CHAPTER 5

PRESENT AND FUTURE WATER DEMANDS

Chapter Outline

PRESENT AND FUTURE WATER DEMANDS

CHAPTER 5

5.1 INTRODUCTION

A primary measure of the size of a municipal water system is the total amount of water that it delivers to consumers. This capacity is the sum of water required for domestic, commercial, and industrial uses, water that is lost out of the system through leakage, in addition to water required for fire protection.

Future water demands have been prepared based on a number of variables including the following:

- Population projections
- Historical water demand
- Land use zoning within the study area
- Projected fire flows

The demand characteristics developed in this chapter will serve as the basis for evaluating the City's existing water system infrastructure and for sizing supply, treatment, storage, and distribution infrastructure across the planning period.

5.2 TERMS AND DEFINITIONS

5.2.1 System Demand

The following terms are used to describe system demand:

- *Consumption* – Consumptive demand is water delivered to the system's users through service connections. Consumption is generally less than demand, the difference being system loss. Consumption is measured by the consumer's meter and is accordingly the metered portion of demand.
- *Demand* – The total amount of drinking water entering the transmission/distribution system from water sources and storage facilities to meet various user needs (excludes raw water that has not passed through the WTP). Demand equals consumption plus system loss and is usually measured by system master meters.
- *Fire Flow Demand* – Demand required for firefighting purposes. Fire flow demands vary by structure type and use and are proscribed by the City and/or fire code. Fire flow demand is considered to be met if the system can deliver the required flow rate while maintaining a minimum residual pressure in the distribution system of 20 psi.
- *System Loss* – System loss is water that cannot be accounted for. It is the difference between the total system demand and the total consumption. System loss is not necessarily the same as leakage. Although the majority of system losses are typically the result of leaks, losses can also be attributed to meter error, as well as unmetered uses such as street flushing, hydrant testing and similar activities, or from bypasses, overflows, etc.

5.2.2 Demand Variations

Water demands in municipal water systems vary widely across time. Seasonal, monthly, daily and hourly demand rates are utilized to evaluate and size various components of the overall water system. For the purposes of this report, the following demand classifications will be used. The definitions are generally listed in order of increasing magnitude.

- *Average Day Demand (ADD)* – The total volume of water that enters the system over a period of one year, divided by 365 days.
- *Maximum Month Demand (MMD)* – The largest total volume of water that enters the system in a one-month period, divided by 30 days.
- *Maximum Day Demand (MDD)* – The largest total volume of water that enters the system in a 24-hour period. MDD is commonly used to size water treatment plants, large diameter transmission mains and factors into the sizing of reservoirs.
- *Peak Hour Demand (PHD)* – The greatest flow occurring in any one-hour period. PHD is used as one criterion for sizing distribution waterlines and factors into the equations used to size pump stations and reservoirs.

5.3 POPULATION

Population projections serve as the basis for future water demand projections. Much of the challenge in projecting water system growth relates to the difficulty in accurately tracking or projecting actual populations.

This section evaluates anticipated growth from a review of several data sources; including historical population data (census information & PSU estimates), County coordinated population projections, and anticipated development.

5.3.1 Historical Municipal Population

Population histories provide a tool for determining the future growth rate of the municipal water system. The population in Dayton has steadily increased from approximately 949 people in 1970 to an estimated population of 2,550 in the year 2007. The City has experienced a slowdown in new residential development and building due to the economic downturn of the past several years, and the population has held steady at approximately 2,550 since the year 2007. As shown on **Figure 5-1**, as similar trend was experienced by Dayton in the recession of the early 1980s. Residential growth was strong during the mid to late 1990s (after the slowdown of the 1980s) due to the development of residential areas along the north and south sides of town.

5.3.2 Anticipated Future Development

Dayton is likely to experience continued growth in the future as a suburb of the greater Portland and McMinnville area. Both areas have a relatively large employment base but less affordable housing than Dayton does. During the planning period, the City anticipates future residential development to continue as both new subdivisions and as infill development (ie. partitions & redevelopment). Major commercial or industrial developments that would dramatically increase the employment opportunities in Dayton are not anticipated during the planning period.

5.3.3 Future Population Projections

As previously noted, the planning period used by this master plan for this public water facilities is 20 years. In order to be eligible for many public funding sources, population projections (and associated demand projections) must be shown to be compatible with local and statewide planning goals, including adopted statewide and County population allocations (which are used as the 'coordinated number' for evaluating population projections). In July 2008, Dayton and Yamhill County agreed on a 20 year population projection of 3,892 through the year 2028 for use as the coordinated population number, based on a population growth rate of 2.25%. Documentation for this coordinated population number and the associated growth rate appears in **Appendix D**. As noted in the assumptions behind the coordinated population number, if the Newberg-Dundee Bypass is completed early in the planning period, the basis for these populations projections may need to be revisited (as it may accelerate the population growth of those who work and commute to the Portland Metro area).

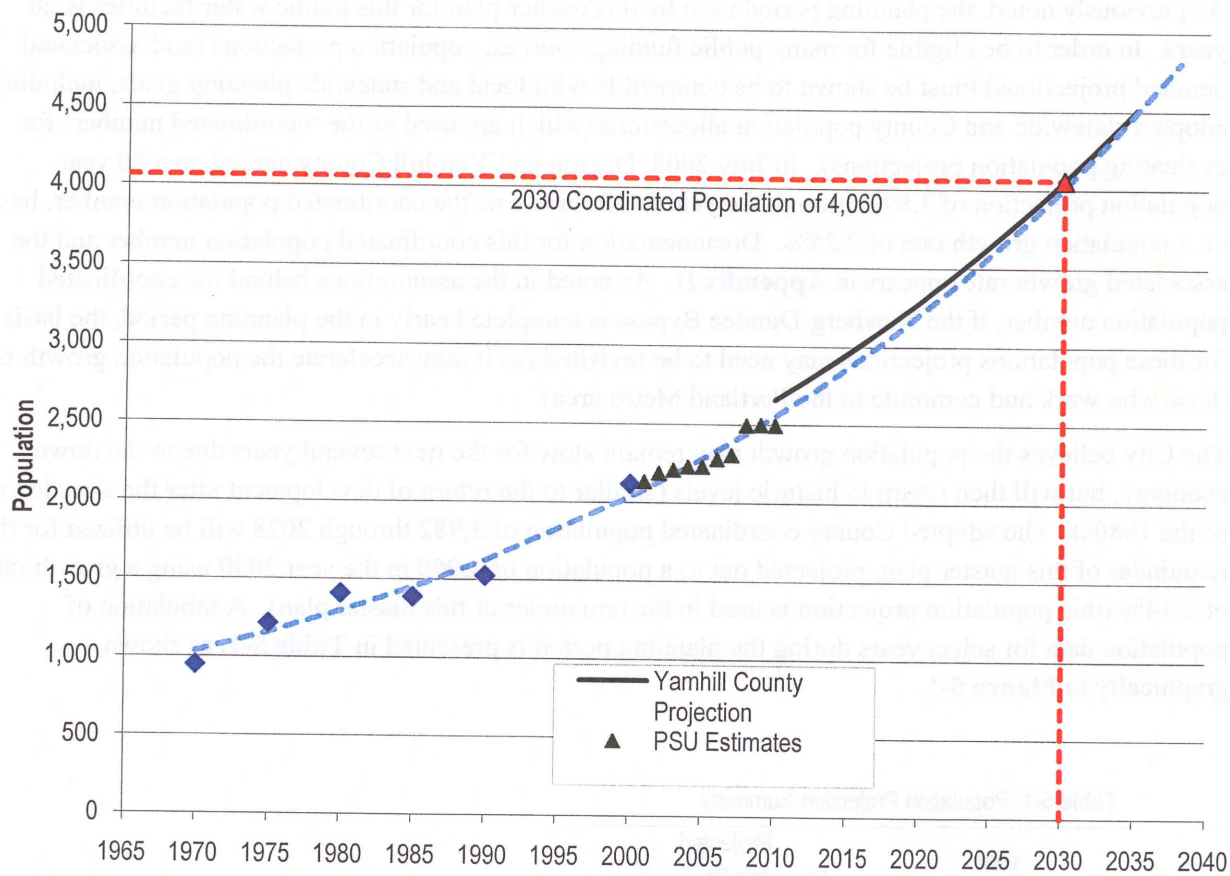
The City believes the population growth may remain slow for the next several years due to the down economy, but will then return to historic levels (similar to the return of development after the slowdown of the 1980s). The adopted County coordinated population of 3,982 through 2028 will be utilized for the remainder of this master plan, projected out to a population of 4,060 in the year 2030 using a growth rate of 2.14% (this population projection is used in the remainder of this master plan). A tabulation of population data for select years during the planning period is presented in **Table 5-1,** as shown graphically in **Figure 5-1**.

Table 5-1 Population Projection Summary

Year	Projected Municipal Population
2010	2,500
2015	2,958
2020	3,287
2025	3,650
2028 (1)	3,892
2030	4,060

(1) County coordinated population allocation adopted in 2008

Figure 5-1 Municipal Population Projections



5.4 Historical Water Demand

Historical records of water demand provided by the City were evaluated to determine usage rates and demand fluctuations. The four year period from 2006 to 2010 was used as a basis to establish historical water demands. The information of this section combined with the population data of Section 5.3 forms the basis for estimating future water demands as presented in Section 5.5.

5.4.1 Water Production

As previously discussed, the City currently obtains all of its municipal drinking water from groundwater wells and springs. The City's current maximum day demand is approximately 560 gpm. The total withdrawal rate permitted (both Certificate Rate and Permit Rate) under the City's active groundwater and surface water rights combined is approximately 2,389 gpm (see **Table 6-1**). The total withdrawal rate permitted is just over 7 times greater than the City's maximum day demand. However, the permitted withdrawal rate is much greater than the amount of water produced from the springs and wells as shown in **Table 6-1.** The total long term production of the wells and springs is 558 gpm (all sources, including the Lafayette wellfield wells), which is essentially equal to the present maximum day demand. Without the Lafayette wellfield wells, the estimated long term production of all Dayton sources is only 350 gpm.

Annual water production is based on master meter readings at the WTP, the watershed springs and the McDougal Wells, and is presented in **Figure 5-2**. Data for 2010 is not quite complete, but represents 11 months of data.

Figure 5-2 Annual Water Production by Source

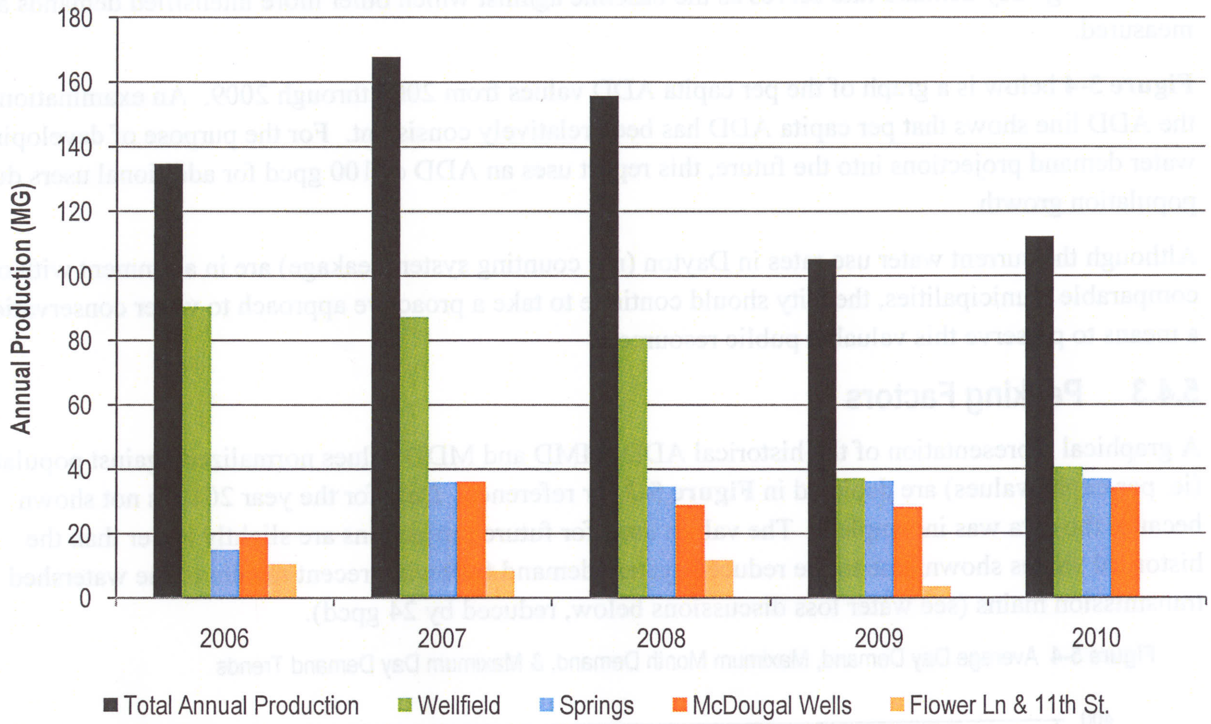
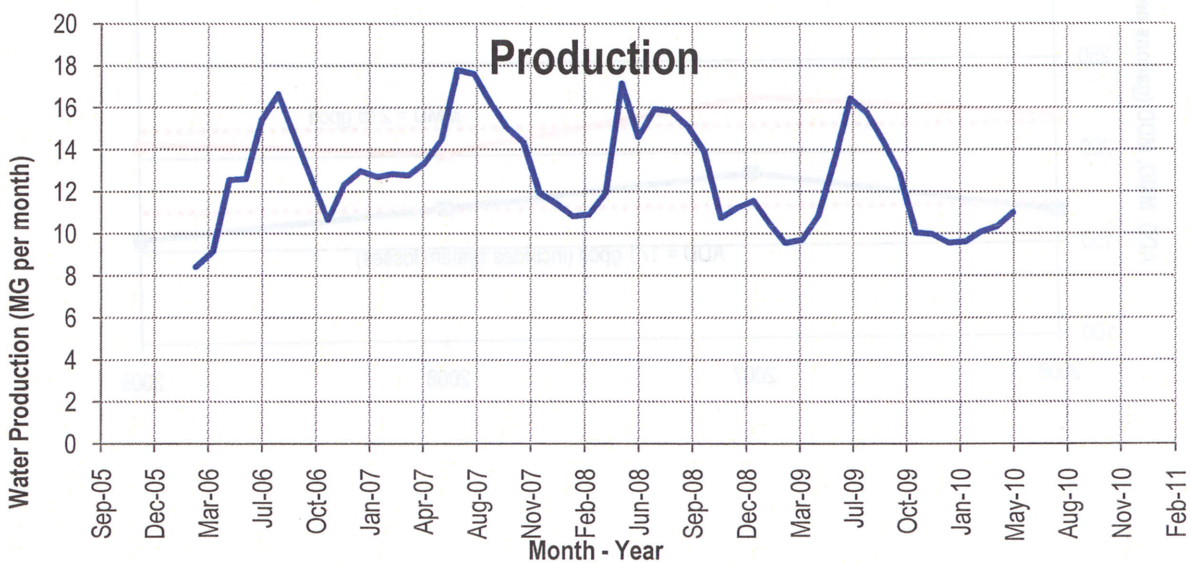


