CHAPTER 3

SYSTEM ANALYSIS

INTRODUCTION

Water system planning is based on a careful analysis of a water utility's ability to meet level of service standards for existing and future customers. The City has adopted design standards, which identify criteria and standards for the water system. These standards can be used to evaluate and analyze the existing water system facilities and water quality within the City's system. Based on these analyses, a summary of deficiencies and options to improve compliance with the required standards are identified.

SYSTEM DESIGN STANDARDS

Performance and design criteria typically address the sizing and reliability requirements for source, storage, distribution, and fire flow. Construction standards set forth in the Development Guidelines and Public Works Standards specify the actual materials and construction standards that contractors, developers, and the City must follow when constructing water system facility improvements. Construction standards, including developer extension guidelines, have been developed for the City and are provided as a separate document. Design standards are discussed in the order shown below:

GENERAL FACILITY STANDARDS

1. Average Day and Peak Day Demand
2. Peak Hour Demand
3. Storage
4. Minimum System Pressure
5. Minimum Pipe Sizes
6. Backup Power Requirements
7. Valve and Hydrant Spacing
8. Fire Flow Rate and Duration

WATER QUALITY STANDARDS

1. Applicable Drinking Water Quality Regulations
2. Existing Drinking Water Quality Standards
3. Anticipated Future Drinking Water Quality Regulations
4. Water Quality Monitoring Schedule

WATER SYSTEM DESIGN STANDARDS

The Washington State Department of Health (DOH) relies on various publications, agencies and the utility itself to establish design criteria. The following is a brief description of two of the most widely recognized performance and design standards.

- **WAC 246-290, Group A Public Water Systems, Washington State Board of Health (May 2008).**

  This is the primary drinking water regulation used by the Washington State Department of Health (DOH) to assess capacity, water quality, and overall compliance with drinking water standards.

- **Water System Design Manual, Washington State Department of Health (August 2001).**

  These standards will serve as guidance for the preparation of plans and specifications for Group A public water systems in compliance with WAC 246-290.

GENERAL FACILITY STANDARDS

Table 3-1 lists the suggested DOH Water System Design Manual guidance and the City of Milton's policies with regards to each standard for general facility requirements.

TABLE 3-1

General Facility Requirements

Standard	DOH Water System Design Manual	City of Milton Standard
Average Day and Peak Day Demand	Average day demand should be determined from previous actual water use data. Maximum day demand (MDD) is estimated at approximately 2 times the average day demand if metered data is not available.	Average day demand is determined from 2003-2008 data. Peak day demand was determined by examining peak day production for the last five years. An average peaking factor of 2.20 for average day to peak day demand was identified (see Table 2-11).
Peak Hour Demand	Peak hour demand is determined using the following equation: PHD = (MDD/1440)[(C) (N)+F} +18 C = Coefficient from DOH Table 5-1 (C=1.6) N = Number of connections, ERUs (N=3,484) F = Factor of range from Table 5-1 (F=225)	Peak hour demand is determined by applying a peaking factor of 1.65 for peak day to peak hour demand, based upon DOH Criteria in adjacent table cell and 2004 peak day data.
Storage	The sum of: • Operational Storage • Equalizing Storage • Standby Storage • Fire Suppression Storage (if required)	Refer to storage analysis in this Chapter.
Minimum System Pressure	The system should be designed to maintain a minimum of 30 psi in the distribution system during peak hour demand and 20 psi under fire flow conditions during MDD.	Same as DOH Water System Design Manual.
Minimum Pipe Sizes	The minimum size for a transmission line shall be determined by hydraulic analysis. The minimum size distribution system line shall not be less than 8 inches in diameter.	Same as DOH Water System Design Manual.

TABLE 3-1 – (continued)

General Facility Requirements

Standard	DOH Water System Design Manual	City of Milton Standard
Reliability Recommendations	• Two or more sources capable of replenishing fire suppression storage within a 72-hour period. • Sources capable of supplying MDD within an 18-hour period. • Sources must meet ADD with largest source out of service. • Back-up power equipment for pump stations unless there are two independent public power sources. • Provision of multiple storage tanks. • Standby storage equivalent to ADD*2, with a minimum of 200 gpd/ERU. • Low and high level storage alarms. • Looping of distribution mains when feasible. • Pipeline velocities not >8 ft/s at PHD. • Flushing velocities of a minimum of 2.5 fps for all pipelines.	Same as DOH Draft Waterworks Standards, Chapter 5, except sources capable of supplying MDD over 24 hour period and flushing velocity criteria not applicable.
Valve and Hydrant Spacing	Sufficient valving should be placed to keep a minimum of customers out of service when water is turned off for maintenance or repair. Fire hydrants on laterals should be provided with their own auxiliary gate valve.	Valve and hydrant standards are outlined in the City's Streets and Utilities Development Regulations, Adopted May 1994; Updated 2000 as Development Guidelines and Public Works Standards.

