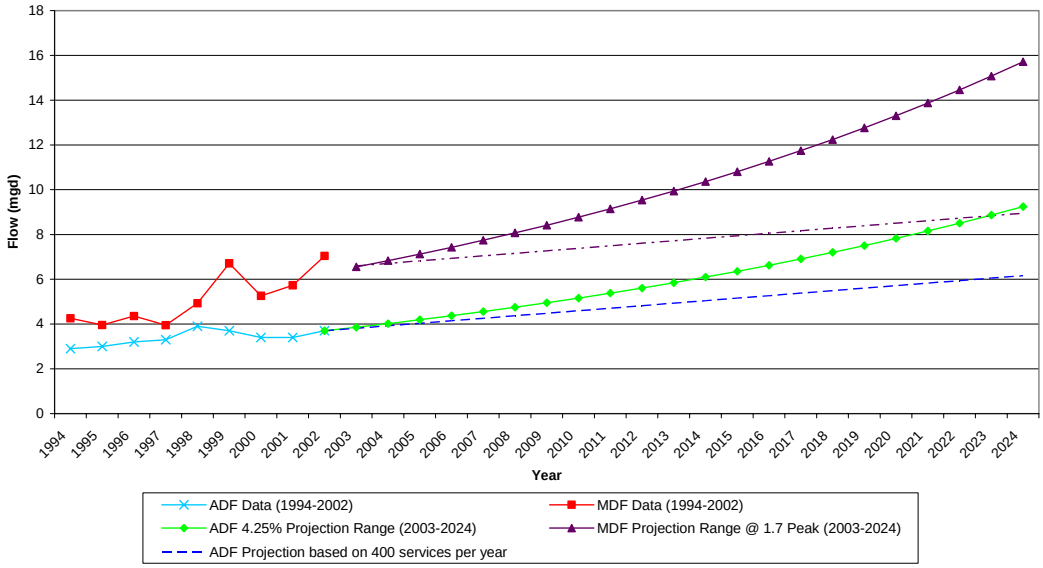
Service Scenarios	Existing Land Use Scenario GPD (average)	Demand Type	Revised Land Use Scenario GPD (average)
1. Future Additional Customer Demand to be Serviced by GCSED	5,029,632	Future Demand	5,965,229
2. Current Customer Demand - GCSED	2,779,817	Current Demand	2,779,817
Sub-Total A	**7,809,449**	**Future Demand**	**8,745,046**
3. Grangeview	52,468	Current Demand	
4. Kemp Road-Col. Glenn Hwy	125,128	Future Demand	125,128
Sub-Total B	**7,987,045**	**Future Demand**	**8,870,174**
5. Areas that are currently serviced by Fairborn	19,000	Current Demand	19,000
6. Areas that are currently serviced by Bellbrook	200	Current Demand	200
Total (Scenario A)			**8,889,374**
7. Areas recommended previously to be serviced by Montgomery County (currently MCSED servics this area)	90,432	Future Demand	377,000
Total (Scenario B)	**7,809,449**		**9,266,374**

The existing water demand over the past 10 years was plotted as shown in **Figure ES-2**, based on water production records at the NRWTP and SWTP. Even though full development of the remaining agricultural and vacant land use categories is not expected to occur until after 2020, projections as depicted are considered appropriate for the planning period.

In recent years, the Maximum Daily Flow (MDF) was found to be typically 1.7 times the Average Daily Flow (ADF); this same ratio was projected to future demands. The MDF is the capacity that OEPA uses to rate water system capacities. The future MDF would be expected to be approximately 13.3 mgd for the 7.8-mgd average day supply; but would increase to 15.8 mgd MDF for the 9.3-mgd ADF.

In past years, the growth in the water system has averaged 400 new service connections per year, resulting in an average customer growth rate of 4.25 percent per year. For future conditions, both of these scenarios were plotted and a range was created. The 9.3 mgd demand from the revised land use projection scenario is on the high side of this range for a 20-year planning period. The revised estimate assumes that more extensive development in the SHSA will not adversely affect development in other portions of the Northwest Regional Water System service area, an assumption that may be overly optimistic.

Figure ES-2
Flow Projections



One constraint that could result in reduced water demand within some portions of the water service area is the absence of sewer service within much of this area. Note that in the more distant future (after 2020), continuing suburbanization may be expected to occur within the urban service area boundary defined by the sewer service area. This could allow further land use changes to accommodate more dense development than the 2020 Land Use Plan anticipates. This would provide for continued growth within the urban service area boundary beyond the 9.3 mgd average demand. **Table ES-2** presents an allocation of demand by current service area boundaries, rounded to thousands for both the original and revised scenarios. Scenario A retains MCSED as a major water supplier in the area at I-675 and Wilmington Pike; under Scenario B GCNRWS provides service to this area.