Figure 5-3 illustrates graphically the trends and variation in historical water projection during different periods of the year. As would be expected, water production increases during the summer to meet increased demand, and decreases during the winter months.

Figure 5-3 Historical Water Production Trends by Month



5.4.2 Average Day Demand (ADD)

Water demand is defined as the sum of all water produced and delivered to the City distribution system. It includes water consumed in all use categories and also includes water loss and unaccounted-for water. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand rate serves as the baseline against which other more intensified demands are measured.

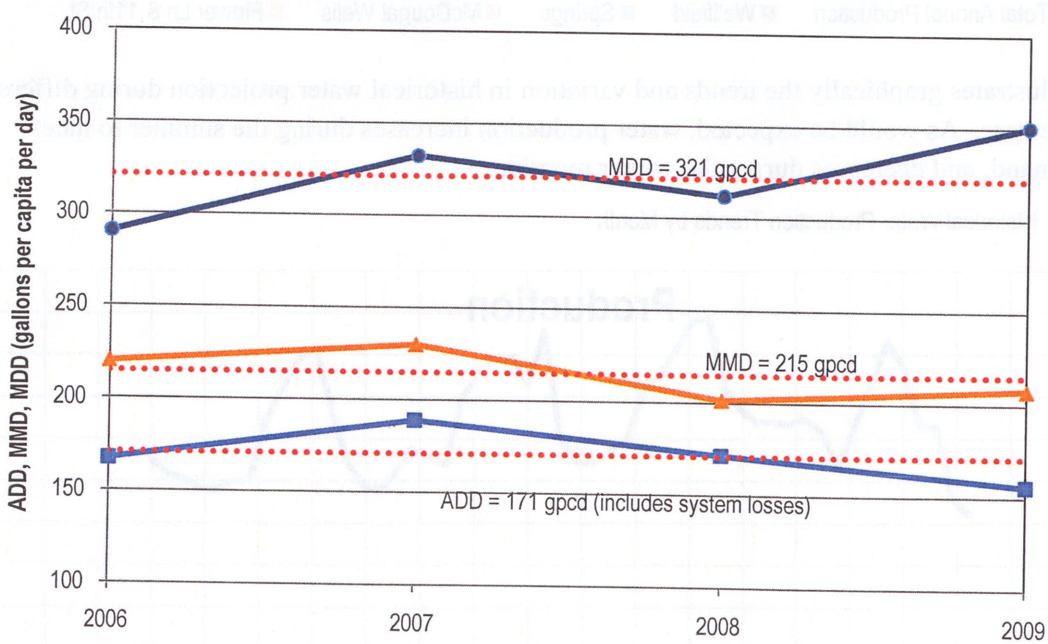
Figure 5-4 below is a graph of the per capita ADD values from 2006 through 2009. An examination of the ADD line shows that per capita ADD has been relatively consistent. For the purpose of developing water demand projections into the future, this report uses an ADD of 100 gpcd for additional users due to population growth.

Although the current water use rates in Dayton (not counting system leakage) are in alignment with other comparable municipalities, the City should continue to take a proactive approach to water conservation as a means to preserve this valuable public resource.

5.4.3 Peaking Factors

A graphical representation of the historical ADD, MMD and MDD values normalized against population (ie. per-capita values) are depicted in **Figure 5-3** for reference. Data for the year 2010 is not shown because the data was incomplete. The values used for future projections are slightly lower than the historical values shown, due to the reduced system demand following recent repairs to the watershed transmission mains (see water loss discussions below, reduced by 24 gpcd).

Figure 5-4 Average Day Demand, Maximum Month Demand, & Maximum Day Demand Trends



Variations in water demand are typically expressed as ratios to the average day demand. Peak demands are important planning factors since facilities must be sized for maximum demands, not average demands. **Table 5-2** shows the current peaking factors, measured or assumed.

Table 5-2 Peaking Factor Summary

Population Group	ADD (1) (gpcd)	ADD:MMD (1) Peaking Factor	ADD:MDD (1) Peaking Factor	ADD:PHD (2) Peaking Factor
Municipal	147	1.30	2.02	5.00

(1) Calculated peaking factor based on measured system demands, corrected to account for water loss reductions following recent repairs in the watershed.
(2) Assumed peaking factor based on typical small system values. This ADD:PHD peaking factor applies only to the consumption portion of the system demand, and not to the leakage portion (leakage is assumed to remain relatively constant over time).

A discussion of the basis for each demand categories is presented below.

5.4.4 Maximum Month Demand (MMD)

Maximum month demands normalized against population are depicted in **Figure 5-4** above. The MMD of 215 gpcd (corrected to 191 gpcd to account for recent water loss repairs in the watershed) results in a ADD:MMD peaking factor of 1.30. Maximum month demand is perhaps the most variable of the peaking factors, as the period is long enough to capture the full effect of seasonal weather trends.

5.4.5 Maximum Day Demand (MDD)

MDD is traditionally defined as the highest production day within the highest production month. MDD values are conventionally utilized to size treatment plant capacity, large diameter transmission mains and factor into the sizing of reservoirs. MDD is typically the most critical water demand scenario and is usually the standard by which system adequacy is measured.

The MDD of 321 gpcd (corrected to 297 gpcd to account for recent water loss repairs in the watershed) results in a ADD:MDD peaking factor of 2.02. The value is reasonable when compared to literature ranges of 1.5 to 3.5. Later sections of this report will apply this peaking factor against population projections to establish MDDs across the planning period.

5.4.6 Peak Hour Demand (PHD)

Due the short duration of peak hour demand and the large cost of constructing source and treatment facilities to match this demand, peak hour demand (unlike maximum day demand) is satisfied with reservoir storage. The distribution network must be capable of supplying peak hour demand with a minimum residual pressure of 20 psi throughout the system.

The City does not currently collect demand data on an hourly basis. Therefore, in order to estimate and project the peak hour demand, a peaking factor is needed. Because of the conservatism typically utilized at the master planning level, an ADD:PHD peaking factor of 5.0 was selected and will be used throughout this report for municipal demands.

5.4.7 Water Loss

Water loss or unaccounted-for water is comprised of the difference between the finished water produced and the water consumed, and consists of all unmetered uses and system leakage. It is important to differentiate these two categories of water loss.

Unmetered use is commonly the result of incomplete or inaccurate metering of consumer demand, including the following typical categories.

- Unmetered or unauthorized connections
- Inaccurate or unrecorded flows for hydrant and main flushing
- Unmetered water for construction activities
- Unmetered water for operations & maintenance uses (street cleaning)
- Unmetered water for fire fighting
- Reservoir overflows
- Spring or well bypass water
- Data collection errors

System leakage, as the name implies, is water lost due to deteriorating pipe, compromised pipe joints , service connections, valves, etc. With proper record keeping and metering of water, the percentage of unaccounted-for water approaches the net volume lost to actual leakage. Conventionally acceptable rates of water loss range between 10 and 15 percent, although water loss for many small Oregon municipalities is around 20%.

OAR 690-086-0150(4)(a) requires municipalities to conduct annual water loss audits. We recommend that the City conduct these water loss audits at least annually. After each water line replacement project, the City should monitor the decrease in system loss thru the water loss audits.

Two unmetered services were identified in the 2004 Water Management and Conservation Plan, both of which were reported to serve cemeteries (although it does not identify locations of the cemeteries). We assume that this referred to this refers to the Brookside Cemetery (south end of 3rd Street) and the Odd Fellows Cemetery (on Thompson Road). Our understanding is that meters were installed on these services in 2006.

Although not part of the water loss calculations presented above (since it occurs prior to the treated water entering the distribution system), by comparing the flow meters feeding the WTP and the Dayton & Lafayette discharge flow meters, it was determined that approximately 7% of the well water (wellfield wells & in-town wells) is unaccounted for. The majority of this is most likely the water used to backwash the pressure filters at the WTP (this backwash flow is not metered). The City should evaluate options to track and record the volume of water used to backwash the filters, in order to verify that there is not excessive leakage from the raw water transmission mains.

Water loss in the Dayton system was evaluated separately for the two water service levels (ie. the in-town distribution system, and the watershed system upstream of the PRV station). Due to the age of portions of the water distribution system (ie. 1930s vintage steel waterlines), water loss in portions of the system have been relatively large in the past.

In-Town Water Loss

The 2004 water project replaced a significant proportion of the steel waterlines within the main (in-town) service level. Since that time, the City has pursued an aggressive leak repair and correction program.

Construction of the new PRV station (2009) resulted in significantly fewer high pressure incidents in this service level (ie. when the old PRV valve failed, it resulted in increased pressure in town, which lead to higher leakage rates). The new PRV station also included a mainline flow meter, which now allows the City to accurately measure the volume of water entering the main service level through the PRV station (the old PRV did not have a flow meter).

Based on recent measurements (after the recent replacement of the leaking steel waterlines on Oak Street and 1st Street), the water loss for the in-town service level has been reduced to an average of approximately 22% (based on the water entering the system from the WTP and through the PRV station from August to November 2010). Actual percentages vary over time as demand and consumption vary.

One significant source of potential leakage within the main (in-town) service level is the 1932 vintage steel waterline that crosses under Palmer Creek between the south end of 1st Street and the easterly end of Palmer Lane. The alignment of this line does not allow for regular patrolling and visual inspection by Public Works, and leakage where it crosses under the creek would be difficult or impossible to visually detect.

Based on discussions with Public Works and the amount of water system maintenance required, we believe much of the loss is due to a leaky pipes and joints, faulty service lines or meters, and possibly from unknown inter-connections between the 2004 distribution system improvements and the old distribution lines that were not located and disconnected (the City has disconnected a number since 2006, but more may exist). As the City continues its program of replacing the remaining steel waterlines in town, the in-town water loss rate should drop even further.

Watershed System Water Loss

The majority of the remaining steel waterlines are located in the watershed service level, where the water loss ratios have historically been much higher. Within the past month, the City finally found and repaired a pair of major leaks in the watershed transmission line that they have been searching for during the past several years. While almost all of the other waterlines repaired in the watershed have been found at depths of approximately 2 feet, the leaking waterline segment was finally found and repaired at a depth of over 15 feet. Tracking the leakage water (much of which was surfacing in nearby creek and drainage channels) back to its source was a significant challenge, particularly since the pipeline alignment was unknown and its excessive depth precluded the use of standard locating techniques.

Preliminary evaluation of water production records indicate that the repair of this watershed pipe leak has reduced water loss in the watershed by more than 60,000 gallons per day (this equates to ±42 gpm, or ±24 gpcd). However, water loss from the old steel pipes in the watershed system is still significant, with unaccounted for water (post repair) estimated to be slightly more than 60,000 gpd.

The City has authorized design to begin on replacement of the entire steel waterline between the watershed springs and the watershed reservoirs. It is anticipated that this will address other significant water leaks whose location cannot be cost effectively determined for repair. Replacement of the remainder of the watershed transmission main (once funding becomes available) should reduce water loss in the watershed system to levels at or lower than the in-town system.

Another significant source of unaccounted-for water in the watershed due to the fact that all water from the springs passes through the sand filter flowmeter, even when a portion bypasses or overflows at the sand filter.

