CITY OF PHILOMATH
Water System Master Plan,
Philomath, Oregon

Section 6

# Water System Evaluation and Recommendations

# SECTION 6
# WATER SYSTEM EVALUATION AND RECOMMENDATIONS

## 6.1. Introduction

As the City continues to grow, present and projected water system deficiencies will need to be corrected, including additional or expanded supply sources, expanded distribution system flow capacity, and increased storage capacity. By first formulating long range improvement plans, short term improvement priorities can best be established. Long range planning recommendations for the water supply, distribution, and storage facilities are presented in this chapter. The chapter also includes a prioritization of the recommendations to enable the City to most efficiently utilize available resources.

### 6.1.1 Basic Design Criteria

The size and location of all water system components including pumping facilities, pipelines and storage facilities determine the ability of the system to meet the water demands under different imposed conditions. Future water demands for various areas in City were estimated based on the land uses shown in the Comprehensive Plan. The criteria used to determine system adequacy are as follows:

- Water production facilities and water rights must be adequate to satisfy peak day demands.
- The system must provide for finish water storage sufficient to provide for equalization, fire flows, and emergency use.
- Peak hour demands for the entire system must be met with system pressures remaining above 20 psi.
- The system must be capable of delivering the required fire flows to all portions of the distribution system in combination with the maximum day demand while maintaining a minimum residual pressure of 20 psi at all service connections.
- The system must be able to refill all storage reservoirs during periods of reduced demand.

### 6.1.2 Methods of Analysis

The City water system consists of the WTP, the pump stations, reservoir, transmission mains and distribution system piping. Each element of this system can deliver a finite amount of water to the end user. The system as a whole must have the hydraulic capacity to deliver the required flows to the point of use.

The capacity of the water transmission and distribution system was evaluated to determine the improvements that need to be made to meet both the existing and future water demands. Computer modeling was used to assess the ability of the proposed future system to deliver the required flows under different conditions (See **Section 6.6**).

In addition to the hydraulic analysis the reliability of the various system components was examined. Based on this examination, recommendations were developed for the replacement of those components that were judged to be questionable in terms of reliability or serviceability.

It needs to be pointed out that the analyses outlined above were based on the assumptions and projections regarding population growth and community development as outlined in **Section 2** and water use projections in **Section 5**. Any large water using industry could seriously change the conditions predicted by the above analysis. Therefore, if and when plans for large industries are presented, it may be necessary to reanalyze expected flows to the affected area to determine the effect on the water system as a whole.

## 6.2. Water Supply and Water Rights

An analysis of the City's existing water rights and water supplies identified three areas of work for the next planning period. These include work to solidify the City's existing water rights, development of a Water Management and Conservation Plan, and obtaining additional reliable water supplies. The details of each of these work areas are discussed in the following sections.

### 6.2.1 Existing Water Rights

A review of the City's current water rights (see **Section 4.2**), showed that some work needs to be done to ensure the rights remain valid through and beyond the planning period. Listed below are the City's existing water rights with the work that must be done in order to strengthen the City's overall water rights position. At the time this plan was written, the City had begun work with a Certified Water Rights Examiner to perform the tasks listed below. As such, it is considered complete for the purposes of this planning effort, and no budgetary provisions are recommended.

Transfer Order 5623 - Marys River 1939 right for 1 CFS - Submit report of beneficial use and work with Water Resources Department to obtain certificate.

Transfer 8527 - Marys River 1952 and 1964 rights for 1 CFS and 0.19 CFS Respectively – Work with Water Resources Department to complete review of transfer application.

Permit S49245 – Marys River 1985 right for 3.5 CFS – Submit extension application.

Permit G9728 – 11th Street Well 1981 right for additional 100 GPM – Submit report of beneficial use and work with Water Resources Department to obtain certificate.

### 6.2.2 Water Management and Conservation Plan

New Oregon Administrative Rules now require the preparation of Water Management and Conservation Plans (WMCP) in accordance with OAR 690-86 guidelines. It is recommended that the City prepare and obtain approval for such a plan early in the planning period. Completion of a WMCP will likely be a condition of approval for the water rights extension application discussed above. It is recommended that the City implement a formal water conservation program in accordance with State guidelines following the completion of the WMCP. A budget of $20,000 should be established to complete the WMCP.

### 6.2.3 Obtain Additional Reliable Water Supplies

Though the 11th Street Well is a reliable source throughout the year, it alone cannot meet the City's demands. Therefore, the City's water supply is largely dependent upon the quantity of water that can be reliably withdrawn from the Marys River. During dry periods, flow in the Marys River can become very low. The State owns an in-stream water right for 10 CFS with a priority date of 1964. During extended dry periods, flow in the river often drops below this value. Therefore, the City has historically chosen to obtain early (pre-1964) water rights as a means of providing adequate water supply. These early, or senior, water rights predate the State's minimum flow right for 10 CFS, and may therefore be used to withdraw water when river flows drop below this value. For the purposes of this discussion, the City's early water rights constitute a reliable water source during the low flow summer months.

The total withdrawal allowed under the City's pre-1964 water rights is 1 CFS or 0.645 MGD. Combined with water from the 11th Street well, the total reliable water available to the City is approximately 1.02 MGD. Based on the data presented in **Section 5**, the peak day demand is currently equal to this value. Therefore, while the existing water rights are sufficient through the planning period, the existing reliable water supplies (i.e., sum of City's pre-1964 water rights and the 11th Street Well) are not. As such, alternative water supplies must be obtained. A number of alternatives exist for developing additional water supplies. A few of these include; additional wells, constructing a storage reservoir in the upper reaches of the Marys River Watershed, and obtaining additional early water rights.