Table ES-2
Demands per Service Area

Service Area	Average Daily Flow (gpd)	Revised Scenario - Average Daily Flow (gpd)
North High	1,855,000	1,855,000
Low	4,116,000	4,116,000
South High	1,230,000	
Scenario A		2,310,000
Scenario B		2,687,000
Northeast High	501,000	501,000
Alpha	107,000	107,000
Total		
Scenario A		**8,889,000**
Scenario B	**7,809,000**	**9,266,000**

For water supply and treatment planning purposes, it is recommended that the 2024 ADF and MDF should be the lower estimates of 7.8 mgd and 13.3 mgd, respectively, for serving the existing service area plus limited areas now served by MCSED, Fairborn and Bellbrook.

Alternatives to include the areas west of I-675, north of Dayton Xenia Road and south of Colonel Glenn Highway would likely be accommodated within this flow projection. Future water demand for these undeveloped parcels was based on commercial land use. Current developed parcels are expected to remain unchanged for future water demand projections. The increase in water demand projections was approximately 100,000 gpd for the change to commercial land use designation in this area; but, this may prove to be low if more intensely developed land uses occur in this area, such as were envisioned by the *Beavercreek Sewer System, Northwest Service Area Sewer Study, November 1993*. For that reason, options for serving this area were evaluated at higher demand values for conservatism.

Another service area boundary change that could increase projected demand in the GCNRWS significantly is inclusion in the SHSA of the area under Scenario B. This area is currently served by MCSED and includes the area along Wilmington Pike, south of Feedwire Road. Even though the 2020 Land Use plan projections called for limited development in this area, revised demand within the SHSA of the GCNRWS, if the MCSED area is included, indicates planning should be for a larger demand for the 20-year planning period and beyond. Based on recent development trends in the SHSA, it is expected that the MCSED service to the area south of Feedwire Road will remain unchanged for the foreseeable future; however, if projected higher water demanding growth requires construction of connecting lines from the east to the Feedwire Road corridor, then this area should be connected into the GCNRWS.

Prior to this study, long term planning for the NRWTP was for a 10-mgd MDF capacity. Interim improvements at the treatment plant should be based on using available capability, but as new facilities are installed, space for facilities to meet the larger future demand (13-16 mgd) should be included in the planning and design.

Section 4 - Future Needs

Source of Supply

CDM reviewed several water supply sources in addition to the existing North, South, and Valley Springs well fields, which have been previously identified as having a maximum safe yield of 10 mgd when supplemented by the future Nutter well field. Furnishing supply beyond the 10-mgd capacity is essential to meeting future demands, as previously defined. The alternatives identified as most viable for GCSED are to purchase more water from Dayton or increase well field capacity to meet future needs.

City of Dayton

The Master Plan prepared for Dayton/Montgomery County in June 1991 recommended serving existing customers in the Grangeview service area and also proposed extending water service east of I-675 and into the area served by the existing GCSED North High Service Area (NHSA). Based on that report, it appeared that the City of Dayton (through Montgomery County) could serve additional areas within Greene County, including all areas north of US 35 and west of I-675. CDM investigated alternatives for serving larger portions of the GCNRWS from Dayton/MCSED. The total projected demand for GCNRWS for the 20-year planning period used for the comparative analysis was approximately 13.5 mgd. The options included:

1) Provide service to the areas north of US 35, west of I-675 along with the existing Grangeview service area.

2) Provide sufficient water for the areas west of I-675 and most of the NHSA. This would require the NRWTP to be expanded to an ultimate capacity of 10.5 mgd.

3) Provide service to the above areas plus areas to the east of I-675 to relieve GCSED of the need to develop additional water resources or to expand the NRWTP above 7.5 mgd.

4) Provide service to the entire GCNRWS to avoid the need to develop additional water resources or to continue operating the NRWTP.

Of these alternatives, the last one was not evaluated in detail; this option requires major improvements within the Dayton/MCSED system that CDM was unable to determine the extent of the improvements with the water distribution system model available from Dayton/Montgomery County. Costs were prepared for each of the first three alternatives for comparison to the option of GCSED expanding the existing facilities to meet future GCNRWS demands. Note that both Dayton and MCSED are currently in process of updating their water system master plans; it is likely that they may be able to provide a more comprehensive estimate of costs for alternatives to serve GCNRWS. Based on available cost information, it appears to be more economical to provide service to this area from GCNRWS than from City of Dayton; however, additional discussions with Dayton/MCSED are recommended to determine whether a cost sharing arrangement can be mutually beneficial to Dayton, MCSED and GCSED.

Expanded Well Supply

The report, *Assessment of Aquifer Sustained Yield Potential in the Upper Little Miami River Watershed,* prepared by Terran Corporation for Greene County, concludes that sustained yields of the existing Greene County well fields could be increased to three times existing capacity without negative impact, excluding the North Beavercreek wells. Based on this report, additional yield may be available from other areas, such as the McGinnis property east of the Little Miami River (LMR), adjacent to the Valley Springs Well Field.