5.4.8 Water Users by Category

Water consumption by use category was determined by reviewing available water-billing records for fiscal year 2008. Residential use is the largest use category and comprises 94 percent of the consumed water total, increasing slightly in the summer months. Commercial uses and multi-family and public/bulk users comprise of a total of 6 percent. A summary of the current water users in contained in **Table 5-3** below.

Table 5-3 Water User Summary

User Classification	# Services	# Residential Units
Single Family Residential	745	745
Duplex (w/ one meter)	6	12
Triplex (w/ one meter)	2	6
Westgate Apartments (___ Ferry Str)	1	8
Housing Authority (___ Ferry Str)	2	26
Commercial	23	N/A
Public	5	N/A
Schools (Elem., J.H., H.S., Head Start)	6	N/A
Churches	7	N/A
RV Park (188 spaces, 1 office, 1 community center w/ 8 showers and 9 washers)	2	125
Users Outside City Limits	25	25
Totals	824	947

5.4.8.1 Residential Consumption

The application of unit demands based on common planning units is often helpful when evaluating the impact of future residential developments. Unit demands are commonly calculated on the basis of demand per equivalent dwelling unit (EDU). Unit demands have been prepared based on the residential consumption records for 2008 and the residential meter population for that same period. Using this method it was determined that the average single family household uses about 216 gallons per day. The average capita consumption was calculated at 76 gpcd. Future planning efforts should update this value to include the results of curtailment and conservation programs.

5.4.8.2 Non-Residential Demand

Due to the small percentage of non-residential demand, the non-residential demands were assumed to track residential demands for water projection purposes. Non-residential demand for Dayton is divided among commercial, public schools and churches. Such consumer groups have a wide range of water demands ranging at times from less-than to significantly more-than typical residential demand rates.

5.5 PROJECTED WATER DEMAND

This section builds on the discussions of population projections in Section 5.3 and the discussion of historical water demand as presented in Section 5.4. The basis for projecting future water demands is based in the establishment of a historical demand baseline along with historical peaking factors. The population projections of Section 5.3 will be combined with historical per capita usage rates and peaking factors established in Section 5.4 to forecast future water demands.

5.5.1 Projected Municipal Water Demand

Projected municipal demands have been based on the following assumptions:

- It is assumed that the ratio of residential to non-residential use (commercial, industrial and public uses) will remain constant. In other words, future commercial and industrial developments will track population growth.
- It is assumed that the long-term per capita water demands will not exceed the City's historical averages. Since the efficacy of planned water conservation programs is unknown at this time, the water demand projections of this report exclude conservation. The future success of the City's water conservation policies will serve to further increase the margins of safety used to plan and design the water system infrastructure.
- It is assumed that new commercial and industrial developments will not be large water users; no provision has been made for new industries with heavy water demands such as food processing or beverage production.
- It is assumed that the population projections of Section 5.3 are reasonable estimates of future municipal populations and that the forecasted peaking factors established in Section 5.4 are reasonable estimates of future demand variations.
- It assumes that future water loss will not exceed the City's historical averages.

5.5.2 Projected Water Demand Summary

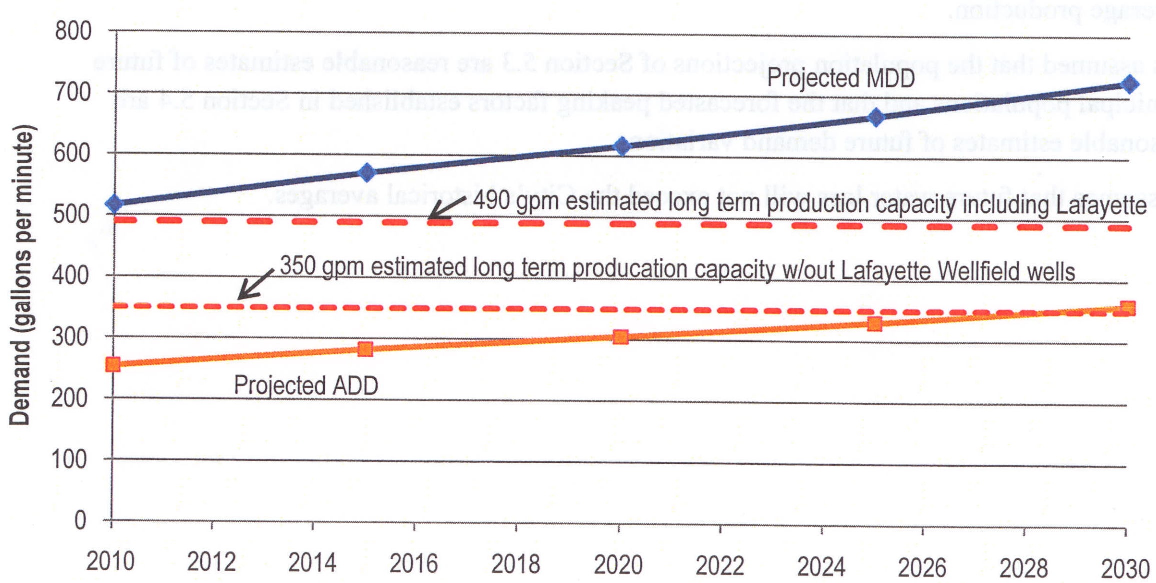
Future water demand for the municipal population is calculated by adding the current demand to the product of the per-capita demand values times the projected additional population for the planning year in question. These results are summarized in **Table 5-4** and illustrated in **Figure 5-5** below.

Table 5-4 Summary of Projected Water Demands

Year	2010	2015	2020	2025	2030	Buildout
Population	2550	2958	3287	3653	4060	6,964
Avg. Day Demand (ADD) (1)						
MGD	0.366	0.407	0.440	0.476	0.517	0.807
(gpm)	254	282	305	331	359	487
Max. Month Demand (MMD) (2)						
MGD	0.476	0.529	0.571	0.619	0.672	1.049
(gpm)	330	367	397	430	467	729
Max. Day Demand (MDD) (3)						
MGD	0.744	0.821	0.888	0.962	1.044	1.631
(gpm)	517	570	617	668	725	1132
Peak Hour Demand (PHD) (4)						
MGD	1.103	1.307	1.471	1.654	1.858	3.310
(gpm)	766	907	1022	1149	1290	2298

(1) - 2010 based on measured ADD. Projection based on 2010 ADD plus 100 gpcd x population growth.
(2) - ADD x 1.30 PF
(3) - ADD x 2.02 PF
(4) - 2010 based on leakage plus 5 X Average Day Consumption. Projection based on 2010 PHD plus 100 gpcd x pop. Growth x 5.

Figure 5-5 Projected Average Day Demand and Maximum Day Demand



Maximum daily demands have special significance because they can put stress on the water supply capabilities of the system. The water sources should be able to supply the entire water demand during the maximum day of the year in addition to any required fire flows (the current system does not meet this criteria). Currently, ADD and MDD are approximately 254 gpm and 517 gpm, respectively.

Buildout water demand projections are shown only to illustrate the estimates for the amount of water needed once all the land within the UGB is developed to zone densities.

As the City reduces overall system loss, these demands will be decreased proportionally. For example, the recent repairs to the watershed transmission line reduced demands by about 42 gpm (which is almost 17% of the current ADD water consumption).

5.6 FIRE FLOWS

The water distribution system is a community's primary resource for fighting fires. Storage facilities and fire hydrants must be suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits. The Insurance Services Office (ISO) and Oregon Fire Code (OFC) provide guidelines to determine fire flows for various structures.

The ISO standards require a minimum flow of 1,000 gpm for a 2 hour duration in residential areas and a flow of 3,500 gpm for a 3 hour duration in commercial areas. The OFC recommends fire flows based in part on an evaluation of the construction materials used in a structure, its physical configuration, separation from other structures and occupancy. On this basis, fire flows for large commercial, industrial and multi-family developments may be higher than 3,500 gpm.

The City has adopted a policy of requiring adequate fire flow capacity as a prerequisite for the purposes of planning for future development, and has codified the fire flow requirements in the PWDS. This information is summarized in **Table 5-5**.

Table 5-5 Minimum Fire Flow Requirements

Location	Recommended Fire Flow (gpm)	Duration (hours)	Required Volume (gallons)
Low Density Residential, R-1	1,000	2	120,000
Medium Density Residential, R-2	1,500	2	180,000
High Density Residential, R-3	2,000	2	240,000
Residential Commercial, RC	2,500	3	450,000
Public (Schools & Institutions)	4,000	4	960,000
Commercial/Industrial (C, I)	-	-	-
New Facilities	3,250	3	585,000
Existing Facilities	Up to 4,000	4	960,000

These fire flow values are for planning purposes only, and are not site or building specific. These values do not supersede or take the place of Oregon Fire Code (OFC) or building code fire flow requirements. Higher values may be necessary based on OFC, Fire Marshall or ISO requirements. Reductions may be allowed by the Fire Chief for buildings with fire sprinkler systems.

It should be noted that these minimum recommendations do not supersede fire flows required by the Oregon Fire Code or building codes.

Fire flows in general, are orders of magnitude greater than MDD or PHD flows. In order to limit the size of water mains delivering fire flows to large combustible structures and the overall volume of water required to suppress a fire, some cities have adopted policies stating that all buildings requiring fire flows greater than 2,500 gpm install an automatic sprinkler system.

In September 2008, the International Residential Fire Code Fire Sprinkler Coalition, a U.S. association comprised of more than one hundred fire service, building code official, and safety organizations representing 45 states, voted unanimously to modify the International Residential Code (IRC) and require sprinkler systems for all new one- and two-family homes and townhouses. The change will first appear in the 2009 IRC. Forty-six states (including Oregon) use the IRC as the model document for their codes regulating new home construction. Future announcements will determine an implementation schedule for this trend in residential fire protection.

Lastly, in addition to the required flow rates presented above, OAR 333-061-0025 requires that a minimum pressure of 20 psi must be maintained in the distribution system at all times, inclusive of fire flow events. Evaluations of the distribution system (existing and future) to deliver the adopted fire flows are presented in Chapter 8 of this report.

6

CHAPTER 6

WATER SUPPLY EVALUATION

Chapter Outline

WATER SUPPLY EVALUATION

CHAPTER 6

6.1 INTRODUCTION

This chapter builds on the inventory of the City's water supply infrastructure as presented in Chapter 4. It discusses the City's water sources and history of water supply development, presents the regulatory framework for water rights and details the water rights secured by the City to date. It also evaluates the pumping capacity available to exercise those rights and concludes with improvement recommendations. Though originating in water supply, groundwater quality is presented in Chapter 7 along with water treatment. Recommended budget numbers to cover the capital costs for the recommendations presented in this chapter appear in Chapter 12.

6.2 EVALUATION CRITERIA

Evaluation of the adequacy of a water supply system is based on a number of criteria. One of the most basic criteria is the availability of water rights (as this affects the legal right to utilize the water when it is available). Once the legal right to utilize the water is addressed, there are several basic criteria for evaluating the possible performance of a water system, including the water sources. These criteria include reliability, resiliency and vulnerability. The parameters presented in this section will be utilized in the analysis and recommendations of this chapter. A short explanation of each of these evaluation criteria is presented below.

6.2.1 Water Rights

As previously noted, in Oregon, all water is publicly owned (both surface water and ground water). The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state. Over the years as greater demands have been placed on limited water resources, OWRD has exercised increasing control over water use. A water right will not guarantee water for the appropriator. Under the prior appropriation doctrine, a water right authorizes diversions of water only to the extent water is available and does not impact a more senior water right. Water rights establish a hierarchy utilized by OWRD to adjudicate water in times of water shortages. Accordingly, it is paramount that the City secure and maintain suitable water rights to meet long term municipal needs. Failure to comply with the requirements and conditions of the City's water rights permits and certificates may result in the restriction or loss of the affected water source.

6.2.2 Reliability and Resiliency of Water Sources

In general, reliability is a measure of how likely the system is to fail and how severe the consequences of failure may be, and resiliency is a measure of how quickly it can recover from a failure Consideration of these criteria can assist in the evaluation and selection of design or operating alternatives.

6.2.2.1 Water Source Reliability

There are two main reliability factors to be evaluated when considering water sources, namely the reliability of the water sources to produce water in sufficient quantity and quality, and the pumping & conveyance reliability (ie. the ability to pump or otherwise convey the water from the source to the point of entry to the distribution system. The City's water source system (sources as a whole) can be considered to have failed when they cannot meet the demands placed on the water system by the users.

The City's water sources (individually) can be considered to have failed when any single source is not able to provide water to the system.

The following standards are recommended to ensure a high level of reliability for the water source system as a whole:

- Two or more sources of water supply should be developed with a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying MDD.
- When the largest single source is out of service, the remaining sources should be able to satisfy MDD (capacity with the largest single source out of service is referred to as firm capacity). Outages or maintenance periods caused by equipment failures may last from several days to several weeks. The remaining sources in the system should have the capacity to provide MDD. In the event of an extended outage, it is not uncommon to assume that a public notification process will be utilized to encourage or require water conservation.
- Pumps at well sites should be provided with auxiliary power (ie. generators) unless provisions can be made for a power connection to two independent primary public power sources. Since providing independent primary power services to the well sites is not typically possible for the Dayton sources, auxiliary power is the only feasible option to address this issue.