Fire Flow Standards

The City of Milton has adopted the 2003 International Fire Code (IFC) by Ordinance. Section B105 specifies the fire flow requirements for buildings. The most recent survey of the City by the Washington Surveying and Rating Bureau was completed in 2006 and the current Public Protection Class rating is 6. Pierce County fire codes, found in the Pierce County Code 17C.60.160 and 165, and King County fire codes, found in the King County Code 17.04 and 08, adhere to the 2006 IFC. As it applies to the water utility, the 2003 IFC meets the requirements of the 2006 IFC. Required fire flows are also described in Chapter 4 of this Plan.

WATER QUALITY STANDARDS

Applicable Drinking Water Quality Regulations

Table 3-2 lists the existing and future drinking water regulations and the applicability of each regulation. This table indicates that several regulations are applicable to the City of Milton.

Existing state law contains regulations for bacteriological contaminants, inorganic chemicals and inorganic physical parameters (IOCs), volatile organic chemicals (VOCs), synthetic organic chemicals (SOCs), radionuclides, total trihalomethanes (TTHMs) and haloacetic acids (HAA5s).

Many of the regulations shown in Table 3-2 define treated source water quality standards and establish source water quality monitoring schedules. The implementation schedules for the proposed new regulations are subject to revision and the City should continue to stay informed regarding regulatory deadlines.

TABLE 3-2

Summary of Drinking Water Regulations

Drinking Water Regulation[1]	Contaminants Affected[2]	City Action
Bacteriological	Coliform	Monitoring
Residual Disinfectant	Total Free Chlorine	Monitoring
Consumer Confidence Report	Reporting Only	Reporting
Inorganic Chemicals and Physical Parameters	IOCs	Monitoring
Arsenic Rule	Arsenic	Monitoring
Volatile and Synthetic Organic Compounds	VOCs, SOCs	Monitoring
Asbestos	Asbestos	Monitoring
Lead and Copper Rule	Lead, Copper	Monitoring
Radionuclide Rule	Radionuclides	Monitoring
Disinfectants/Disinfection Byproducts Rule – Stage I and II	TTHMs, HAA5, Chlorite, Bromate	Monitoring and Planning
Groundwater Rule w/Triggered Source Monitoring	Bacteriological	Monitoring and Planning
Surface Water Treatment Rule	Microbial Contaminants	Not Applicable
Information Collection Rule	Bacteriological	Not Applicable
Filter Backwash Recycling Rule	Bacteriological	Not Applicable
Interim Enhanced Surface Water Treatment Rule	Bacteriological	Not Applicable
Long Term 1 Enhanced Surface Water Treatment Rule	Bacteriological	Not Applicable

(1) Drinking water regulations as of 2009.
(2) TTHM = Total Trihalomethanes; HAA5 = Five Haloacetic Acids; IOCs = Inorganic Chemical and Physical Characteristics; VOCs = Volatile Organic Chemicals; SOCs = Synthetic Organic Compounds.

WATER QUALITY STANDARDS AND ANALYSIS

Minimum standards for water quality are specified in terms of Maximum Contaminant Levels (MCLs). Primary MCLs are based on chronic and/or acute human health effects. Secondary MCLs are based on factors other than health effects, including aesthetics. MCLs are specified in WAC 246-290 and described in the following pages and tables. Water quality data and a water quality monitoring schedule are presented later in this chapter.

Each July, the City is required to publish a Consumer Confidence Report which notifies the customers of the water system of the quality of their drinking water. Appendix J includes the most recent version of this report.

Bacteriological

Acute violations of bacteriological MCLs are as follows:

- E. coli and/or Fecal coliform presence in a repeat sample
- Coliform presence in a set of repeat samples collected as a follow-up to a routine sample with fecal coliform or E. coli presence
- Coliform is detected in more than 5 percent of samples during routine sampling

Non-acute violations of bacteriological MCLs are as follows:

- Coliform presence in multiple routine samples
- Coliform presence in a set of repeat samples collected as a follow-up to routine a sample with coliform presence
- E. coli and/or Fecal coliform presence in multiple routine samples with no presence in repeat samples

Public notification requirements for violations are included in Chapter 7. Sample letters and notifications are included in Appendix J.

The City is required to sample for bacteriological contaminants nine times each month. Samples are taken on the second and fourth Tuesday of each month. Five samples are taken on the second Tuesday and four samples are taken on the fourth Tuesday of each month. A copy of the sampling locations and the repeat samples are included in Appendix J. The City completes triggered source monitoring per the Groundwater Rule when necessary.

Inorganic Physical and Chemical Characteristics

WAC 246-290-310 specifies primary and secondary MCLs for inorganic physical and chemical characteristics. Primary MCLs are based on health effects, and secondary MCLs are based on factors other than health effects, such as aesthetics. Primary and secondary MCLs for inorganic chemical and physical characteristics are summarized in Tables 3-3 and 3-4.

At the time of design and construction for the Corridor Wells, it was unknown if iron and manganese levels would increase and exceed MCLs once in operation. The facility was designed to allow for treatment to be installed at a later date if necessary. A letter to DOH regarding the Corridor Wells is included in Appendix J and provides additional background information for the project. Since bringing the wells online, the City has received discolored water complaints. If a purveyor receives five or more individual customer complaints about iron and manganese levels, or a petition signed by at least five people in the service area, DOH may require purveyors to install iron and manganese treatment. To mitigate this problem, the City has temporarily stopped using these wells. As a long term solution, the City plans to install iron and manganese treatment on site, which is described in more detail in Chapter 8 Capital Improvement Projects.