The feasibility of delivering 3 mgd of additional flow from the McGinnis property through the existing 24-inch transmission main to the NRWTP was modeled by CDM, and the results indicate that expansion of the Valley Springs well field onto the adjacent McGinnis property could defer the need for construction of the Nutter well field and transmission main extension. Detailed assessment of the availability of water on the McGinnis property would be the subject of a separately authorized hydrologic analysis by Greene County. Similarly, Greene County will need to engage in negotiations with the property owners. Hydrogeological studies to locate additional water to meet future MDF should be undertaken to confirm that the conclusions of the Terran study are applicable to the McGinnis and other potential sites.

It is further recommended that before final decisions are made on designs needed to pursue this option, field tests be performed on the existing Valley Springs well pumps to confirm the results of the model scenario. The pump tests will confirm if the pumps are performing along factory curves and will identify the present operating conditions of the pumps. This is recommended because GCSED staff reports the well pumps were designed for artesian flow conditions that are no longer being experienced, and, as a result, the pumps are not delivering water at the rated design flow.

Treatment

SWTP

The SWTP operates as a supplemental source of supply for the GCNRWS, with average annual daily flows of between 0.4 and 0.6 mgd for 1999-2003, and produces approximately 1.4 mgd during peak demand periods. The OEPA rated capacity of the facility is 0.86 mgd peak flow. The production records indicate a gradual, but steady, increase in production from the SWTP between 1999 and 2003 (164 million gallons treated in 1999 and 187 million gallons treated in 2002). This trend followed a decrease in production from the facility after the installation of the Valley Springs well field in 1998 (211 million gallons treated in 1998) allowed increased supply from the NRWTP. In addition to the increase in average flows, there was an increase in the plant's peak day production amounts and frequency of use during the same time period. This trend was reversed in 2003, with a total production of 141 million gallons. After that low production year, the SWTP provided 165 million gallons in 2004.

The SWTP operates as a traditional groundwater treatment plant for iron and manganese removal. The plant had been producing water with acceptable quality, with finished water iron concentrations between 0.04 and 0.1 mg/l and finished water manganese concentrations between 0.01 and 0.05 mg/l. Recently, however, the plant

has experienced difficulties in producing water with acceptable quality of iron in the treated water from the filters. In addition, a number of other deficiencies have been noted. The SWTP has become a maintenance challenge for the County staff. Failure of critical components, especially valves, has become a routine occurrence. Increased maintenance of the facility is expected to be required to keep it operational. The County staff had planned to take the facility out of operation by 2005 due to these maintenance issues; however, this cannot occur until adequate capacity becomes available from the NRWTP to replace the production from the SWTP. Furthermore, the recent production data from the SWTP indicates that the GCNRWS has become more reliant on production from the South plant each year, especially on peak demand days.

The prior need to keep the SWTP well field operating to inhibit migration of the Elano VOC contamination plume appears to be no longer an issue, and it is recommended the plant be removed from service as soon as additional supply and treatment capacity can be provided at the NRWTP and transmission system deficiencies are addressed.

NRWTP

A Filter Pilot study was performed to identify the feasibility of operating the existing filters at rates higher than the OEPA approved rate. The initial re-rating study did not achieve the required 95 percent compliance rate for iron and manganese removal; thus, a Phase 2 period of testing was required. The Phase 2 testing demonstrated that the NRWTP can operate at filter rates of 4.5 gpm/sf during peak demand periods, and meet standards for iron and manganese. On March 4, 2005, OEPA accepted this modified report, and they have accepted the recommended increase in the allowable filtration rate. With one filter out of service, the rated capacity of the filter system is 7.7 mgd.

This does not represent all improvements needed to bring the NRWTP capacity up to OEPA approved 7.7 mgd capacity. Current NRWTP capacity is limited by well field supply and finished water pumping units within the facility; GCSED staff are working with OEPA to identify mutually agreed upon capacities for these two critical systems. It is possible that GCSED staff may need to perform additional equipment testing to demonstrate system rated capacity to OEPA.

Prior reports have identified the remaining NRWTP process limitations as: aerators and reaction tanks, site piping, and service pumping. County staff has already implemented earlier recommendations to increase the capacity of the facility pumping to 5.76 mgd by replacing two of the 75-hp pumps with 125-hp pumps; further increase to 6.5 mgd can be accomplished by replacing the last 75-hp pump with a 125-hp pump. Change in regulatory design standards has resulted in a requirement for additional reaction tank capacity and the aerators should be upgraded when next replaced. Portions of the site piping improvements were installed as part of the recent Chemical Building project; however, more piping improvements remain.

Some of these piping changes are expected to be integrated into the distribution system improvements; others involve additional on-site piping changes needed to meet future plant capacity expansions. One example is the installation of additional finished water pumping capacity beyond the 10 mgd used as the basis for the 1999 Site Master Plan.