6.2.2.1.1 Water Source Production Reliability

Interruptions to water source production can occur due to problems with a given well or spring. Shallow wells can be subject to a higher contamination potential than deeper wells. Contamination may be the result of a commercial or industrial accident, or a well or spring can be determined to be groundwater under the direct influence (GWUDI) of surface water. Changes in the quality of the groundwater (independent of well depth or spring construction) can also jeopardize water production, and the absence of suitable water treatment may require a given well or spring to be taken off-line. If a well or spring is unable to produce water of sufficient quality to allow for use (with or without treatment as applicable, the source can be considered to have failed).

6.2.2.1.2 Water Source Pumping or Conveyance Reliability

Even if a water source is capable of producing water, if the system is unable to deliver the water to the point of treatment or storage, the source can be considered to have failed (failure to deliver water from storage to the point of use is a failure of the distribution system). Interruptions to water conveyance can occur due to a failure of the equipment used to deliver water from the well (typically failure of the well pump and/or the electrical service to the pump), or from a spring (typically failure of a transmission line between the spring and the point of treatment or storage).

As noted above, pumps at well sites should include provisions for auxiliary power. Permanent on-site auxiliary generators installed at each well site (with automatic transfer switches) will provide the greatest reliability. While a mobile generator (with a manual transfer switch at each site) can be used to address power failures at individual well sites, it cannot service multiple well sites in the event of an area wide power failure. Since the proper operation of the WTP currently relies on multiple wells operating at the same time, on-site auxiliary power is critical unless provisions are made that will allow the WTP filters to backwash without multiple wells in operation (see Chapter 7 for discussions on this issue).

6.2.2.2 Water Source Resiliency

The resiliency if the City's various water sources has both a subjective and an objective component, depending on the type of failure experienced. As noted above, source resiliency is a measure of how quickly a source can recover from a failure. For wells, resiliency due to a well pump or motor failure are dependent on the availability of replacement well pumps, motors or controls, as well as the availability of local contractors with the equipment and skills to replace the failed components. Resiliency due to failure of the methane strippers (at the wellfield wells) are similarly based on the availability of local replacement parts (pumps, blowers, controls, etc). However, resiliency due to changes in water quality (to the point where existing treatment systems are no longer adequate) are typically dependent on availability of funding to design and construct upgrades to the treatment system, so the consequences of these type of changes are typically more severe and longer lasting.

6.3 FEDERAL STORAGE

The US Corp of Engineers (COE) currently operates a total of 13 reservoirs within the Willamette Basin to impound water for the purposes of flood control, generation of hydroelectric power, and other conservation uses including water supply. In 1954 the State allocated water rights for the Federal storage volume as irrigation rights, a development that continues to prohibit the OWRD from issuing water rights from this storage source for municipal purposes. As such, the stored water in federal reservoir projects is not presently available for municipal users, and utilization of this water for municipal purposes would require approval from the State of Oregon (in addition to entering into an agreement with the COE to purchase a portion of the *uncontracted* (ie. unallocated) storage volume in the federal impoundments). While much of the water stored in COE impoundments is contracted for designated uses, there are significant quantities of *uncontracted* water that are theoretically available for purchase from the COE. However, the cost to purchase such *uncontracted* water (once the water rights/water use issues are addressed) is unknown at this time.

The acquisition of new municipal water rights is becoming increasingly challenging and many municipalities in the northern Willamette Basin, including Dayton, have long term water needs that exceed either their water rights or the available water from their sources. The need for water to offset the unavailability of new groundwater rights, the outright unavailability of water from existing water sources, and the need for redundant sources, makes Federal storage an attractive consideration for many municipalities. The primary advantage of this approach is that this source is likely to be more reliable than a newly acquired water right with a junior priority date, since storage releases are not considered as part of the natural streamflow, and thus are not subject to the same restrictions as a junior water right during lower flow conditions.

Municipal access to Federal storage is viewed as one of a limited number of options to serve municipal demands in the long term and will likely play a role in municipal water supply after the City's water rights are fully developed, particularly if the regional water supply options discussed below (based on treatment of Willamette River water) are implemented.

6.4 WATER SOURCE EVALUATION

The City currently utilizes 10 municipal groundwater wells and a series of springs. A detailed summary of these sources was presented in Chapter 4. Well logs for each well appear in **Appendix E**. The location of the various wells and springs were shown on the figures in Chapter 4.

Previous studies and reports indicate the presence of two aquifers in the study area. One is the basalt aquifer located in the hills north of Dayton, and the other is a sand and gravel aquifers of alluvial water bearing sections overlaid by a clay and silt dominated layer.

6.4.1 Water Use Regulations (Water Rights)

A summary of Oregon water use regulations (water rights) is contained in Chapter 3.10. A summary of the City's existing water rights permits and water rights certificates is contained in Section 4.3.1. The City currently holds water right *certificates* on the watershed springs, the watershed wells (McDougal), and the in-town wells, but only holds water rights *permits* on the wellfield wells.

Oregon's water code provides that a new water rights *certificate* may only be issued for the quantity of water that the certificate holder has demonstrated can be beneficially used. Once a water source is developed to the maximum feasible capacity within the permit time period, the permit holder is required to submit a claim of beneficial use (COBU) certifying the amount of water that can be pumped and put to beneficial use. Procedurally, the COBU pumping rate will typically define the final water rights certificate rate. From a regulatory perspective, once OWRD approves a water rights certificate, the permits for a given source are closed out, and the difference in pumping rate allowed under the permit versus the final certificate flowrate are typically forfeited.

However, once a water rights certificate is issued, the City can typically retain the rights to the flowrates allowed under the certificate, even if the City does not continuously apply that amount to beneficial use, or if a particular well is no longer capable of producing the certificate flowrate. In concept, this allows City's to transfer excess capacity from one well to a new well (ie. a separate point of appropriation), with the combined flowrates equaling the certificate flowrate.

6.4.2 Water Rights Strategy

In the Willamette Basin and Yamhill sub-basin, all groundwater is over-appropriated, and it is expected that no <u>new</u> ground water rights permits will be approved by OWRD in the foreseeable future. Therefore, the City will need to maximize the use of their existing water rights certificates and/or permits, in addition to pursuing other water source options.

Table 6-1 lists the permitted/certificated flowrates from each of the City's water sources, along with the estimated long-term production rates, and the excess water rights that the City currently has (but for which water is not physically available at the current approved withdrawal rates).

Table 6-1 Water Right Permit/Certificate Rates vs. Estimated Long Term Production Rates

Source & Priority Date	Certificate Rate (1) (gpm)	Permit Rate (1) (gpm)	Estimated Long Term Production Rate (2) (gpm)	Difference gpm
West (Lower) Springs, Dayton Watershed (1904)	50	-	50(3) (20 summer)	0
East (Upper) Springs, Dayton Watershed (1960)	63	-	63(3) (25 summer)	0
McDougal Well #1 (1960)	300	-	30	270
McDougal Well #2 (1972)	76	-	65	-4
Post Office Well(4) (1960)	76	-	-(4)	-
Flower Lane Well (1960)	224	-	25	199
11th Street Well (1978)	100	-	25	75
Wellfield Well 1 (1996)	-	300	40	260
Wellfield Well 2 (1996)	-	300	40 (Lafayette)	260
Wellfield Well 3 (1996)	-	300	90	210
Wellfield Well 4 (1996)	-	300	70 (Lafayette)	230
Wellfield Well 5 (1996)	-	300	60 (50% Lafayette)	240
Totals	889	1,500	490 summer 350 w/out Laf owned wells)	1,740

(1) See Table 4-1

(2) See Table 4-3

(3) Combined long term production rate from both watershed spring sources is estimated at 45 gpm during the summer (113 gpm during the winter).

(4) Estimates of irrigation flows for parks from Post Office Well is beyond the scope of this Water Master Plan, and will need to be evaluated separately by the City.

The City has certificated water rights totaling 889 gpm (watershed springs & wells, in-town wells), and permitted water rights totaling 1,500 gpm (wellfield wells), for a total of 2,389 gpm for all sources. The difference shown represents the difference between the amount of water the City is authorized to utilize and the amount that is currently counted as available from the City's existing water sources for planning purposes.

6.4.2.1 Existing Water Rights Permits

As shown in **Table 6-1**, the estimated long term production rates available from the wellfield wells (Wells 1 through Well 5) are presently significantly less than the permitted discharge rate. Before the City submits the COBU for the wells in the Dayton-Lafayette wellfield, they will need to ensure that the wells are operating at their maximum efficiency, so that the City obtains water rights certificates for the maximum amount of water that is available at these locations. The City should coordinate with their hydrogeologist and water rights examiner (GSI Water Solutions) regarding the process for submitting claims of beneficial use (COBU) for the five wells in the wellfield to OWRD, and any other testing or documentation that must be submitted.

If the estimated long term production rates for the wellfield wells remain significantly lower than the permitted discharge rates, the City may wish to evaluate whether a water rights transfer to additional points of diversion is feasible. It is anticipated that any such additional points of diversion will need to be within the same groundwater basin (ie. within the Palmer Creek Basin), but may not need to be on the same property as the existing wells. However, they would need to be relatively close to the existing transmission main (between the wellfield and the WTP) to avoid excessive costs to connect to the existing Dayton system.

The practical difficulty with transferring a portion of the wellfield water rights to new points of appropriation is that this is not provided for under the Settlement Agreement discussed in Section 4.2.2.2. Any such proposal would like have to be approved by the other parties to the wellfield water rights settlement agreement. Investigation of the acceptability of such a proposal is beyond the scope of this water study, and will not be considered further at this time. For purposes of this report, it is assumed that water available to the City from the wellfield wells is limited to the estimated long term pumping rates listed on **Table 6-1**.

Although we are not counting on additional sources west of Dayton (along the raw water pipeline) for planning purposes, we recommend that the City investigate potential locations where additional wells might be able to be installed along the raw water pipeline from the wellfield, as discussed in the recommendations section of this chapter.

6.4.2.2 Existing Water Rights Certificates

As shown in **Table 6-1**, the estimated long term production rates available from the in-town wells and the McDougal Wells is also significantly less than the allowable discharge rate under the water rights certificates. The long term production rates for the watershed springs is estimated to equal the existing water rights certificate rates.

As with the wellfield wells, the City may wish to evaluate whether water rights transfers to additional points of diversion is feasible for the in-town wells and the McDougal wells. It is anticipated that any such additional points of diversion will need to be within the same groundwater basin (ie. within the Miller Creek Basin for the McDougal wells, and within the Palmer Creek Basin for the in-town wells).

From a baseline vantage point, the City has adequate existing water rights to serve its core municipal needs throughout the planning period, **IF** they had sources that could produce the permitted water rates. The best-case water-rights scenario is that the City is able to find locations to install additional points of diversion under their existing water rights (to fully utilize the flowrates allowed under the existing water rights permits and certificates). A worst-case scenario assumes that the City cannot utilize any more of their existing water rights than is currently available from the existing water sources, and that it is not economically feasible to utilize the watershed springs if they are determined to be GWUDI sources that must be treated to surface water standards.

Although we are not counting on additional sources within or east of Dayton (along the raw water pipeline) for planning purposes, we recommend that the City investigate potential locations where additional wells might be able to be installed, and excess water rights from existing wells transferred to the new wells, as discussed in the recommendations section of this chapter.

6.4.2.3 Additional Water Rights (Purchase & Transfer)

As previously discussed, new groundwater rights are generally no longer available in Western Oregon. However, existing water-rights can be purchased (with or without purchasing the land to which the water-right is attached), and an application submitted to the WRD to modify the type of use allowed (ie. from agricultural to municipal), and to modify the approved point of use to match the City's current water use area.

Currently, agricultural users consume the majority of the nearby groundwater capacity. In an effort to ensure that reliable water supplies are available in the future, the City should consider the purchase of early water rights from nearby agricultural users, as these water rights or land become available. This will shift a portion of the finite groundwater capacity from agricultural usage to municipal usage. As noted above, the City would have to file a water rights transfer to change the use from agricultural to municipal, and to change place of use.

Transferable water rights with early priority dates that produce significant amounts of water in the surrounding area are not normally available except when purchased as part of the purchase of an existing farm. Although the City should purchase these water rights if and when they become available, there is no guarantee that the option will arise to purchase existing water rights with early priority dates, and therefore may not be a feasible long term solution for water supply.

As touched on briefly in Section 4.2.2, many of the existing early priority date water rights draw water from relatively shallow, higher producing aquifers. While the shallower nature of the agricultural aquifers results in higher producing wells, it also raises the risk of GWUDI issues when these wells are used as a municipal water source. As part of the evaluation and investigation prior to purchase of an agricultural groundwater right, the City should also get a determination from the ODWP as to the susceptibility of the well from a GWUDI perspective. A high producing, early priority date groundwater well with GWUDI issues may still be worth purchasing, but it would require a surface water treatment facility (which should be considered in conjunction with the purchase price of the water-right.

Although we are not counting on the purchase of new water rights for planning purposes, we recommend that the City investigate the purchase of existing groundwater rights that may be associated with agricultural land surrounding Dayton, as discussed in the recommendations section of this chapter. This recommendation is based on the water right owner's willingness to sell, and thus may or may not provide additional water supply within the planning period.