TABLE 3-3

Water Quality Standards for Inorganic Chemical Characteristics

Chemical	Primary MCL (mg/L)
Antimony (Sb)	0.006
Arsenic (As)	0.01
Asbestos	7 million fibers/liter
Barium (Ba)	2.0
Beryllium (Be)	0.004
Cadmium (Cd)	0.005
Chromium (Cr)	0.1
Cyanide (HCN)	0.2
Fluoride (F)	4.0
Mercury (Hg)	0.002
Nickel (Ni)	0.1
Nitrate (as N)	10.0
Nitrite (as N)	1.0
Selenium (Se)	0.05
Sodium (Na)	None(1)
Thallium (Tl)	0.002
Chemical	**Secondary MCL (mg/L)**
Chloride (Cl)	250.0
Fluoride (F)	2.0
Iron (Fe)	0.3
Manganese (Mn)	0.05
Silver (Ag)	0.1
Sulfate (SO4)	250.0
Zinc (Zn)	5.0

(1) Although an MCL has not been established for sodium, there is enough public health significance connected with sodium levels to require inclusion in inorganic chemical and physical monitoring.

Source: State Board of Health Drinking Water Regulations, effective April 1999.

TABLE 3-4

Water Quality Standards for Inorganic Physical Characteristics

Characteristic	MCL	MCL Type
Color	15 Color Units	Secondary
Specific Conductivity	700 mhos/cm	Secondary
Total Dissolved Solids (TDS)	500 mg/L	Secondary

Source: State Board of Health Drinking Water Regulations, effective April 1999.

Volatile Organic Compounds (VOCs) and Synthetic Organic Compounds (SOCs)

There are currently 21 regulated VOCs and 30 regulated SOCs. A list of these compounds and their MCLs is included in Table 3-5. Recent testing for these contaminants did not yield any results above the MCL.

TABLE 3-5

Regulated VOCs and SOCs

Organic Chemical	Primary MCL (mg/L)[1]	Organic Chemical	Primary MCL (mg/L)[1]
Vinyl Chloride	0.002	Chlordane	0.002
Benzene	0.005	Dibromochloro-propane	0.0002
Carbon Tetrachloride	0.005	2,4-D	0.07
1,2-Dichloroethane	0.005	Ethylene dibromide	0.00005
Trichloroethylene	0.005	Heptachlor	0.0004
Para-Dichlorobenzene	0.075	Heptachlor epoxide	0.0002
1,1-dichloroethylene	0.007	Lindane	0.0002
1,1,1-Trichloroethane	0.2	Methoxychlor	0.04
cis-1,2-Dichloroethylene	0.07	Polychlorinated biphenyls (PCBs)	0.0005
1,2-Dichloropropane	0.005	Pentachlorophenol	0.001
Ethylbenzene	0.7	Toxaphene	0.003
Monochlorobenzene	0.1	2,4,5-TP	0.05
Ortho-Dichlorobenzene	0.6	Benzo(a)pyrene	0.0002
Styrene	0.1	Dalapon	0.2
Tetrachloroethylene	0.005	Di(2-ethylhexyl) adipate	0.4
Toluene	1	Di(2-ethylhexyl) phthalate	0.006
Trans-1,2-Dichloroethylene	0.1	Dinoseb	0.007
Xylenes (total)	10	Diquat	0.02
Dichloromethane	0.005	Endothal	0.1
1,2,4-Trichloro-benzene	0.07	Endrin	0.002
1,1,2-Thrichloro-ethane	0.005	Glyphosate	0.7
Arochlor	0.002	Hexachlorobenzene	0.001
Aldicarb	0.003	Hexachlorocyclopentadiene	0.05
Aldicarb sulfone	0.003	Oxamyl (vydate)	0.2
Aldicarb sulfoxide	0.004	Picloram	0.5
Atrazine	0.003	Simazine	0.004
Carbofuran	0.04	2,3,7,8-TCDD (dioxin)	0.00000003

(1) 40 CFR 141.61(a) & (c); adopted by State Board of Health, effective April 1999.

Lead and Copper

In 1991, the EPA promulgated the Federal Lead and Copper Rule. The State of Washington adopted this rule in 1995, with minimal changes. The Lead and Copper Rule is intended to reduce the tap water concentrations of lead and copper that can occur when corrosive source water causes lead and copper to leach from water meters and other plumbing fixtures. Possible treatment techniques to reduce lead and copper leaching include addition of caustic soda or soda ash to the source water prior to distribution.

Ninety percent of distribution system lead samples collected according to the procedures outlined in State law must have concentrations below the "Action Level" of 0.015 mg/L. Similarly, 90 percent of copper samples must have concentrations less than 1.3 mg/L. Systems exceeding the action levels are required to provide public notification and implement a program for reducing lead and copper levels.