This will likely require additional and larger pumps along with larger suction and discharge piping connections. These changes are all anticipated for future conditions beyond the immediate and short-term improvements needed at the NRWTP and are all dependent on the SHSA and remaining area's development potential being realized within the planning period. Additional potential long-term improvements may also include replacement of the original 0.5-million gallon aboveground steel clearwell with a second 3-million gallon concrete aboveground clearwell; although this cost has not been included in any current cost estimates for the NRWTP.

CDM evaluated upgrading the existing NRWTP to continue providing the current level of service (iron and manganese removal) and also for providing an enhanced level of service (softening to levels comparable to City of Dayton water currently supplied to some Greene County residents). A number of technologies for iron and manganese removal were initially considered, and CDM recommended several alternatives for further evaluation. Cost and technical analyses favored continuation of the same treatment for iron and manganese removal and addition of ion exchange softening, if there is support for providing community-wide softening.

Distribution System

CDM created a water distribution model to perform mathematical simulations for the operation of the GCNRWS. The selected modeling platform was the WaterCAD model, which was used to perform analyses of the system. The model was created using AutoCAD drawings supplied by GCSED and supplemented with data obtained during discussions with GCSED staff.

To calibrate the model, CDM and GCSED staff conducted hydrant tests to validate the flow/pressure relationship at discrete points within the water system. The model was calibrated by first comparing the static (hydrant not flowing) pressure to the pressure simulated in the model under the same field conditions. The model also used dynamic or residual conditions (hydrant flowing) to compare a second set of pressures. Overall, the calibration effort went very smoothly, and most test points calibrated very well. Using the calibrated model, CDM evaluated the capability of the existing distribution system components to meet current and a range of projected future demands.

The primary analyses performed included:

- Bimodal demand runs (48-hour maximum day or two maximum days back-to-back) to ensure tank refilling with existing system components
- Fire flow analyses to determine capability to deliver minimum fire flows to areas served by hydrants

CDM attempted to keep pressures above 20 psi under all conditions, and above 30 psi under most conditions. These conditions would enable refilling of elevated water storage tanks (EWST) on a maximum day and deliver a minimum of 500-gpm fire flow at a 20-psi residual to residential areas served by fire hydrants. Higher fire flow target ranges were established for commercial properties, typically 2,500 gpm.

After the finalization of the initial model analysis a series of commercial and residential developments in the SHSA were proposed to GCSED staff. Each of these developments proposed land uses with higher densities than recommended by the 2020 Land Use Plan. As a result, a series of Amendments to the project were authorized for CDM to analyze a variety of different land use scenarios and consider possible modification of service area boundaries to include areas south of Feedwire Road currently served by MCSED. Two basic scenarios were developed to replace the baseline scenario of serving only the 2020 Land Use Plan level of development. Scenario A is based on full build out within the SHSA, with water demand based on development plans where available and build out in the remaining areas to the standards projected by the Land Use Plan. Scenario B provides for the same conditions within the anticipated GCSED service area, plus additional service to the area south of Feedwire Road currently served by MCSED.

Additional scenarios were also run to analyze specific problems and concerns in the eastern portion of the North Low Service Area and Northeast High service area. Results of these additional scenarios are discussed as part of the findings and recommendations below.

Immediate Needs

The immediate-term analysis considered issues that are present today and evaluated demands based on the 2000 to 2002 billing records.

- Under two consecutive maximum days, the system can maintain good pressures in most areas with existing system components. All tanks can be kept greater than 65 percent full, and the majority can be kept above 75 percent full. The pressures throughout the system hold up very well. The places where lower pressures are predicted are located in areas of high elevation.

- Fire flow runs were performed on the model by calculating the theoretical fire flow available at every hydrant under existing conditions. Areas providing less than 1,000 gpm were reviewed in general, and areas providing less than 500 gpm were recommended for improvements.

There are a total of three areas with deficient fire flow (less than 500 gpm). One area is in the NHSA on Gerspacher Drive, and two areas are in the North Low at the ends of Ferguson Drive and Crosswood Drive. In all three of these areas, the fire flow deficiency is due to small diameter mains (4-inch), and the area is supplied through a single-feed line. Other locations exist within the system, however, where looped 4-inch mains are in service and provide adequate fire flow.

Storage Analysis

Storage analysis indicates the existing service areas currently have sufficient EWST volume to meet OEPA requirements for providing one-day supply in the event of a problem. The GCNRWS currently has 8.35 million gallons of elevated water storage, with an additional 3.5 million gallons of ground storage at the NRWTP. The system has ten EWSTs that are evenly distributed, based on the existing service boundaries. As demand increases and the existing service areas change, additional storage will be

required. **Table ES-3** summarizes storage by pressure zone and the corresponding current and future demands for each zone. The table indicates that two pressure zones will have a storage deficiency in the long term.