6.4.3 Regional Water Supply System Options

As previously noted, in 2008 Yamhill County completed the "Yamhill County Water Supply Analysis", which examined both the status of existing municipal water supply sources within Yamhill County, as well as options for increasing supply sources. As was noted in that report, the options available for individual small municipalities for increasing their water supply sources (or obtaining new sources) are limited at best. A number of options considered in the 2008 County Water Supply Analysis dealt with the development of a regional water system, whereby the various cities would construct interties to share existing sources and/or develop new sources that could be used as a regional water supply. As noted above, one of the stipulations of the May 2000 Settlement Agreement was that both Dayton and Lafayette committed to "*integrate into the Cities' ongoing water master planning. . . a preference for regional water supply development to meet future needs*" (agreement 2b).

Regional water supply options presented in Section 5 of the 2008 Yamhill County Water Supply Analysis that most apply to Dayton include utilizing the McGuire Reservoir (either alone or in conjunction with Walker Reservoir), or constructing a surface water treatment plant on the Willamette River.

One of the options presented in the 2008 Yamhill County Water Supply Analysis was to have the City of Dayton cooperate with other Yamhill County cities (including the City of McMinnville) to develop a regional water treatment plant that draws water from the Willamette River. Subject to acquisition of water rights, such a treatment plant could either utilize either natural river flows, or utilize water drawn from federal storage in COE impoundments located in the Willamette basin. As noted in the study, public perception of the Willamette River as a supply source is generally negative, although recent developments such as the Wilsonville Water Treatment Plant and the City of Dundee's interest in a Willamette River Plant has improved that perception. If Willamette River surface water rights can be secured, the water will have to pass through an extensive treatment process, which will affect the overall cost of this option. The 2008 study (section 5.4.1) discussed several locations for siting a Willamette River intake and water treatment plant for a regional water system. Sites reviewed included locations near Dayton, Dundee or Newberg.

Historically, local concern with Willamette River water quality centers around the "Newberg Pool", the portion of Willamette River that stretches from the mouth of the Yamhill River to Willamette Falls. There are two areas of primary concern, namely water quality and fish deformities. The first is based on pollution in river sediments from existing and historical industrial discharges from facilities located within and downstream of Newberg. However, these industrial discharge concerns do not affect the water quality upstream of Newberg (ie. at Dayton or at Dundee).

Another historical public concern about the Newberg Pool relates to the high incidence of skeletal and spinal deformities in certain species of resident (ie. non-migratory) fish in this section of the Willamette (being roughly twice the rate observed in portions of the river further upstream). A multi-year study completed in 2004 by a multi-disciplinary team of OSU scientists definitively demonstrated that the deformities were caused by two types of fish parasites which burrow into the bone of young fish and disrupts normal bone development (study presented at the Wilsonville Water Quality Forum 6/30/04). Unlike chemical pollutants, the fish parasites represent little or no risk to human health, as cooking or freezing will kill the parasites in infected fish.

As discussed in more detail in Chapter 7, one potential location for a Willamette River intake structure and pump station was identified on the outskirts of Dayton (ie. southwest of Neck Road), located immediately adjacent to the Dayton UGB. The east bank of the Willamette River banks in this area is more stable than the portions of the river between Dayton and Newberg. This location is also upstream of the "Newberg Pool", which will help alleviate negative public perception related to treating Willamette River water for municipal use.

6.4.4 Existing Sources, Water Production Reliability

Discussions with the City's hydrogeologist reveals that groundwater levels in the City wells is declining over time. Static water levels are recorded periodically in each of the operating wells, and the City should continue to monitor water levels and adjust well pumping rates to minimize further declines in static water levels. We strongly recommend that the City operate the wells for long-term sustainability (even if it means restricting production), rather than operating the system to meet short term demands.

Below is a synopsis of the water *production* reliability evaluation of the City's existing water supply sources.

Watershed Springs, Production Reliability

As noted in Chapter 4.3.2, the watershed springs require significant work to bring them into conformance with ODWP requirements for spring sources, and to comply with requirements of the Groundwater Rule. Failure to comply with these requirements will likely result in the springs being determined to be groundwater under the direct influence (GWUDI) of surface water, which will result in these sources being unavailable to the City without treatment meeting surface water treatment standards.

Therefore, until the springs are upgraded and it is demonstrated that they can remain as groundwater sources, they cannot be considered to be reliable sources. If the springs can be upgraded to avoid the surface water influence issues, they are anticipated to remain as reliable sources for the City, as the water quality is otherwise very good. Alternatively, if the springs cannot be upgraded, construction of a treatment plant to treat the spring water to surface water standards would also allow the springs to remain as reliable water sources.

An evaluation of the improvement and potential treatment requirements for the watershed springs is discussed further in Chapter 7.

McDougal Wells, Production Reliability

Although the ODWP expressed concern about whether the McDougal Wells were subject to surface water influence, testing performed by the City in 2007 and 2008 (see Chapter 4.3.3.2.1) demonstrated that these wells were not surface water influenced, and they should be considered as reliable production sources for the study period, albeit at discharge rates significantly less than allowed under the water rights certificate for McDougal Well 1.

Flower Lane Well & 11th Street Well, Production Reliability

Although these wells are high in iron and manganese, the currently discharge to the WTP, with the treated water being mixed with the treated wellfield water and sent to the distribution system. We are not aware of any production issues with these wells, and they should be considered as reliable production sources for the study period.

Post Office Well, Production Reliability

As noted in Chapter 4.3.3, this well is not currently in use as a production well for domestic water, but is currently used only for irrigation water for the Courthouse Square park. Additionally, the 2004 ODWP Source Water Assessment deemed the construction of this well as inadequate due to the lack of any information on a well seal on the original well log. Also, this well has high levels of iron and manganese (as well as reported problems with hydrogen sulfide), but a raw water line to the City's WTP was not constructed as part of the 2004 water project. If the City does decide to utilize this well as primary production source for domestic water, testing similar to that performed on the McDougal Wells will likely be required, as well as construction of a raw water pipeline to the WTP. Based on this, the Post Office well cannot be considered to be a reliably available source for domestic water during the study period.

Wellfield Wells 1-5, Production Reliability

The wellfield wells produce water that, after treatment at the WTP, is consistently of good quality. Once Well 1 and Well 3 are upgraded with a VFD and flowmeter to allow discharge control based on flowrate, all of the wellfield wells will be capable of producing at a defined water discharge rate while controlling drawdown to levels that remain above the screens.

Although the production rates of the wellfield wells are significantly less than was originally anticipated (and less than the water rights permit rates), they appear to be capable of consistently producing water during the planning period. The greatest risk associated with the reliability of these wells (besides the fact that they can only be used as a secondary source) is that the water rights conditions and the settlement agreement dictate that if the water level declines more than certain trigger levels, that the City must curtail production from these wells. However, implementation of the automatic discharge control strategy noted above also allows the City to control well pumping rates to better control long term water level declines.

Another issue with the wellfield wells in the issue with iron bacteria bio-fouling of the well screens. The City has already had to rehab several of the wellfield wells due to this issue (most recently Well 4 in 2009). Discussions with the City's hydrogeologist (GSI Water Solutions) indicate that apparently some of the area farmers also struggle with this issue of bio-fouling of well screens. It does not appear to be unique to the City wells, but is believed to be due to the particular water chemistry in this aquifer. Based on experience to date, the City will need to budget to rehab the wellfield wells on a regular, rotating basis. The initial recommended rehabilitation frequency is every five years for each well.

6.4.5 Existing Sources, Pumping or Conveyance Reliability

The City relies heavily on the hydraulic capacity and mechanical reliability of the well pumps to deliver water to the distribution grid for consumption (either directly as with the McDougal wells, or indirectly through the WTP as with the in-town and wellfield wells). Unlike some municipalities that utilize topographic relief and gravity-fed water sources, all of the water in Dayton (other than the watershed springs) must be pumped from the source. The failure of a well pump whether stemming from mechanical or electrical causes, diminishes the availability of water for municipal needs.

Below is a synopsis of the *pumping or conveyance* reliability evaluation of the City's existing water supply sources. Discussions related to reliability of the distribution system pumps (at the WTP) are discussed in Chapter 7.

Watershed Springs, Conveyance Reliability

As noted in Chapter 4.6, the existing waterline which conveys the spring water to the watershed storage reservoirs, and from thence to town, is 1930s vintage steel waterline that is well past the end of its service life. The City has repaired the portion of the transmission main between the springs and the reservoirs a number of times over the past several years, and the line exhibited significant corrosion. Since this is the lowest pressure segment of this line, it must be assumed that the higher pressure portions of this line are also in poor condition. A significant portion of the waterline alignment between the reservoirs and McDougal Road runs through the woods along an unknown alignment, which means that the City is not able to regularly patrol the waterline alignment and check for leaks. The replacement of the old steel waterlines from the watershed to town should be considered as a critical priority. Since the springs flow to town by gravity, auxiliary power is not required.

McDougal Wells, Flower Lane Well & 11th Street Well, Pumping and Conveyance Reliability

The McDougal, Flower Lane and 11th Street Well pumps are relatively small submersible pumps of a size that is readily available from local suppliers, and which can be easily services or replaced by local well contractors. The discharge lines from the McDougal Wells are relatively short, are readily accessible to City forces, and are located on property owned by the City. The discharge lines from the Flower Lane and 11th Street wells run along public rights-of-way to the WTP, and are readily accessible to City forces. The City has equipment to repair any leaks that may develop in the conveyance lines from these wells.

None of these wells have provisions for auxiliary power. Since the City relies on these wells to feed the WTP, improvements to provide for auxiliary power are recommended early in the planning period.

Post Office Well, Pumping and Conveyance Reliability

The pump for the Post Office Well is also of a size and type that is readily available from local suppliers, and which can be easily services or replaced by local well contractors. As noted in Chapter 4.3.3.2, the location and alignment of the discharge line from this well to the Courthouse Square Park irrigation system is unknown, although it is believed to be a 1930s vintage steel line. Since utilizing this well for irrigation of the park results in significant savings of water as opposed to using treated water from the distribution system, the replacement of the irrigation line should be addressed by the City early in the planning period.

This well does not have provisions for auxiliary power. Since it is used solely as an irrigation well, auxiliary power is not considered to be necessary for this installation, as power outages during the irrigation season are typically short, and loss of irrigation water for even a few days is not critical.

Wellfield Wells 1-5, Pumping and Conveyance Reliability

The pumps for the Wellfield wells and methane strippers are also of a size and type that is readily available from local suppliers, and which can be easily services or replaced by local contractors, as are the VFDs that control the well pumps and the methane stripper booster pumps.

Each of these wells is provided with a generator receptacle and a manual transfer switch, although the City would have to rent multiple generators in order to run these wells at the same time. Since the proper operation of the WTP filters (especially the backwashing cycle) requires operation of multiple pumps to provide adequate flows, improvements to provide for on-site auxiliary power at each site is recommended early in the planning period.

6.4.6 System-Wide Water Source Reliability

Three criteria for evaluating source reliability were introduced in Section 6.2.2.1, and each are addressed in turn.

Clearly the goal of these design criteria is to ensure the uninterrupted supply of drinking water during periods of maximum use; however, there are other standards and operating modes that can be applied to achieve the same outcome. As future sources or storage reservoirs come on-line, the ability to buffer or ride-out short period MDD demands is improved. Water conservation is another approach that can be used to reduce the demands placed on a utility during periods of maximum use.

- *Two or more sources of water supply should be developed with a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying MDD.*

Under the existing system, fire flows of 4,000 gpm for a 4-hour duration (960,000 gallons) can be satisfied by a combination of the existing 1.5 MG ground storage reservoir at the WTP and the reservoirs in the watershed once the recommended improvements are made.

Below we analyze the ability to refill the reservoir under two scenarios. The first scenario involves the water system operating under existing conditions (ie. prior to replacement of the remaining steel waterlines) under both present day MDD and future MDD. The second scenario assumes that the City replaces the old steel waterlines and reduces the system losses to 15%.

> *Scenario # 1 (no system loss reduction)*. Assuming the system is operating at present day (2010) MDD levels, the complete recharge of the fire suppression storage volume is not possible, because the present day MDD is 0.744 MGD and the estimated long-term production rate of the City's sources is only 0.504 MGD (about two thirds the present day MDD). Therefore, the City cannot even meet the current MDD without over-pumping their existing wells.
>
> To replenish the fire suppression storage in 72 hours meet this criteria in 2010, the City would need a current water production rate of approximately 0.941 MGD (653 gpm). To meet the criteria in 2030, the City will need a production rate of approximately 1.410 MGD (979 gpm).
>
> *Scenario # 2 (system loss reduced to 15%)*. Assuming that the present day (2010) demand is reduced through water conservation and system leakage repair (for a system-wide leakage rate of 15%), the 2010 MDD would be approximately 0.413 MGD. The reduced MDD of 0.413 MGD (286 gpm) is less than the current long-term production rate of 0.504 MGD (350 gpm). Under these conditions (reduced MDD & all sources in operation), the City could refill the reservoirs in approximately 4.4 days (longer than the 72 hour requirement). Even with the reduced system loss, the City would need a long term supply of 0.733 MGD (509 gpm) in order to replenish the reservoir in 72 hours (approximately 159 gpm more than the current long-term production rate). Therefore the City still wouldn't be able to meet this criteria.
>
> In 2030 (end of the planning period), the City's reduced MDD (15% leakage) would be approximately 0.739 MGD (513 gpm). The source production rate in 2030 required to meet MDD and replenish the fire suppression storage in 72 hours would be approximately 1.059 MGD (735 gpm), which is just over double the 2010 estimated long-term production rate of the City's sources.