In July 2009, the City performed routine lead and copper testing as required by DOH. The City took 21 samples from specific sample locations throughout the City's distribution system. Table 3-6 provides the results of the City's lead and copper testing. The City is below the Action Level for both lead and copper and thus meet DOH requirements. As a result, the City is on a reduced monitoring schedule and is required to take samples once every 3 years.

TABLE 3-6

Lead and Copper Testing

	Copper	**Lead**
Sampling Date	**July 2009**	**July 2009**
Action Level, mg/L	1.3	0.015
State Reporting Level, mg/L	0.2	0.002
Maximum Concentration Reported, mg/L	1.1	0.008
90^{th} Percentile Concentration	0.47	0.006
Samples Taken	21	21
Samples Exceeding Action Level	0	0
Minimum Concentration Reported, mg/L	0.11	0.002

Radionuclides and Radon

Radionuclides include radioactive substances occurring naturally in subsurface waters. Regulated substances include radium-226 and radium-228, uranium, gross alpha particles, and gross beta particles. Table 3-7 summarizes radionuclide MCLs.

Though a radon MCL was included in the originally proposed Radionuclide Rule, it was determined that a radon MCL will now be issued as a separate rule. In November of 1999, EPA proposed a preliminary radon MCL of 300 pCi/L. EPA is considering an alternative MCL of 4,000 pCi/L if states or water purveyors implement a multimedia mitigation program aimed at reducing household indoor-air health risks from radon gas from soil as well as tap water. The date for publication of the final Radon Rule is unknown at this time.

The City is required to collect two samples every three years from each source. In May, July and August 2009, the City collected radionuclide samples for radium and gross alpha and gross beta particles at each source. Radium levels were undetected in all samples. Gross alpha and gross beta levels were also undetected.

TABLE 3-7

Radionuclide MCLs

Parameter	MCL
Radium-226	3 pCi/L
Combined Radium-226 and Radium-228	5 pCi/L
Gross alpha particle activity, excluding uranium	15 pCi/L
Beta particle and photon radioactivity from man-made radionuclides	4 millirem/year[(1)]

(1) Determined by measuring gross beta activity, tritium and strontium-90
Source: State Board of Health Drinking Water Regulations, effective April 1999.

Disinfectants/Disinfection Byproducts (D/DPB)

WAC 246-290-300(6) requires purveyors of public water systems that provide water treated with chemical disinfectants to monitor for disinfectants and disinfection byproducts. The Disinfection/Disinfectants Byproduct Rule (D/DBP Rule) establishes residual disinfectant concentrations and maximum contaminant levels for disinfection byproducts.

Trihalomethanes (THMs) and five haloacetic acids (HAA5) are a group of organic compounds that can be formed as a result of drinking water disinfection by chlorine and are, therefore, often referred to as disinfection byproducts. Total trihalomethanes (TTHMs) include the sum of the concentrations of four disinfection byproducts: chloroform, bromoform, bromodichloromethane, and dibromochloromethane.

The Stage 1 D/DBP rule became effective in February 1999 and the City's compliance deadline was December 2003. Under Stage 1 of the D/DBP Rule, the MCLs for TTHM and HAA5 are 80 μg/L and 60 μg/L, respectively, and are based on the running annual average of four quarterly samples. Systems are required to prepare and implement a disinfection byproducts monitoring plan. The Stage 1 D/DBP Rule will remain in effect for compliance until October 1, 2013.

Four disinfection byproduct samples collected from one site were taken in 2004-2005. The running annual average for TTHM and HAA5 was 23.2 μg/L and 2.8 μg/L, respectively.

Stage 2 of the D/DBP Rule was published in January 2006 and compliance with the new regulations begins on October 1, 2013. Under Stage 2 of the D/DBP Rule, the MCLs for

TTHM and HAA5 remain 80 μg/L and 60 μg/L, respectively; however, compliance with the MCL is based on the running annual average of each individual sample instead of the running annual average of all samples combined. The number of samples taken is dependent on the population served. Systems serving between 500 and 9,999 people must collect two samples per year.

The City has obtained a 40/30 certification, which is granted to systems which all Stage 1 D/DBP sample results are below 40 μg/L for TTHM and 30 μg/L for HAA5 and has no monitoring violations. Documents associated with the certification are included in Appendix J.

Arsenic Rule

Arsenic is an inorganic chemical that has received significant attention due to proposed rule revisions. Long-term exposure to low concentrations of arsenic in drinking water can lead to skin, bladder, lung, or prostate cancer. Non-cancerous effects of ingesting arsenic at low levels include cardiovascular disease, diabetes, and anemia, as well as reproductive, developmental, immunological, and neurological effects.

The MCL of 0.01 mg/L became effective in February 2002 and compliance with the new MCL standard began January 23, 2006. The Arsenic Rule makes monitoring requirements consistent with monitoring for other IOCs. Sampling for arsenic is required once every 3 years. Any system that has a sampling point monitoring result exceed the MCL must increase the frequency of monitoring at that sample point to quarterly sampling. Compliance with the MCL would be based on the running annual average of the samples. Systems triggered into increased monitoring would not be considered in violation of the MCL until they have completed 1 year of quarterly sampling. However, if any sample result will cause the running annual average to exceed the MCL at any sampling point, the system is out of compliance with the MCL immediately.