Table ES-3 - Storage Per Pressure Zone and Corresponding Demands

Pressure Zone	Current (2004) Storage (EWST) MG	Current (2004) Demand MGD	Projected Future (2024) Demand MGD Baseline	Projected Future (2024) Demand MGD Scenario A	Projected Future (2024) Demand MGD Scenario B	Projected Year that Demand surpasses Storage[3] Baseline	Projected Year that Demand surpasses Storage[3] Scenario A	Projected Year that Demand surpasses Storage[3] Scenario B
North High	2.00	0.93	1.86	1.86	1.86	NA	NA	NA
Low	3.75	1.23	4.12	4.12	4.12	2022	2022	2022
South High	2.00	0.62	1.23	2.31	2.69[1]	NA	2020	2011
Alpha[2]	0.10	0.05	0.11	0.11	0.11	NA	NA	NA
Northeast High	0.50	0.009	0.50	0.50	0.50	NA	NA	NA
Total	8.35	2.84	7.82	8.90	9.28			

[1] Includes serving area along Wilmington Pike from Feedwire Road south to East Briggs Road which is currently served by MCSED under Scenario B

[2] Does not consider reconfiguration of the Alpha pressure zone

[3] Based on linear growth in demand

The SHSA is anticipated to experience a large growth in demand over the next 20 years based on recent development plans such as for "The Greene", "Madison's Grant" and the Sugar Creek town Center (Dille property). It is anticipated that an additional EWST will be needed in the southwestern portion of the SHSA to meet fire flow and one-day storage requirements. A recommended site location for a tower would be along Brown Road, where the elevation is approximately 995-ft MSL. This site should be acquired and held for future use when the ADF in the SHSA exceeds the 2 million gallons of storage provided by the Darst Road tanks. Space should be provided for two tanks with a total of up to 1.2 MG on the site to allow pacing storage to growth and/or replacing the Darst Road No. 1 EWST.

Table ES-3 also indicates that the Low Pressure Zone (North Low and South Low) will also have a storage deficiency in the long term. The table also shows that the NHSA will have a surplus of storage, and in an emergency, could back feed the Low Pressure Zone. Additionally, to serve a growth area, the Low Pressure Zone service boundary has been expanded to the east. This larger service area, coupled with future demands, suggests a need for an additional EWST. To geographically balance the storage for the Low Pressure Zone, a site along Trebein Road, where the elevation is approximately 930-ft MSL, would be well suited. This tank site is not needed for the immediate future; however, the tank should be constructed as demand increases in this area. This site would also be needed if the existing agreement with Xenia for water supply to the Eastern Regional Water System was terminated and water was supplied from the GCNRWS.

One area with current excess storage is the Northeast High pressure zone. This area has a surplus of storage to the extent that the EWST is having an adverse effect on water quality in the area. GCSED could be served with less storage in this area; however, there would be added cost to construct a smaller tank (a standpipe) and relocate the existing EWST. To determine whether this approach would be cost effective, we contacted a

fabricator of EWSTs; they indicated that the likely cost of relocating the tank would be only 10% less than a new tank. For a 0.5 MG EWST the cost of a new tank would be approximately $700,000. If relocation were to cost 10% less, there would be a $70,000 savings. The cost of a small standpipe would be approximately $200,000. Based on these costs, relocation and replacement with a standpipe would be more than the cost of constructing the same size tank at the new location. Other alternatives could include providing booster chlorination and a recirculation system to keep the water in the EWST "fresh" or to relocate the tank and provide a pump to meet fire flow demands.

Long term, the pressure zone boundaries are expected to be revised and demands reallocated from the NHSA and SHSA to the Low Pressure Zone. There are areas currently served from the NHSA and SHSA that could be served from the Low Pressure Zone, if water mains to these areas were installed. Two such areas are near County Line Road and Willow Run Drive in SHSA and the eastern end of New Germany-Trebein Road in NHSA. As development occurs in these areas, GCSED should serve these areas from the Low Pressure Zone and increase storage accordingly. In addition the eastern portion of the Alpha service area should be moved into the Low pressure zone from the Low-Low area to provide improved pressure and fire protection.

Up to 0.295 mgd ADF could be served by the Low Pressure Zone in areas currently served from the NHSA and SHSA, increasing the need for added storage in the Low area.

Redundancy Analysis

Redundancy analysis involved a general review of the level of looping and redundancy within each individual pressure zone for the entire system. Overall, redundancy for the Northwest Regional Water System is acceptable. The system has a good backbone of 8-inch and 12-inch mains that supply interior areas and areas that branch off the distribution network. Many customers on the outskirts of the system are only supplied by a single-feed water main. Most of these single-feed areas support many customers such as the northeast portion of the system starting at Beaver Valley Road continuing to West Enon Road and Greene Country Club. Additionally, there are interior portions of the system with only a single-feed water main, such as Research Park Drive and Patsie Drive. If not already in place, GCSED should establish a policy to require developers to loop to existing lines wherever feasible, instead of allowing "piggy-back" extensions of service in single-feed areas.

Several of the redundancy issues will be addressed with recommended system improvements that increase the number of supply mains to these areas.