Since the City cannot replenish the fire suppression storage under either of these scenarios, it is evident that the City needs additional water sources to meet this water supply criteria. As the City continues to grow, the need for additional sources will become even more critical.

- *When the largest single source is out of service, the remaining sources should be able to satisfy MDD (capacity with the largest single source out of service is referred to as firm capacity).*

As noted in **Table 6-1**, the City's current water sources have an estimated long-term production capacity of 350 gpm (without counting water from the Lafayette wellfield wells). The largest single source is Wellfield Well 3, with an estimated long-term production rate of 90 gpm. Without Well 3, the firm capacity is approximately 0.374 MGD (260 gpm). The 2010 MMD is 0.744 MGD, almost two times the firm capacity of the existing sources. If the system leakage was reduced 15%, the 2010 MDD would be approximately 0.413 MGD (287 gpm), still about 27 gpm more than the available firm capacity of 260 gpm.

The City cannot meet this criteria based on the 2010 MDD, let alone the future 2030 MDD. Therefore, the City needs to secure additional long-term sources in order to meet this criteria. Although it does not solve the problem, the City should work to reduce the overall system leakage, as it makes the scope of the problem significantly less severe, and the amount of new source water required in the future can be reduced.

- *Pumps at well sites should include provisions for auxiliary power.*

An important measure of reliability is the provision of an emergency power source for each well site. Since the infrastructure for two separate and independent primary power feeds to each well site does not exist, this requires the reliance on on-site power generation.

Although the wellfield wells are currently provided with manual transfer switches and are able to connection to trailer mounted generators, the City does not have generators capable of powering these wells. The main portable generator at the WTP is required to keep the treatment system and the distribution system pumps in operation, and is thus should not be considered as available for use at the well sites. The City would have to rent generators for each of the well sites, which may not be feasible during a major power outage. Additional of on-site generators and automatic transfer switches should be installed at each of the well facilities.

6.5 GROUNDWATER PROTECTION

The federal Safe Drinking Water Act of 1986 requires that every state have a drinking water protection program in place to guard against contamination of groundwater. The City may wish to voluntarily develop a Drinking Water Protection Plan to meet the DEQ and Oregon Health Department administrative rules. The plan is a valuable source of information as it relates to the management of municipal or county lands overlaying the groundwater aquifers in general, and to the identification of potential sources of contamination and municipal emergency responses in particular. Development of such a groundwater protection plan is beyond the scope of this Water Master Plan.

6.6 AQUIFER STORAGE & RECOVERY (ASR) EVALUATION

As discussed in Section 3.10, Aquifer Storage and Recover (ASR) is an option that should be considered by municipalities which have adequate water rights, but with water sources that are not adequate to meet peak demands during the summer months. For an ASR program to be feasible, a city must have a reliable water source available (water rights, etc.) that either meets primary drinking water standards or can be treated to these standards prior to injection into the aquifer, and which is located to allow the water to be economically obtained, treated and conveyed to the injection site. The following is a preliminary evaluation of ASR potential for the City's various water sources (excluding the spring sources). In the future, if any of the assumptions listed are determined to be invalid, the City may wish to pursue these ASR evaluations further.

Wellfield Wells 1-5, ASR Potential

Even discounting any water chemistry issues (ie. interactions between injected water and the existing groundwater), the challenge for the wellfield wells is that the City does not have a water right or water source in this area to use as source water for injecting back into the ground. Use of surface water for injection would require a surface water right, a surface water treatment plant, and transmission lines from the surface water source to the wellfield wells. Even if treated water from town were proposed for use (whether derived from the in-town wells, the McDougal wells or the watershed springs), there is currently no way to get the treated water from town out to the wellfield area (without taking all of the wellfield wells completely out of service, and pumping the water through the existing transmission main).

Since the wellfield serves Lafayette as well as Dayton, and must be available as a supplemental water source during all times of the year to supply water to either city (in the event that their respective watershed sources become unavailable), it is not considered feasible to take the existing transmission main out of service for extended periods of time. Construction of a separate pipeline from town out to the wellfield would be prohibitively expensive, particularly given the number of old and failing pipelines that Dayton still has within the City and the watershed (which need to be replaced).

Another concern would be whether injecting water into the wellfield aquifer would simply be making more water available for withdrawal by the surrounding farmers with senior priority dates on their water rights (ie. once water is injected into the ground, it doesn't stay contained around your well, but can be withdrawn by any well that taps into the same aquifer).

At this time, ASR does not appear to be a feasible option for the wellfield wells.

In-Town wells (Flower Lane, 11th Street, Post Office), ASR Potential

As with the wellfield wells, utilization of ASR for the in-town wells would require (in addition to addressing water chemistry issues) a source of water for use as injection water. Since the in-town wells do not face the same water transmission issues as the wellfield wells, they may warrant further evaluation if such a water source becomes available in the future.

At this time, ASR does not appear to be a feasible option for the in-town wells.

McDougal Wells, ASR Potential

Assuming that the watershed springs can be improved to address all primary drinking water standards, they could theoretically be available as a source of injection water for the McDougal Wells. However, under the water rights agreements that the City obtained for the wellfield, the McDougal wells and watershed springs (along with the in-town wells) must be utilized as the City's primary water source, with the wellfield wells serving only as a supplemental supply source (ie. when the primary sources have inadequate capacity to serve the City needs).

Based on this premise, the only watershed water available for ASR injection would be excess production (if any) from the watershed springs which is beyond that needed to supply Dayton's winter usage demands. During most periods of the year, the water from the McDougal Wells & the springs is needed just to meet the City's normal water demands (ie. if the wellfield sources are not counted, the City does not have much, if any, excess water most of the time).

At this time, ASR does not appear to be a feasible option for the McDougal wells. If the City is able to increase the production of the watershed spring area and obtain additional water rights (which is not considered likely), additional evaluation may be warranted.

Use of Surface Water for ASR

Even if the City were to construct a surface water treatment plant (or participate in a regional WTP), it would make more sense to simply use the treated water directly, rather than injecting it into the ground and then paying to pump it back out later (assuming surface water rights allowed for the use of the surface water during the summer months). Since the location (evaluated in this study) for a regional surface water treatment plant source is on the Willamette River southeast of Dayton, the challenge would still be to get the water from the point of treatment to the proposed point of injection (ie. through pipelines).

Hypothetically, if the water rights for the future surface water plant only allowed for water withdrawal during the winter months, it might make sense to use the treated water for ASR purposes during the winter. However, under such a restricted water rights scenario, it is unlikely that a regional surface water treatment plant could even be financed or constructed (since the Yamhill Valley region needs the water most during the summer, not during the winter).

Utilization of surface water as an ASR injection sources does not appear to be a feasible option, now or in the future.

6.7 Recommended Approaches & Improvements

Based on the above discussions, it is clear that the City must secure new long term reliable water source(s) in order to maintain long term growth. Since it is unlikely that this issue will be resolved by any single solution, the City should proceed along a number of different avenues in order to be prepared to take advantage of opportunities as they may arise in the future. The discussions below summarize recommendations related to some of these various different approaches. In some cases, the proposed approaches combine various aspects of the different categories listed below, so the divisions below may be somewhat arbitrary. The City should begin implementing these recommendations in the very near future since the current available firm water supply is very close to the present MDD.

The recommended improvements and studies are summarized in **Table 6-2** (at the end of this chapter).

6.7.1 Water Loss Reduction (Transmission & Distribution Improvements)

As discussed in Section 5.4.7, the water loss experienced by the Dayton in-town distribution system is only about 22%, while losses from the watershed transmission system is still more than 60,000 gpd.

Although a water loss ratio of zero is desirable in theory, it is not typically feasible given the complexity and practical realities associated with municipal distribution systems. A typical and reasonable water loss ratio goal for small municipalities is a 10% to 15% loss rate.

When prioritizing water system improvements, the City should bear in mind that reduction in distribution system leakage is actually equivalent to obtaining new sources (since more water is available for use to meet consumption requirements). It has the additional benefit of reducing the unit cost required to produce water from the City's existing sources, since the City is no longer paying for producing and treating water that leaks into the ground (ie. the City is already paying to produce and treat the leakage water, but does not receive any revenue from this water since it does not pass through a water uses meter).

Further reduction in water losses from the in-town distribution system and replacement of the watershed transmission main will have the same effect as increasing the source production available for use by consumers.

Recommendations for distribution system improvements that will reduce water loss (and increase the effective volume available from the City's existing sources) are included in Chapter 8.

6.7.2 Water Rights and Regulatory Issues

There are two areas related to water-rights that need to be addressed by the City during the study period. The first relates to work associated with converting existing water rights permits to certificates, and the other relates to maximizing the use of water under the existing water rights permits and certificates.

6.7.2.1 Water Rights Transfers to Fully Utilize Existing Water Rights Permits

As discussed above, the water rights in the wellfield are currently at the permit stage, and the City will need to apply to convert these to certificates at some point in the future. The estimated long term production rates available from the wellfield wells (Wells 1 through Well 5) are presently significantly less than the water rights permit rates. Before the City applies for a water rights certificate for the Dayton-Lafayette wellfield, we recommend that the City pursue the following course.

We recommend that the City retain GSI Water Solutions (or a comparable hydrogeology/water rights firm) to prepare maps of potential locations where additional wells might be able to be installed along the raw water pipeline from the wellfield, and to approach property owners in that area (and the parties to the settlement agreement) to investigate the potential for obtaining authorization to install additional wells. If such an agreement can be reached and additional wells installed, the source water assumptions in this Master Plan should be updated to reflect this new information.

Recommended budget numbers for such an investigation are included in Chapter 12.

In addition, the City should continue monitoring of the wellfield wells, conduct test pumping to verify production rates and well efficiency, and prepare the COBU, etc. at appropriate time.

6.7.2.2 Water Rights Transfers to Fully Utilize Existing Water Rights Certificates

As discussed above, the water rights for sources other than the wellfield wells are at the certificate stage. However, the estimated long term production rates available from the in-town wells and the McDougal Wells is significantly less than the allowable discharge rate under the water rights certificates. The long term production rates for the watershed springs is estimated to equal the existing water rights certificate rates.

We recommend that the City retain GSI Water Solutions (or a comparable hydrogeology/water rights firm) to prepare maps of potential locations where additional wells might be able to be installed (either in town where additional raw water pipelines to the WTP could be installed, or along McDougal Road where wells into the basalt aquifer may be feasible and could connection to the watershed transmission line), and to approach property owners in that area to investigate the feasibility of for obtaining permission to install additional wells. If such an agreement for additional wells can be reached with property owners, the source assumptions in this Master Plan should be updated to reflect this new information.

Recommended budget numbers for such an investigation are included in Chapter 12.

One location for an additional well that should be investigated is the existing WTP site at the west end of Ferry Street. It appears that the 50 foot radius of control required around the well site (as required by ODWP rules for areas with sewer systems) can be provided in either the northeasterly or the northwesterly corner of the WTP/reservoir site).

In addition, if the existing springs cannot be upgraded to allow them to be utilized without the need for a surface water treatment facility (due to GWUDI issues), we recommend that the City retain GSI Water Solutions (or a comparable hydrogeology/water rights firm) to investigate the possibility of transferring the springs water rights to groundwater wells drilled in the same vicinity.

6.7.2.3 Purchase Early Priority Date Groundwater Rights

As discussed above, it is also recommended that the City search for potential early priority date transferable water rights and purchase them based on availability. In order to allow the City to evaluate the availability of water-rights that may be associated with agricultural land surrounding Dayton and along the raw water pipeline (if and when such land comes up for sale), we recommend that the City retain GSI Water Solutions (or a comparable hydrogeology/water rights firm) to prepare maps of land surrounding the City which has existing groundwater rights and/or wells that could be integrated into the City system if they were purchased.

Recommended budget numbers for such a study are included in Chapter 12.

6.7.2.4 Water Conservation Plans & Policies

As the City faces growing demands and limited resources, water conservation will play an increasingly important role in managing water resources. Conserved water becomes a new and relatively inexpensive source of water for the City.

As noted under Section 3.12 and Section 4.2.2, the City was required to prepare a Water Management and Conservation Plan for review and approval by the Water Resources Department (WRD). The requirement for completing this plan is tied to both the settlement agreement for the wellfield wells, as well as a condition of the water rights for this well.

The City should verify that the WMCP approved by the City Council in March 2004 was also submitted to and approved by the WRD. The WMCP is typically updated on 10 year intervals (ie. 2014), which will fall during the early part of the planning period.

Recommended budget numbers for the WMCP update are included in Chapter 12.

The City should also develop a long-term water conservation program, including an update of the City's emergency water restriction ordinances and/or resolutions. The events that trigger emergency water restrictions should take into account the fact that a significant portion of the WTP reservoir is dead storage and not available to the City without risking damage to the distribution pumps and the fire pump, and the fact that the watershed reservoirs contribute only minor flows during fire flow events (until the watershed transmission main is replaced).