Arsenic samples collected in 2005 detected arsenic at a maximum level of 0.003 mg/L, which is well below the MCL.

Asbestos

Asbestos is the name for a group of naturally occurring, hydrated silicate minerals with fibrous morphology. Included in this group are chrysotile, corcidolite, amosite, and the fibrous varieties of anthophyllite, tremolite, and actinolite. Most commercially mined asbestos is chrysotile. Asbestos has flexibility, strength, and chemical and heat resistance properties that have adapted it to many uses including building insulation, brake linings, and water pipes.

In recent years, there has been much concern with the health risks associated with asbestos. Several studies and case histories have documented the hazards to internal organs as a result on inhalation of asbestos fibers. Data is limited on the effects of ingestion of asbestos fibers or on the effects of inhalation exposure from drinking water. Ingestion studies have not caused cancer in laboratory animals, although studies of asbestos workers have shown increased rates of gastrointestinal cancer.

Asbestos is listed as a primary inorganic contaminant; however, it is not routinely included in IOC samples for public water systems. Asbestos monitoring is to be conducted every 9 years unless a waiver is applied for and granted by DOH.

The City currently has a waiver to postpone asbestos monitoring until 2010.

Residual Disinfectant

The City injects a chlorine concentration of approximately 0.6 mg/L into the water from the wells at the treatment plant. The City measures residuals at various locations throughout the distribution system in conjunction with its Coliform Monitoring Plan. The City does not provide direct chlorination to Well No. 5 at this time; however water from this well is mixed with the treated water from all other sources.

WATER QUALITY MONITORING SCHEDULE

Water quality monitoring is required for regulatory compliance and to monitor water system conditions. DOH has distributed a *"Water Quality Monitoring Report for the Year 2008"* to the City of Milton that defines monitoring schedules and sample locations. A copy of that report is included in Appendix J, along with treatment waiver information. Table 3-8 provides a summary monitoring schedule for the City of Milton.

TABLE 3-8

Water Quality Monitoring Summary

Parameter	Sample Location	Sampling Frequency	Notes
Asbestos	Source (S01, S02, S04, S06)	Once every nine years.	All sources: State Waiver through 2010
Bacteriological	Distribution System	Nine per month	See Coliform Monitoring Plan
General Pesticides	Source (S01, S02, S04, S06)	Two samples every 3 years at each source	
Herbicides	Source (S01, S02, S04, S06)	Two samples every 3 years at each source	
Inorganic Chemicals	Source (SO1, SO2, SO3, SO4)	One sample every 3 years at each source	
Insecticides	Source (S01, S02, S04, S06)	Two samples every 3 years at each source	
Lead and Copper	Source and Distribution System	Will be notified by the DOH when required	Most recent testing in 2009.
Nitrates	Source (S01, S02, S04, S06)	One sample every year at each source	No waiver option
Radio-nuclides	Source (S01, S02, S04, S06)	Two samples every 3 years at each source	
SOCs	Source (S01, S02, S04, S06)	One sample every 3 years at each source	Most recent testing in 2009.
VOCs	Source (S01, S02, S04, S06)	One sample every 3 years at each source	Most recent testing in 2009.

CONCLUSION

The City's water currently meets all applicable drinking water quality standards.

Well No. 3 is located near an old waste disposal site for wood products. Elevated levels of arsenic have been observed in nearby surface water sources. However, during the City's regular IOC testing, arsenic has not been detected. The City has also seen elevated levels of iron and manganese at the Corridor Wells recently, and is exploring treatment options to reduce levels.

The City provides all required drinking water quality information as a part of its annual Consumer Confidence Report that is required by the EPA.

WATER RIGHTS ANALYSIS

Water rights are described in Chapter 1 and summarized in Table 1-3. The City's Water Right Self-Assessment is included in Appendix D. The water rights held by the City allow a total annual withdrawal of 2,811 acre-feet/year (2.51 mgd) and instantaneous withdrawals of 5,420 gpm (7.80 mgd) from groundwater sources.

A review of peak day demands from 2003 to 2008 shows flows between 1.57 mgd and 2.17 mgd. These flows are well below the instantaneous withdrawal limitations provided in the water rights. Table 3-9 compares the projected maximum day demands (instantaneous withdrawals) with existing instantaneous water rights. The City has adequate instantaneous withdrawal water rights to meet projected maximum day demands through build-out.

TABLE 3-9

Instantaneous Water Rights Analysis

Year	Instantaneous Water Right (Q_i)		Projected Instantaneous Withdrawal		Water Right Surplus/(Deficit)	
	(mgd)	(cfs)	(mgd)	(cfs)	(mgd)	(cfs)
2009	7.80	12.08	2.04	3.16	5.76	8.92
2015	7.80	12.08	2.39	3.70	5.41	8.38
Buildout	7.80	12.08	3.18	4.92	4.63	7.16

Table 3-10 compares the projected annual withdrawal requirement (projected average day production) with existing annual withdrawal water rights. The projected annual withdrawals assume a constant average demand per customer. Water use efficiency measures and their impacts on water rights are discussed in Chapter 5.