- North High -Two elevated storage towers (both at Gerspacher Drive) serve the NHSA. A majority of the single-feed lines in the this area are short, less than 1,000 feet, and a main break in any given location may only isolate a few customers. There are four areas served by single feeds that range from 7,495 to 26,835 feet.

- North Low - This area is served by two elevated water storage towers. Overall, this area has fewer single-feed areas than the North High zone. However, there are more

areas in North Low that are fed by single-feed lines greater than 1,000 feet. There are three areas that are served by single feeds that range from 6,723 to 65,500 feet.

- South Low - This zone is served by two elevated water storage towers. Ten single-feed water mains totaling over 114,000 feet serve significant areas. There are two areas that are served by single feeds that range from 44,300 to 49,400 feet.

- South High - This area is served by two elevated storage towers at the Darst Road site. Significant areas that are fed by a single-feed water main are served by 13 lines, with a total length of over 73,000 feet. There are three areas that are served by single feeds that range from 13,635to 19,125 feet.

- Alpha - The entire Alpha Pressure Zone is supplied through a single-feed water main controlled by an altitude valve. One EWST serves this area. In the event of a main failure near the altitude valve, the entire zone would depend on the water stored in the Alpha tower. Under current average day conditions, the Alpha tower would drain from full to empty in 24 hours, and in 27 hours under current maximum day demand.

- Northeast High - The Northeast High area is supplied by a single-feed water main. One EWST serves this area, and in the event of a main failure near the Routzong Road booster pump station, customers would depend on the volume of water present in the tower. Under current average day and maximum day conditions, the tower would drain from full to empty over a period of several days.

Distribution System Chlorine Monitoring

The GCNRWS includes several areas that are currently served with water purchased from other suppliers; however, GCSED staff must monitor the chlorine residual in the distribution system daily. This requires staff to drive throughout the County to collect and record the test data (the same applies to the Eastern Regional and Southwest Regional Water System).

Remote monitoring of these sites may be available with either existing wet chemistry analyzers or with developing probe type technology. Wet chemistry analyzers are proven technology but require a point of wastewater disposal for the discharge from the analyzers; insert probe type analyzers are becoming more available; but do not have an extended performance history. Either of these units can be connected to the existing SCADA system located at the NRWTP that monitors water levels (pressures) and pumping operations within the remote systems. Use of these systems could reduce staff time for this routine monitoring function, with potential cost savings to the customer. Because of the evolving technologies for distribution system monitoring, a separate analysis is recommended to determine the appropriate number and locations of remote monitors and whether this option would be truly cost-effective. This analysis should be incorporated with a pilot test of newly emerging monitoring devices to assess the reliability and long-term maintenance requirements of these new monitors.

Section 5 - Recommendations

Supply

Dayton Supply: Pursue negotiations for purchasing water from Dayton/MCSED for the undeveloped area west of I-675 and north of US 35 as soon as possible. This will likely require re-negotiation of the existing service agreement with the City of Dayton. If cost sharing for the necessary improvements to serve this area can be satisfactorily arranged to keep Greene County's costs below that needed to serve the area from GCSED, it is recommended that this area be served by purchasing water from Dayton/MCSED. If not, then the least expensive option appears to be to sere the area from the GCNRWS.

Expanded Well Supplies: As soon as possible, complete the installation of Valley Springs Well No. 10.

Then investigate the potential yield of the areas adjoining the Valley Springs well field (McGinnis property) for developing an additional well field. If testing demonstrates additional water supply can be economically developed at this site, obtain the property and install wells at the McGinnis well field to meet increasing demands. Concurrently, field test the existing Valley Springs well pumps to identify current operating conditions. Modify the existing Valley Springs well pumps concurrent with development of the McGinnis wells to match the pumps to new operating conditions.

Only after the McGinnis well field improvements have been completed, or abandoned as infeasible, should the Nutter well field development be started. This approach will defer the larger costs for raw water transmission mains, which will need to be extended from the Nutter well field to the NRWTP. This decision needs to be made soon, because it may be advantageous to install portions of the connecting raw water transmission main from the Nutter well field to the NRWTP in conjunction with treated water transmission main improvements, identified as immediate needs, from the NRWTP to the currently developing eastern portion of the North Low service area. This should be the subject of a separate analysis after the feasibility of the McGinnis well field is documented.

After developing additional well field capacity at Valley Springs/McGinnis, a decision as to whether to continue operating the South well field can be made. Although this decision is outside of the scope of this Master Plan, and will require coordination with OEPA and Elano, recent information developed by Elano's consultants indicates that the contamination plume for TCE and PCE may be dissipating. GCSED should continue to monitor the progress of the remediation efforts and decide when pumping of the South well field can be terminated.

Long term, the Nutter well field and transmission main still needs to be installed. Depending on whether the McGinnis site is determined to be a viable option, the Nutter well field and transmission main may need to be moved to a short-term or even immediate needs category.