Development of budget numbers for developing such an update to the emergency water restriction ordinance is beyond the scope of this study.

6.7.3 Improvements to Existing Sources

There are a number of improvements recommended to the City's existing water supply sources, as summarized below.

6.7.3.1 Watershed Springs Improvements

Detailed discussions regarding the recommended improvements to the watershed spring sources in contained in Chapter 7, since there are potential water treatment options that must also be evaluated as part of the springs upgrade evaluations.

6.7.3.2 Watershed Leases & Easements

As discussed in Section 4.3.2, the City does not currently own the land containing the watershed springs and filter buildings (they currently lease this land, and hold water rights to the spring water).

We recommend that the City continue negotiating with the property owners regarding the execution of a long term lease agreement, or the purchase of the property and/or execution of permanent exclusive easements covering the springs, access roads, pipelines and structures utilized in collecting, treating and conveying the domestic water for which the City has water rights certificates, and controlling access to the property. As previously discussed, State drinking water rules require the City to be able to control access to their drinking water sources.

If negotiations for a long term lease or purchase of the property are not successful, we recommend that the City Council discuss whether they consider it in the City's best interest to pursue condemnation proceedings to procure this property for permanent City use. This will largely depend on the success of any improvements that the City may construct to bring the springs up to current State standards. If the City elects to improve the springs and they remain available as a long-term municipal water source, the City needs to obtain control of this land to be able to comply with security requirements under State rules and guidelines.

Since either the lease negotiation or condemnation proceedings are largely legal issues, development of budget numbers this work is beyond the scope of this study, and are not included.

6.7.3.3 Removal of Trees around Existing Spring Sand Filter Site

As discussed under Section 4.4.3, there are a significant number of very large trees located close to the sand filter structures that need to be removed before they fall and damage the structures. It is recommended that the City remove all trees that are large enough or close enough to the filter buildings to damage or destroy the roof when they fall, as soon as feasible.

The City is encouraged to obtain quotes from several licensed, bonded tree removal contractors to confirm these estimates, particularly since many of these trees may need to be topped and taken down in sections, and some of them may require the pieces be lined to the ground individually to avoid damage to the sand filter structures. Whatever the cost for removal of the trees, it will be substantially less expensive than the cost to repair any damage caused by falling limbs or trees. If the City cannot afford to take out all of the trees at the same time, they should budget to remove as many as possible each year until the work is completed.

Recommended budget numbers for such tree removal are included in Chapter 12.

6.7.3.4 Auxiliary Power at Existing Wells

Providing auxiliary power at all existing well facilities is viewed as an essential step in maintaining current pumping levels during times of emergency. The existing wells that feed the WTP (Wellfield Wells 1-5, Flower Lane & 11th Street wells), or which feed the watershed service level, cannot currently be considered to be available during an area wide power outage, due to the lack of backup emergency power equipment.

The proper operation of the WTP filters (especially during the backwash cycle) requires multiple wells to be in operation in order to provide adequate flows (ie. 350 gpm), the addition of on-site auxiliary power generators (and automatic transfer switches) at each site (9 wells) is recommended as early in the planning period as possible.

As discussed in Section 9.3.1 and 9.4.1, providing generators at all of the City's existing wells will provide the City with a water storage "credit" equivalent to over 600,000 gallons of standby storage.

Recommended budget numbers to cover the capital costs for the recommended generator improvements appear in Chapter 12.

6.7.3.5 Evaluation of Long Term Production Capacity from City's Existing Wells

During the course of preparing this Master Plan, it became apparent that comprehensive information regarding the efficiency and long term production capacities of the City's existing wells, as well as aquifer evaluations, is not uniformly available. While pump tests and associated evaluations have been performed on some of the wells over the years (usually in conjunction with rehabilitation work), most of this information is years out of date and often does not correspond with well production currently being experienced.

The long-term production rates estimated in Section 4.3.3 are based on the best information available, but are not based on actual current production testing. Conducting detailed well discharge testing and aquifer evaluations are beyond the scope of this master plan, but are critical to the City's ability to accurately plan for future water needs. It is recommended that the City retain GSI Water Solutions (or other hydrogeologist) to assist the City in performing detailed production and efficiency testing on all of the City's existing wells. This can be used to evaluate the condition of the aquifers and to verify assumptions behind the long term pumping rates used in this report (and correct these estimates if necessary).

We recommend that the City budget to have the City's hydrogeologist (GSI Water Solutions) re-evaluate the yield and estimated long-term production capacity of each existing well on no more than a five year cycle.

If a given well long term production capacity drops below the pumping capacity by a significant margin, replacement of the well pump may be in order for energy conservation purposes (rather than throttling back the discharge on an oversized pump).

Recommended budget numbers for such a study are included in Chapter 12.

6.7.3.6 Wellfield Well 1 & Well 3, VFD Control Upgrades

As noted above, Wellfield Well 1 and Well 3 remain to be upgraded to the Automated Discharge Control Strategy as summarized in Section 4.3.3.1 (ie. to match the configuration at Wells 2, 4 & 5). The City plans to proceed with these upgrades as funding becomes available.

6.7.3.7 Wellfield Wells, Rotating Rehabilitation Program

As noted above, the wellfield wells are susceptible to severe iron bacteria well screen bio-fouling problems, which also appears to be a problem common to many of the area irrigation wells. We recommend that the City schedule to rehabilitate the wellfield wells on a regular, rotating basis at five year intervals. Based on this, the City should budget to rehabilitate one wellfield well each year on an ongoing basis.

We assume that these costs will be split with Lafayette as provided under the joint water system IGA.

Recommended budget numbers for this rehabilitation work is included in Chapter 12.

6.7.3.8 McDougal Wells, Discharge Line Improvements

City records indicate that the existing underground discharge lines between the McDougal Wells and the watershed transmission main are steel. We recommend that these steel lines be replaced in conjunction with (or prior to) the replacement of the watershed transmission main.

Recommended budget numbers to cover the capital costs for these recommended improvements appear in Chapter 12.

6.7.3.9 Chlorination Improvements at McDougal Wells

Assuming that chlorination (or treatment) improvements are required at the watershed springs (see Chapter 7), we recommend that the chlorination system at the McDougal Wells be upgraded as summarized below.

Currently the water passing through the watershed transmission line is chlorinated just downstream of the point where the wells connect to the watershed transmission main. This configuration is required to ensure that water from either the wells or from the watershed springs is chlorinated as it flows toward town. During periods of low downstream demand (or no demand), water from the wells flows up the watershed transmission main to the reservoirs (and is not chlorinated). Due to widely varying flowrates due to demand variations, precise control of the chlorine concentrations is difficult at best (ie. flowrates past the chlorine building are based solely on demand, and have no bearing on the production flowrates from either the wells or the springs.

If the watershed springs end up being chlorinated at or near the spring source, the McDougal wells should be retrofitted with chemical feed pumps whose operation is tied to the well pump motor starters (ie. chlorine feed pumps will inject chlorine into the well discharge lines only when the well pumps are operating). This will provide for more precise control of chlorine concentrations, and ensure that all water produced by the wells is chlorinated, whether it flows up toward the reservoirs or down toward town.

Recommended budget numbers to cover the capital costs for these recommended improvements appear in Chapter 12.

6.7.4 New Source Development

This study included discussion about improvements related to new water sources, as summarized below.

6.7.4.1 New Wells

Recommendations related to new wells (either with transfer of existing water rights or the purchase of existing water rights) were discussed above (under recommendations for water rights and regulatory issues).

6.7.4.2 Support Regional Water Source and/or Treatment Options

As discussed in Section 4.2.2, as part of the settlement agreement for the wellfield wells, the City agreed to *"include a preference for regional water supply development to meet future needs"* in their Water Master Plan. Although this is a water source option, it is discussed in more detail in Chapter 7, particularly in relation to a potential future surface water treatment plant on the Willamette River.

It is also recommended that the City support a regional intertie between the Cities of Yamhill County. The regional intertie could provide long-term water supply solutions by allowing Dayton to purchase water from other municipalities that have a more abundant supply. The intertie could also allow Dayton to develop water resources outside of the surrounding area and use the intertie as a transmission conduit or to exchange water with other municipalities.

In particular, the City should also investigate the possibility of interconnection to the McMinnville water system, and purchasing water from the City of McMinnville. Depending on the conditions of such an agreement, if it were to be reached, the City would have to construct a transmission main from the connection point to the McMinnville system to Dayton, as well as a master meter station and pressure regulating equipment if necessary. Since a detailed evaluation of an interconnection with McMinnville is beyond the scope of this master plan, we recommend that if (or when) such a political agreement becomes a possibility, that the City update this Water Master Plan to evaluate the specific alternatives that might be mutually acceptable to the two cities.

It is also recommended that the City support any feasibility study (if initiated by Yamhill County or a regional water supply agency) to determines the availability of Willamette River water via new water rights or Army Corps storage.

Budget numbers for work associated with these options is beyond the scope of this study, and are not included.

6.7.5 Water Source Recommendations Summary Table

The following table is a brief summary of the various water source improvement recommendations developed by this master plan. For more details on particular projects, refer to the discussions in the body of the study.

Table 6–2: Recommended Water Supply Improvements & Projects

Project Code	Project
S-1	Replace steel transmission & distribution lines to increase volume of source water available for consumption (see recommended improvements in Chapter 8)
S-2	Water Rights Permits (Wellfield Wells), investigation study for potential new well sites for water rights transfers
S-3	Water Rights Certificates (In-Town & McDougal Wells), investigation study for potential new well sites for water rights transfers
S-4	If Watershed Springs cannot be upgraded to meet State standards, investigation study on potential for transfer of spring water rights to wells drilled at same site
S-5	Investigate purchase of existing water rights. Investigation study to develop map of all property around City & wellfield with existing senior water rights, contact property owners to determine interest in selling water rights. Purchase property with senior water rights as it becomes available for sale.
S-6	Water Management & Conservation Plan update when required by WRD.
S-7	Update City's emergency water restriction ordinances & resolutions.
S-8	Watershed Springs upgrades (see Chapter 7)
S-9	Watershed long-term lease, exclusive easements and/or property purchase/acquisition.
S-10	Hazardous tree removal at watershed springs/sand filter sites
S-11	Install on-site auxiliary power generators & automatic transfer switches at all City wells (9 wells, excluding the Post Office Well).
S-12	Production testing and evaluation of all City wells by hydrogeologist to verify long term production estimates and determine recommended schedule for rehabilitation at each well (every 5 years).
S-13	McDougal Wells, replace any existing steel discharge lines between wells & watershed transmission main (±300')
S-14	McDougal Wells, chlorination system upgrades (after completion of watershed spring improvements)
S-15	Wellfield wells, rotating rehabilitation program, one well per year (to address production losses due to iron bacteria bio-fouling)
S-16	Wellfield Well 1, VFD control upgrades
S-17	Wellfield Well 3, VFD control upgrades
S-18	Resolution of support for concept of further investigation of regional water source and/or treatment options
S-19	Contact McMinnville to initiate discussions regarding potential inter-tie to McMinnville water system to allow Dayton to purchase supplemental water during period of shortage.

7

CHAPTER 7
WATER TREATMENT EVALUATION

Chapter Outline

WATER TREATMENT EVALUATION

CHAPTER 7

7.1 INTRODUCTION

This chapter builds on the inventory of the City's water treatment infrastructure as presented in Chapter 4, the regulatory requirements presented in Chapter 3, and presents treatment program options designed to achieve regulatory compliance and meet demands during the planning period. The chapter begins with the identification of treatment objectives and a review of historical water quality parameters.

The second half of the chapter addresses treatment recommendations and capacity with regard to future water demands as developed in Chapter 5, discusses the role of the City's watershed springs, and concludes with recommended improvements. Capital costs for the recommendations presented in this chapter appear in Chapter 12.

7.2 TREATMENT OBJECTIVES & PROCESSES

Water treatment in the context of a centralized plant is performed by the aggregate of discrete process units. Each process unit provides a specific treatment role and contributes its 'product' to the flow stream as water passes through the treatment plant. The combination of these incremental treatment steps creates a treatment 'train' whose finished water product is intended to meet the overall treatment objectives as well as regulatory standards.

The WTP should be provided with treatment processes capable of providing current benefit with an operating margin that will allow the City to successfully treat water to meet anticipated near term regulatory requirements. The following paragraphs of this section address different aspects related to the generalized treatment alternatives.

7.2.1 Source Water Characteristics

Treatment objectives vary depending on the source water characteristics (groundwater versus surface water, chemical composition, etc.). As overall municipal demand increase, and if existing or new groundwater sources are not adequate to meet demand, the City will need to development additional groundwater or surface water sources, which may or may not need to be treated. Treatment needs for surface water are significantly more complex, whether the City participates in a regional water treatment option utilizing surface water or develops their own source.

Water from the City watershed sources (wells and springs) is characterized as having good water quality and doesn't require treatment (other than disinfection) prior to entering the distribution system.

Water from the City wells located on the valley floor is generally characterized by moderate to high concentrations of iron and manganese. Wells in the Dayton-Lafayette wellfield also have significant concentrations of methane. It is anticipated that any new wells developed on the valley floor will have moderate to high levels of iron and manganese. Therefore, it will be most cost effective to develop future wells as close as feasible to one of the raw water transmission mains to the WTP.