TABLE 3-10

Annual Water Rights Analysis

Year	Annual Water Right (Q_a)		Projected Annual Withdrawal		Water Right Surplus/(Deficit)	
	(mgd)	(ac-ft/yr)	(mgd)	(ac-ft/yr)	(mgd)	(ac-ft/yr)
2009	2.51	2,811	0.93	1,038	1.58	1,773
2015	2.51	2,811	1.09	1,216	1.42	1,595
2029	2.51	2,811	1.44	1,616	1.07	1,195

SOURCE OF SUPPLY ANALYSIS

DOH requirements for source are based on the ability of the water system to provide enough capacity to meet the maximum day demands of the water system. Table 3-11 provides an analysis of the system's existing source versus the projected peak day demands for the system. The City will need to increase its reliable pumping capacity from its wells to meet the maximum day demand pumping requirements by build-out.

The pumping capacity available is based on the City's normal use patterns for source production, which are currently limited by aquifer capacity. Per City policy, wells may be pumped 24 hours per day. Well Nos. 3, 5, 10, 12 and the Corridor Wells are primarily used to supply the system with respective capacities of 225 gpm, 120 gpm, 500 gpm, 475 gpm, and a combined output of 700 gpm for a total available capacity of 2,020 gpm. The City is projected to have a deficit of 187 gpm by build-out, which is anticipated to occur in 2025.

TABLE 3-11

Source of Supply

Year	Maximum Day Demand (gpd)	Pumping Rate (gpm)	Current Well Output (gpm)	Surplus/ (Deficit) (gpm)
2009	2,041,431	1,418	2,020	602
2015	2,390,473	1,660	2,020	360
Build-out	3,177,973	2,207	2,020	(187)

TREATMENT

The City treats well water for corrosion control and pH control, and disinfects using chlorination, and budgets for annual maintenance of the treatment system. As a result, the treatment components are in fairly good condition.

Current capacity for the corrosion control for Well Nos. 3, 10 and 12 is limited to an instantaneous rate of 2,000 gpm by flow meter capacity. The sodium hydroxide injection system is operating at 83 percent capacity with an 11.5 percent solution. The solution could be adjusted up to 13 percent to offset the meter limitations. Since water from only three of the City's wells go through this portion of the treatment system, the 2,000 gpm limitation is not significant in the overall capacity of the system.

The sustainable rate of withdrawal for the chlorination system is also 2,000 gpm. The City has two chlorine gas tanks totaling 300 pounds, and uses an injection system. Flow rates can be adjusted All sources except Well No. 5 are chlorinated. It is not projected that a sustainable rate of greater than 2,000 gpm will be required for chlorination.

The City does not have a contact time (CT) tank as part of the treatment system. Instead, CT is achieved within transmission mains. Well No. 3 has an 8-inch transmission main from the well to the treatment plant. This source must meet 4-log virus inactivation. In order to ensure adequate CT for Well No. 3, the chlorine residual must be greater than 0.4 mg/L at the entry point to the treatment plant. The Corridor Wells also require 4-log virus inactivation. CT is accomplished through piping on site, with a residual of 1 mg/L required at the entry point to the system. The City should consider further study on CT improvements if these residuals cannot be met.

Also, as previously discussed, the Corridor Wells have elevated levels of iron and manganese. On-site treatment is necessary to address this issue and allow the City to fully utilize the Corridor Wells.

STORAGE ANALYSIS

Storage requirements for the City of Milton are determined according to the DOH *2001 Water System Design Manual*. The storage requirements are based on the sum of the following:

- Operational Storage
- Equalizing Storage
- Standby Storage
- Fire Suppression Storage
- Dead Storage

The formulas for calculating these components of the storage requirements are provided in the DOH *2001 Water System Design Manual.*

Operational Storage

Operational storage is the volume of the reservoir devoted to supplying the water system while, under normal operation conditions, the source(s) of supply are in "off" status. This volume is dependent upon the sensitivity of the reservoir water level sensors and the tank configuration necessary to prevent excessive cycling of source pump motors. Operational storage is in addition to other storage components, thus providing a factor of safety for equalizing, standby, and fire suppression components. For this analysis, operational storage is the top 16 feet of the 15th Avenue Reservoir, the top 10 feet of the 1-MG Reservoir and the top 23-1/2 feet of the 2-MG Reservoir.

Equalizing Storage

Equalizing storage is typically used to meet diurnal demands which exceed the average daily and peak day demands. The volume of equalizing storage required depends on peak system demands, the magnitude of diurnal water system demand variations, the source production rate, and the mode of system operation. Sufficient equalizing storage must be provided in combination with available water sources and pumping facilities such that peak system demands can be satisfied.

Equalizing storage is calculated using the following equation:

$V_{ES} = (Q_{PH} - Q_S)$ 150 minutes

V_{ES} = Equalizing storage component (gallons)
Q_{PH} = Peak hourly demand (gpm)
Q_S = Total source of supply capacity, excluding emergency sources (gpm)

The equalizing storage requirement according to the above formula is summarized in Table 3-12.