SWTP

Continued operation of the SWTP is necessary until the NRWTP has sufficient supply and treatment capacity to meet all of the demands of the Northwest Regional Water System. Until that occurs, the County will continue to rely on the treated water from this facility, even though the facility has a number of operational deficiencies that make continued operation difficult. Elimination would result in approximately 4 hours per day of operator time being eliminated. This may not be sufficient to warrant reduction in staff by itself; but coupled with other recommended efficiencies, including eliminating several of the sequential systems, and automated remote monitoring of water quality parameters (such as chlorine) in remote parts of the distribution system, staff requirements could be reduced or modified to allow a staff position to be filled with a lower staff classification.

NRWTP

OEPA has approved the NRWTP filter pilot study to re-rate the filters at higher capacity, thereby deferring the cost of expanding the filter system, and decreasing the long-term cost of plant expansion at the NRWTP. OEPA has also requested additional supporting documentation of the existing well field capacity and finished water pumps; this Master Plan assumes that adequate supporting documentation will be provided by Greene County to confirm prior estimates of capacity for those processes.

Short term, GCSED should immediately start design for upgrading the pumping facility at the NRWTP to increase capacity to 7.7 mgd, as a minimum. Based on projected peak demands, increased capacity will be needed by 2007 to 2013, depending on the actual rate of growth that is experienced. Using a mid-range estimate, the increased capacity would be needed by 2010. With design starting in 2005, an expanded capacity could be available for the peak demand period of 2007, if growth continues at an accelerated pace. If growth slows, construction could be deferred for several years. It is also necessary that changes to the existing aerators and reaction tanks be implemented at that same time. If a project is selected to meet only the 7.7 mgd capacity, then a future expansion of the NRWTP to above 7.7 mgd would require a later expansion of the filters. The added capacity (above 7.7 mgd) is expected to be needed in the period 2010 to 2014; however, continued rapid growth could require added filter capacity before 2010. Because of the savings inherent in fewer phases, the potential multiple disruptions to the NRWTP and the potential for implementing cost savings associated with eliminating the SWTP, it is recommended that the NRWTP be expanded to 10.5 mgd and sufficient well capacity provided at the McGinnis or Nutter well field to allow the SWTP to be decommissioned at the earliest possible date. If funding is not available, then the project should be more limited in scope and the NRWTP expanded to 7.7 mgd and the SWTP kept in service.

Modifying the basic design objectives of the NRWTP to provide community wide softening would be dependent on community desire to implement a centralized softening process. If there is community support for centralized softening, it is recommended that a weak acid ion exchange system be implemented. If such support is not currently available and the issue is deferred for future consideration, the issue of process alternatives should be reviewed again to determine whether improved

technology has resulted in membranes that are more tolerant of barium and silica. In the meantime, it is recommended that existing well supplies be monitored on a more frequent basis for these water matrix constituents to confirm the presence of these components at the concentrations previously noted.

Distribution System

A series of capital improvement projects are recommended to address the needs of the Northwest Regional Water System over the next 20 years. This section lists project costs rounded to the thousands. Some of these projects are expected to be jointly funded by developers, with the County paying over-sizing costs where appropriate. See **Table ES-4** for a summary of distribution system improvement costs.

Table ES-4
Distribution System Improvement Costs

	Most Likely Funded By		
Project Type	**Developer**	**Greene County**	**Grand Total**
Immediate	$ 728,831	$ 2,205,578	**$ 2,934,409**
Short Term	$ 7,854,840	$ 6,359,235	**$ 14,214,075**
Long Term	$ 7,660,811	$ 4,394,508	**$ 12,055,319**
Discretionary	$ 95,378	$ 505,508	**$ 600,885**
Grand Total	**$ 16,339,860**	**$ 13,464,828**	**$ 29,804,688**

Projects are recommended in the following categories based on Scenario B, to provide service to the area south of Feedwire Road:

- ***Immediate Action*** projects should be constructed in 2005 through 2009 as funds permit. Ten projects (eight to be funded by Greene County), with a total cost of approximately $2,940,000, are in this category, which would help address some of the single-feed areas, provide additional redundancy and address water quality concerns in the Northeast High Service Area.

- ***Short-Term*** improvement projects should be constructed in the 2009 to 2014 time frame. A total of 23 projects are in this category, 13 of which will need to be funded by Greene County, with a total cost of over $14,200,000, to address some of the single-feed areas and to provide additional redundancy. A significant number of these projects (including several funded by Greene County) are dependent on the rate of growth in water service area demand for the SHSA. One major project in this category, of which a portion is expected to be deferred, is the installation of a new transmission main along Factory Road. The last portion of this improvement is scheduled for installation when the new US Rt. 35 interchange with Factory Road is completed in 2011 to 2015, based on MVRPC planning. If development in SHSA is slower than expected, this project could be deferred by installing a water main extension along North Fairfield Road to supplement the supply to the Indian Ripple booster pump station.
- ***Long-Term*** improvement projects should be constructed more than 10 years out, or after 2014. Depending on circumstances surrounding actual growth in the

future, these projects may become necessary sooner. The specifics of long-term projects should be re-evaluated prior to design.