Water from surface water sources in the Dayton area (Willamette River) will require extensive treatment utilizing a multi-barrier approach (such are screening, sedimentation, filtration, and disinfection).

7.2.2 Taste & Odor

Taste and odor, at objectionable levels, occurs in many water utilities nationwide and although the safety of the water in these systems is not at risk, consumers may perceive that the water is unsafe to drink because it has an unpleasant smell or taste. City does not currently experience significant problems due to this issue, since the wells that previously had this type of problem are now routed through the WTP.

Taste and odor issues will be important criteria if the City decides to utilize the Post Office Well as a domestic water source. If the City develops or participates in the development of a surface water treatment plant, taste and odor issues will also become an important treatment objective.

7.2.3 Inactivation/Removal of Microbial Contaminants

The treatment standards (relating to microbial contaminants) that the City is required to meet are dependent on the type of source water being dealt with. In general, the categories are, in order to least to most extensive treatment requirements,

(1) Groundwater sources,
(2) GWUDI (groundwater under direct influence of surface water) sources, and
(3) Surface water sources.

As previously noted, Dayton currently utilizes 10 groundwater wells and a series of springs.

All of the wells except for the Post Office Well have been determined to have adequate construction and are classified as normal groundwater. To the best of our knowledge, testing for the Post Office Well has not been conducted to demonstrate that the well seal is adequate.

The watershed springs have been identified as *potential* GWUDI sources, and unless improvements can be made that allow the City to test and demonstrate that the springs are not surface water influenced, more stringent treatment standards will most likely apply to this spring water.

If the City participates in the development of (or develops) a surface water treatment plant drawing from the Willamette River, full surface water treatment standards will apply to that source.

Microbial contaminant treatment objectives for each of the three categories of source water are presented below.

7.2.3.1 Microbial Treatment, Groundwater Sources

As presented in Chapter 3, the Ground Water Rule (GWR) went into effect December 1, 2009.

For those of the City's groundwater sources that have been determined to be groundwater sources (no direct influence from surface water), the Ground Water Rule (GWR) is the primary regulation related to treatment standards. Compliance with the GWR will require the provision of 4-log (99.99%) inactivation of viruses and compliance monitoring (continuous monitoring of chlorine residual) in order to avoid being subject to the requirements of triggered monitoring.

The required 4 log virus inactivation is currently provided for all of the wellfield wells, as well as the active in-town wells (with the exception of the Post Office Well), all of which discharge raw water to the WTP. Based on conversations with ODWP, the City Public Works Department worked with ODWP staff to demonstrate that the McDougal Wells comply with the 4 log virus inactivation standard. These findings should be confirmed as more information about the alignment of the watershed lines and location of watershed services becomes available.

Failure to provide the 4-log virus inactivation requires the water system to be operated under the triggered monitoring mode, which requires more extensive sampling in the event of any positive routine total coliform testing. Triggered monitoring is viewed as a necessary transitional phase prior to the upgrade of the system to meet the 4-log virus inactivation standard and compliance monitoring requirements. The provision of permanent facilities that can reliably and efficiently achieve 4-log virus removal/inactivation is viewed as an important treatment goal.

7.2.3.2 Microbial Treatment GWUDI Sources

In addition to virus inactivation, additional levels of treatment will be required should any of the City sources be reclassified as GWUDI. In addition to the 4-log (99.99%) treatment for viruses, public water systems utilizing GWUDI sources are required to install and properly operate a water treatment process that reliably achieves 3-log (99.9%) removal and/or inactivation of *Giardia lamblia*, and a minimum of 2-log (99%) removal and/or inactivation of *Cryptosporidium* (see Chapter 3 for a more extensive discussion of surface water treatment standards).

7.2.3.3 Microbial Treatment Surface Water Sources

The microbial treatment standards related to surface water treatment are essentially the same as those that apply to GWUDI sources (ie. minimum of 4-log treatment for viruses, 3-log treatment for *Giardia lamblia*, and 2-log treatment for *Cryptosporidium*) (see Chapter 3 for a more extensive discussion of surface water treatment standards). However, a surface water treatment plant is typically far more complex, and typically uses a multi-barrier approach to meeting these standards (ie. such are screening, sedimentation, filtration, and disinfection), whereas pretreatment (such as screening or sedimentation) is typically not necessary for GWUDI source water.

7.2.4 Filtration

Filtration as a water treatment process is, in a majority of cases, required of water systems with surface water sources or those classified as GWUDI. Filtration is less commonly required for the treatment of groundwater, but when required, it is most often used to remove iron and manganese. Dayton is currently one of the public water systems (classified as groundwater systems) that utilizes filtration to remove iron and manganese.

It should be noted that the existing WTP filters are not designed to treat surface water, nor are they adequate for this purpose. Filtration as a treatment process for groundwater sources, GWUDI sources or surface water sources is discussed below.

7.2.4.1 Filtration, Groundwater Sources

Due to the elevated iron and manganese levels in the City's groundwater, adsorption pressure filters are utilized. Any expansion of the existing WTP in the future is expected to utilize the same type of pressure filter as is currently utilized. However, since the production from the existing Wellfield wells is so far below the existing WTP capacity, expansion of the WTP by installation of an additional filter bank is not anticipated during the study period.

7.2.4.2 Filtration, GWUDI Sources & Surface Water

Filtration will be a required treatment technique if any of the City wells or springs are reclassified as GWUDI. Public water systems utilizing GWUDI are required to provide 3-log inactivation and/or removal of *Giardia lamblia*, and a minimum 2-log removal and/or inactivation of *Cryptosporidium*.

As an aside, while 4-log virus inactivation and/or removal is also required, this is almost universally achieved as inactivation with the use of a disinfectant. **Table 7-1** outlines the regulatory removal credits (contrasted with inactivation credits) granted to two filter technologies.

As previously presented in Chapter 3, compliance with the LT2 rule may require additional *Cryptosporidium* inactivation/removal requirements above the current 2-log level based on the demonstrated level of *Cryptosporidium* in the source water. This is potentially a limiting factor for the direct filtration approach, one that may require additional treatment methods (other than chlorination) to meet the regulatory requirements. Accordingly, the selection of a specific filter technology becomes more important in a GWUDI setting.

Table 7-1 Conventional Regulatory Removal Credits for Filtration Technologies

Pathogen	Direct Filtration	Membrane Filtration (1)
Giardia lamblia	2-log	Up to 4-log (2)
Viruses	1-log	Up to 0.5-log (2)
Cryptosporidium	2- log	Up to 4-log (2)

(1) Defined as the rejection of particulate matter larger than 1 micrometer
(2) As verified by challenge testing

It is anticipated that the final decision to utilize direct filtration or membrane filtration will be made in the preliminary design phase, based on input from the ODWP and the location and type of source water to be treated. This selection will undoubtedly be made on the basis of performance, lifecycle cost, and ease of maintenance and/or expansion.

7.2.5 Disinfection

Inactivation of microbial pathogens with a disinfectant complements removal rates achieved through the filtration process. The City currently disinfects with chlorine (liquid sodium hypochlorite). It is anticipated that the City will continue to utilize liquid chlorine as the disinfectant of choice at any new or expanded WTP improvements.

7.2.6 Plant Reliability and Redundancy

A key treatment objective is to be able to provide treatment for ADD in the event of a disruption or failure of any single process component. This is based on the reasonable assumption that the difference between ADD and either PHD, or MDD can be satisfied by storage reserves or by water use curtailment on an emergency basis. In such cases, timely notification of consumers is critical and an emergency notification and curtailment plan is essential to quickly reduce water demand.

7.3 EXISTING WTP EVALUATION

A detailed discussion and summary of the City's existing WTP is contained in Section 4.4.4, and is not repeated here. The existing WTP has a treatment capacity of 750 gpm. The estimated long term production rates from all of the wells discharging to the existing WTP is approximately 350 gpm (less than half of the existing design filter capacity).

If the City acquires additional wells on the valley floor and increases the raw water flow rate to the WTP above 750 gpm, additional capacity will be required. Since the existing WTP is already plumbed for an addition filter bank (for a total treatment capacity of 1,500 gpm), the improvements should be relatively simple to implement. Additional capacity beyond 1,500 gpm will require substantial improvements to and expansion of the WTP.

As discussed in Section 4.4.4, the Dayton WTP plant supplies water to both Dayton and Lafayette. Dayton and Lafayette each have two finish water pumps each (nominal capacity of 250 gpm & 500 gpm for each city), as well as piping and valves to allow addition of one extra pump for each City. The existing pumping capacity of the WTP may need to be increased depending on who owns the new water sources and the capacity of these sources.

7.3.1 Existing WTP, Evaluation of Pressure Filter Operation

The reliability and redundancy of the existing Dayton WTP is closely related to the reliability and redundancy of the source water that feeds the WTP filters. There are two issues relating to the source water to the filters. The first is the ability of the wells to remain in service during emergency conditions, and the second relates to the ability of the system to provide the minimum required flows to adequately backwash the filters under all conditions.

7.3.1.1 Reliability of Raw Water Wells

As discussed in Chapter 4, Chapter 6 and Chapter 9, if the raw water wells feeding the WTP must do not remain in service during emergency conditions, the WTP cannot operate, and auxiliary power generators should be installed at all wells. While the existing WTP has a propane powered generator, during a prolonged area-wide power failure the WTP will not receive any source water if the raw water wells are not also operational. As discussed in Chapter 6 and Chapter 9, the City should provide auxiliary power generators and automatic transfer switches at all of the wells supplying the WTP.

7.3.1.2 WTP Pressure Filter Backwash Evaluation

As discussed in Section 4.3.3, the WTP requires a minimum of 350 gpm to be delivered to the filters in order to adequately backwash the filter tanks sequentially. As illustrated in **Table 4-7**, the current long-term production rate of all the WTP raw water wells combined is 350 gpm (assuming all wells are in constant service). Therefore, when any single well is out of service (for maintenance or repair), the flow rate entering the WTP is not adequate to properly backwash the filters. Adequate backwash rates are very important to successfully clean the filter media beds, allowing the contaminants to be removed. If the backwash flow rates are too low, the media beds will not be fluidize, leaving a portion of the contaminant load in the filter bed, eventually leading to poor filtration. Continued low backwash rates will shorten the lifespan of the filter media and lead to premature media failure and replacement.

Two potential solutions to ensure adequate backwash rates were considered, as summarized below.

- *Alternative 1.* Construct or purchase additional wells to increase the raw water flow rate entering the WTP (ie. additional sources), to ensure that 350 gpm is available at all times. The additional flow rate will need to be high enough (and from enough sources) so that the 350 gpm can be guaranteed even if the largest single well is out of service. Unless the City discovers a well source that can be on-line in the near future, this alternative is not available to address this concern in the short term, and will not be considered further.

- *Alternative 2.* If the City cannot find additional raw water sources in the near future to increase the flow rate entering the WTP, an alternate approach must be considered. The filter backwashing problem is <u>not</u> due to the <u>volume</u> of water available from the raw water wells, but rather is due to inadequate <u>flowrate</u> directly from the wells. Therefore, one solution is to add an influent clearwell to the WTP, with pumps to move the water from the clearwell to the filters to ensure adequate backwash flowrates (ie. allow the wells to fill the volume of the clearwell over time, and then pump water to the filters at an increased rate as required for backwashing).

  Figure 7-1 is a schematic showing the conceptual layout of the improvements proposed for this alternative. Based on the WTP design criteria, each of the pressure filters requires a flowrate of 350 gpm for a minimum of 4 minutes to adequately backwash the filters. Each filter requires backwashing every 12 hours under normal conditions. Therefore, as a minimum, the clear well must be sized to store the larger of the backwash water volume for all 6 filters, plus adequate volume to ensure that the filters can be run for before and after a backwash cycle for an adequate time to take water quality measurements if necessary.

  Assuming a 350 gpm backwash flowrates for 8 minutes (2 times minimum) for each of the 6 tanks, as well as 5 minutes before and 5 minutes after backwashing, results in a minimum backwash volume of 20,300 gallons. Even if only two of the least productive wells are in service during the backwash cycle (Flower Lane & 11th Street, 25 gpm each for 48 minutes = 1,450 gallons), a 21,000 gallon tank will provide adequate volume with a ±14% safety factor. This 21,000 gallon tank will also allow the WTP filters to be operated at 350 gpm for up to 60 minutes with all wells out of service, or on a 3 hour cycle with a 175 gpm inflow rate.

  Two equal size booster pumps will be provided, to provide redundancy and to ensure that the WTP can remain in service even with one pump out of service. The pumps will need to be provided as either canned vertical turbine or canned submersibles to ensure that the pump intake is below grade, so that the dead storage issues (similar to those related to the main WTP reservoir, per Section 9.3.1.5) are avoided. The pumps will be provided with VFDs to allow the filter pumping rate to be automatically adjusted to match the inflow rate from the wells, and still allow the pumps to ramp up as required to provide the required backwash flowrates.

Improvements to ensure adequate backwash flowrates are provided at all times are necessary to maintain the pressure filter integrity, longevity, and decrease long term maintenance costs. Based on the discussions above, construction of a new influent clearwell and twin booster pumps is recommended.