Standby Storage

Standby storage is provided in order to meet demands in the event of a system failure such as a power outage, an interruption of supply, or break in a major transmission line. The amount of standby storage should be based on the reliability of supply and pumping equipment, standby power sources, and the anticipated length of time the system could be out of service.

Standby storage is calculated using the following equation:

V_{SB} = 2 (ADD) - 1440 minutes (Q's)
V_{SB} = Required standby storage component (gallons)
ADD = Average daily demand for the design year (gallons) excluding irrigation
Q's = Total source of supply capacity, with the largest source out of service (gpm)

In no case, however, shall the standby storage volume be less than the following:

V_{SB} = 200 gallons times the number of approved residential connections, plus the average daily demand of all other users on the system excluding irrigation

Standby storage requirements according to the above formula are presented in Table 3-12. Throughout the 20-year planning period, the required standby storage is 200 gallons per Equivalent Residential Unit.

Fire Suppression Storage

Fire suppression storage is provided to ensure that the volume of water required for fighting fires is available when necessary. Fire suppression storage also reduces the impact of fire fighting on distribution system water pressure. The amount of water required for fire fighting purposes is specified in terms of rate of flow in gallons per minute and an associated duration. Fire flows must be provided at a residual water system pressure of at least 20 pounds per square inch.

Fire suppression storage is calculated using the following equation:

$$V_{FSS} = NFF*T$$

V_{FSS} = Required fire suppression storage component (gallons)
NFF = Needed fire flow (gpm) (4,763 gpm)
T = Duration (minutes) (240 min)

Per discussions with the Fire Marshall, the City can nest fire suppression storage and standby storage.

Dead Storage

Dead storage is the volume of unusable water stored in the reservoirs because it is not available to all customers at the minimum pressure of 30 psi. The 15th Avenue Reservoir does not have any dead storage due to the elevation of the tank. The 1-MG and 2-MG Reservoirs, strictly based on elevations, have a significant amount of dead storage. However, the 434 Zone can be operated as a closed zone by isolating the reservoirs, pumping to the 520 Zone, and then supplying the zone and setting the HGL through PRVs. In an emergency situation, the 434 Zone could be operated this way, thus eliminating dead storage within the two reservoirs.

Table 3-12 provides the City's storage requirements.

TABLE 3-12

Storage Analysis

	Entire System			434 & 520 Zone		
	2009	**2015**	**2029**	**2009**	**2015**	**2029**
Gross Storage Volume	3,350,000	3,350,000	3,350,000	3,000,000	3,000,000	3,000,000
Dead Storage	0	0	0	0	0	0
Available Storage	**3,350,000**	**3,350,000**	**3,350,000**	**3,000,000**	**3,000,000**	**3,000,000**
Operational Storage	948,990	948,990	948,990	806,133	806,133	806,133
Equalizing Storage	51,111	111,143	246,587	38,333	83,357	184,940
Fire Suppression Storage(1)	675,000	675,000	675,000	675,000	675,000	675,000
Standby Storage(1)	795,162	931,119	1,237,859	596,372	698,339	928,395
Required Storage	**1,675,100**	**1,735,133**	**2,433,436**	**1,519,466**	**1,564,490**	**1,666,073**
Storage Surplus/ (Deficit)	**1,674,900**	**1,614,867**	**916,564**	**1,480,534**	**1,435,510**	**1,333,927**

(1) The City can nest fire flow and standby storage per discussions with the Fire Marshal.

Based on this analysis, the City has adequate storage for the projected growth.

BOOSTER STATION ANALYSIS

The booster station analysis ensures that each zone in the City's system has sufficient capacity to meet the required demands. Required booster station capacity is different for those pumping to an open system than for those pumping to a closed system.

An open system is a pressure zone which is governed by an atmospheric storage tank, such as the 330 Zone and 434 Zone. A closed system is a zone that is closed to the atmosphere, in which pressures are controlled by a booster station, such as the 520 Zone.

For open systems, WAC 246-290-230 requires that the booster station be designed to meet the Maximum Day Demands (MDD) for the zone with all pumps in service and meet the Average Day Demand (ADD) with the largest pump out of service. Table 3-13 provides the 15th Avenue Booster Station analysis for the City's 434 Zone and 520 Zone, since all water pumped to the 520 Zone also passes through the 15th Avenue Booster Station, with the exception of what is produced by Well No. 5.

TABLE 3-13

15th Avenue Booster Station – Open System

	2009	2015	2029
ADD (gpm)	476	558	742
MDD (gpm)	1,049	1,228	1,600
Pumping Capacity (gpm)	800	800	800
Pumping Capacity with Largest Routinely Used Pump Out of Service (gpm)	400	400	400
Well Capacity in Zone (gpm)	120	120	120
Pump & Zone Capacity with Largest Routinely Used Pump Out of Service (gpm)	520	520	520
Total Zone Capacity (gpm)	920	920	920
Meet ADD with Largest Pump Out of Service	Yes	No	No
Meet MDD with All Pumps	No	No	No
Capacity with Proposed Improvements (gpm)(1)	NA	1,920	1,920
Meet ADD with Largest Pump Out of Service with Improvements	NA	Yes	Yes
Meet MDD with All Pumps with Improvements	NA	Yes	Yes

(1) Includes an additional 1,000 gpm pump, see Chapter 8.