- ***Discretionary*** projects are recommended to create loops for areas that would benefit from redundancy. These projects should be incorporated, as funds permit, to improve fire flow delivery and customer service during main breaks.

- ***Distribution System Monitoring*** projects involve the installation of chlorine residual analyzers in the water distribution system connected to the existing water system SCADA to provide continuous readout of the chlorine residual throughout the NRWS and sequential systems that currently require daily testing by field personnel. It is suggested that a pilot test of newly emerging monitoring devices be conducted to determine the reliability and long-term maintenance requirements of these new monitors. If the pilot proves successful, staff currently used for these daily testing requirements could be free to perform other duties within the water system. If successful, this change, together with elimination of the SWTP, could allow GCSED to more readily accomplish the plan for staff reduction needed to enhance competitiveness. No budget estimate has been included for this approach; instead a separate analysis is recommended.

Section 6 - Priority and Implementation

This section summarizes the recommended plan for GCSED to continue providing its customers the current level of service. If Greene County elects to pursue an enhanced level of service by implementing community wide softening, an alternative capital improvement plan will be needed to meet the additional cost of the softening facility, estimated at approximately $4.3 million for the initial 10.5 mgd phase. In addition a more detailed analysis of the costs and benefits for the typical customer would need to be prepared for comparison to the costs of centralized softening; no cost for these additional analyses has been included in the project costing summary.

Long-term expansion of the Northwest Regional Water System to serve growth areas within western Greene County is recommended. This will require expansion of the water supply, treatment, and distribution systems. Planning for future growth may require expansion of well field and treatment capacity to a capacity of up to 13-16 mgd to meet demands through 2024. Implementation of these improvements is anticipated to require a phased approach to match GCSED funding constraints. Costs of improvements to the NRWTP beyond the short-term horizon are not included. Updates to this Master Plan are recommended under the following conditions:

- within a 5- to 10-year time frame to re-evaluate the assumptions on which this plan is based, and to update water demand projections.

- future connection of the Eastern Regional Water System to the Northwest Regional Water System after the contract with Xenia expires. The necessary water supply and treatment facilities have not been included in this proposed implementation program.

To assist GCSED in financial planning for capital improvements, a proposed Implementation Plan is provided in **Table ES-5**. Costs of improvements to the NRWTP beyond the short-term horizon are not included. Interim improvements to the SWTP have not been included; these are assumed to be within GCSED repair and replacement funding. These costs are indicated in the year(s) they are expected to be authorized. Distribution system costs are intended to be only the County portion of needed improvements; many other projects are identified in *Technical Memorandum 3* will be installed at the developers' expense as part of the growth in service areas.

Distribution system improvements are further described in **Appendix A,** which includes a table and figure from *Technical Memorandum 3*. The improvements are classified as immediate (up to 5 years), short-term, and long term. Individual projects may need to be accelerated or deferred, based on development patterns. This schedule is not tied to GCSED bonding procedures; therefore, some projects may require separate short-term financing.

Table ES-5
Implementation Plan

Item	Year Implemented							Total Cost ($1000s)
	2005 ($1000s)	2006 ($1000s)	2007 ($1000s)	2008 ($1000s)	2009 ($1000s)	2010-2014 ($1000s)	2015-2024 ($1000s)	
Supply Improvements								
Valley Springs Well No.10	206							206
McGinnis Engineering	154	154						309
McGinnis Construction			2594					2594
Nutter Engineering						597		597
Nutter Construction						5012		5012
Dayton Connection		-		-				0
Subtotal								8717
Treatment Improvements								
Pumping Facility Improvements	309	1286						1594
Filter Expansion					435	2175	1186	3796
Subtotal								5390
(Alternate NRWTP Phasing - Not Included in Total Below)	639	3197					1186	5023
Distribution System Improvements								
See Table ES-4 and Appendix A	200	500	500	500	500	6360	4900	13460
Totals	869	1940	3094	500	935	14144	6086	27568

Notes:
1.Nutter construction can be implemented in Phases if so desired. That could result in portions of the Nutter costs being incurred in the period after 2015.
2. Similar potential exists for the Filter expansion at the NRWTP to be delayed until after 2009 if the SWTP is maintained in service; if not then the filter expansion will be required to be implemented concurrent with the Pump Building expansion.
3. Additional phases will add more costs to those shown.
4. Treatment subtotal does not agree with costs in prior tables because of phasing costs.
5. Costs are updated to May 2005 costs (ENR CCI = 7398).
6. Distribution costs for immediate action projects (2005-2009) are not based on defined implementation schedule.
7. Dayton connection may be more most cost effective solution for the areas west of I-675; see TM-3 and results of further negotiation with Dayton/MCSED.

Appendix A
Distribution System Improvements