The 15th Avenue Booster Station is currently deficient at supplying maximum day demands and will no longer be able to supply average day demands with the largest pump out of service by 2013.

For closed systems, WAC 246-290-230 requires that the booster stations provide Peak Hour Demands (PHD) at 30 psi system wide. For purposes of reliability, the booster station should be able to provide this pressure when the largest pump is out of service. The booster station must also be capable of providing the required fire suppression to the closed zone with the largest routinely used pump out of service. Table 3-14 provides the booster station analysis for the City's 520 Zone. For the 1 MG and 2 MG Reservoir Booster Stations, the largest pump and the largest routinely used pump is 1,400 gpm.

TABLE 3-14

1-MG and 2-MG Booster Stations – Closed System

	2009	2015	2029
PHD (gpm)	1,053	1,233	1,640
Fire Flow (FF) Requirement (gpm)	3,750	3,750	3,750
MDD (gpm)	638	747	993
Pumping Capacity (gpm)	4,800	4,800	4,800
Pumping Capacity with Largest Routinely Used Pump Out of Service (gpm)	3,400	3,400	3,400
Meet PHD with Largest Routinely Used Pump Out of Service	Yes	Yes	Yes
Meet FF and MDD with Largest Routinely Used Pump Out of Service(2)	No	No	No
Capacity with Proposed Improvements(3)	6,200	6,200	6,200
Meet PHD with Largest Routinely Used Pump Out of Service with Improvements	NA	Yes	Yes
Meet FF and MDD with Largest Routinely Used Pump Out of Service with Improvements	NA	Yes	Yes

(1) The pumps are able to provide all the necessary flow to meet fire flow demands in the system. Chapter 4 provides the Washington State Department of Health system-wide 20-psi pressure analysis.

(2) Includes an additional 1,400-gpm pump, see Chapter 8.

The 1-MG and 2-MG Booster Stations are currently deficient at supplying maximum day demands and fire flow with the largest pump out of service. Additional pumps are required to meet redundancy and reliability requirements. The City has a wholesale water agreement with Mt. View-Edgewood to provide 500 gpm to the 520 Zone. It is anticipated that this intertie will be active during peak months and should be noted in the booster station analysis. With the intertie operational, the City is currently able to meet maximum day demands and fire flow in the 520 Zone. However, it cannot be assumed that this source will always be available since it must be manually opened, and thus cannot be considered in the capacity analysis of the 1-MG and 2-MG Booster Stations.

With the improvement projects described in Chapter 8, the City's booster stations will be able to meet all requirements for providing flows. The projects are scheduled for within the 6-year planning period.

DISTRIBUTION SYSTEM ANALYSIS

A description of the distribution system facilities was provided in Chapter 1. An analysis of the transmission and distribution system is provided in Chapter 4, Hydraulic Analysis. System deficiencies for the distribution system are also presented in Chapter 4. The City currently has an aggressive annual pipe replacement program, targeting failing or unreliable distribution mains that show high leak history. The City's replacement program shall be evaluated and adjusted based upon results in Chapter 4 and any recommendations shall be included in Chapter 8, Capital Improvement Program.

WATER SYSTEM RELIABILITY ANALYSIS

FACILITY RELIABILITY

The City's facility reliability is typically provided through redundancy. The following paragraphs describe the source production facilities, reservoirs, and booster stations.

Source Reliability

The City currently has sufficient source and pumping capacity at its wells to provide the necessary water to the system. By buildout, however, it is estimated that the City will require an additional 187 gpm of source capacity beyond what the wells can provide, based on 24-hour pumping. It is recommended that the City begin developing an additional source.

The City's two interties, one with the Lakehaven Utility District to supply fire flows along the SR 99 corridor and the other with the Mt. View-Edgewood Water Company to supply flows to the 520 Zone, increase the system's reliability and provide additional capacity in the case of peak demands or a high flow situation.

Treatment

The City's current treatment system is sufficient for projected demands, with the exception of needing iron and manganese treatment at the Corridor Wells.

Storage

According to the storage analysis, the City's storage capacity is sufficient to meet demands through build-out and the 20-year planning period.

Booster Stations

According to the previous booster station analysis, the City does not have sufficient pumping capacity to supply the 434 and 520 pressure. The 15th Avenue Booster Station is currently unable to meet maximum day demands, and is projected to be deficient by approximately 308 gpm by 2015. An additional 713 gpm capacity will be required by build-out to maintain required levels of redundancy.

The 1-MG and 2-MG Reservoir Booster Stations currently require an additional 1,400 gpm of capacity between to supply fire flow and maximum day demands while maintaining redundancy levels by build-out.

Booster station reliability is currently a limiting factor of the system.