#### 6.2.3.1 Develop Additional Wells

Philomath is not in a particularly good groundwater area. Northwest of Philomath the hills are formed by the Siletz River volcanics, an igneous formation which yields small to moderate water quantities. There is some potential for drilling municipal wells in this formation, but such wells would be exploratory in nature and would be drilled without a high likelihood of success. The 11th Street well was drilled through terrace deposits into the Siletz River volcanics bellow. The terrace deposits typically yield small to moderate amounts of poor to moderate quality water. South of the City lie older alluvium deposits which are in most places less than 100 feet thick. Beneath the alluvium deposits is the Spencer Formation, a marine series yielding small quantities of poor quality water. The older alluviums in places do yield fairly large quantities of water, but it is usually of poor quality. The best, and only reliable good aquifer near Philomath, are the younger alluviums lying in the flood plain along the Willamette River. Wells in these materials can yield over 1000 gallons per minute.

The closest younger alluvium deposits suitable for municipal well development are 6.2 miles east of the City, northeast of the Corvallis airport. Developing a well field in the Willamette flood plain alluviums would require two or three good well sites and a long supply pipeline to convey water to town. The supply pipeline would be a relatively large diameter buried pipeline. A rough estimate of the construction costs for the pipeline alone is approximately 2.6 million dollars. This does not include the costs for the development of the wells. The high cost of this alternative, renders it infeasible when compared to the other alternatives.

#### 6.2.3.2 Construct a Dam and Reservoir

The City could store water, most likely in a dam and reservoir, and release that water into the river when it is needed. The released water would be solely the City's and would not be subject to use by others. This scheme might be accomplished best by constructing an adequately sized dam and reservoir on a tributary of the Marys River in a location where a fish ladder would not be required. During periods when there is insufficient water in the river to meet the City's water needs, water from the reservoir would be released into the river and withdrawn at the WTP.

The development of water resources in the Marys River Basin has been studied to various degrees throughout the history of the Willamette Basin Project. The most recent and most thorough evaluation of the Marys River Basin occurred in the mid-1970's. The US Army Corps of Engineers published the results of this work in 1975 in a document titled "Marys River Basin Oregon: Review Report for Water Resources Development." As part of this work, the Corps identified three sites for large multipurpose reservoirs.

These are the Noon Site, Wren Site, and Tumtum Site. These are large multipurpose reservoirs of a much larger scale than that required for the City. The 1975 report, also lists a fourth storage alternative that includes a system of small tributary reservoirs. As part of this alternative, they identified four sites for the smaller reservoirs. These are Shotpouch Creek, Bark Creek, Mulkey Creek, and the East Fork of the Marys River. While still much larger than required, these tributary reservoirs are likely to be closer to the scale required for the City. Therefore, these tributaries are a good starting point for the determination of potential reservoir sites.

In the current regulatory climate, the overall project cost for the construction of a dam and storage reservoir can quickly ascend into the multimillion dollar range. Therefore, this alternative is much more costly than the other alternatives described below. As such, this alternative is not recommended at this time. Nonetheless, as the City continues to grow beyond the planning period the construction of a dam and storage reservoir in the upper reaches of the Marys River may eventually be required.

#### 6.2.3.3 Obtain Additional Early Water Rights

During the summer months, the Marys River has a finite capacity for water withdrawals. Currently, agricultural users consume the majority of this capacity. In an effort to ensure that reliable water supplies are available, the City could purchase additional early water rights from the nearby agricultural users. This would essentially shift a greater portion of the finite capacity of the river from agricultural usage to municipal usage. The City recently acquired an irrigation water right as part of a land purchase. The City has applied to transfer the point of diversion for this right to the WTP and change the use from irrigation to municipal. This right is listed in **Table 4-1**. The diversion allowed under this right is 1 CFS or (0.645 MGD) with a priority date of 1952. Upon approval of the transfer, the City will have a total of 2 CFS (1.29 MGD) of pre-1964 rights. In order to meet the projected peak day demand at the end of the planning period (2.79 CFS or 1.80 MGD) without having to rely on the 11$^{th}$ Street Well, the City should obtain an additional 0.79 CFS (0.51 MGD) of pre-1964 water rights as soon as possible. Currently the City is working to obtain early water rights. As a preliminary goal, the City has elected to obtain enough early water rights to meet peak day demands through buildout. Based on the information presented in **Section 5**, the peak day demand at buildout is approximately 5.77 CFS (3.72 MGD). Therefore the acquisition of an additional 3.77 CFS (2.43 MGD) of early water rights is recommended.

The process of obtaining and transferring existing water rights is complicated. A basic element of state water law is the "use it or loose it" doctrine. This requires that water rights must be regularly exercised in order to remain valid. A certificated water right remains valid forever, so long as it is used. If the water right is not used for a period of five or more years, it then becomes subject to forfeiture and cancellation. The process is not automatic. The state must first prove that the water right has not been used. The law includes a presumption of forfeiture upon a showing of non-use for the five-year period. The water right holder then has an opportunity to show whether the non-use was "excused" for one of a number reasons listed in the statutes. Excuses for non-use include, but are not limited to: economic hardship; other government regulations that prevent water use; or participation in a conservation reserve program.

A review of the Water Resources Department files shows the early (pre-1964) water rights for the Marys River listed in **Appendix F**. Many of the rights listed in **Appendix F** are likely not transferable due to inactivity. Over the years, agricultural practices in the Marys River Basin have shifted from row crops with high irrigation requirements to less consumptive crops such as grass seed and Christmas Trees. As a result of this and other trends, many of the water rights listed in **Appendix F** have likely been unused for more than five years. As described above, such rights are non-transferable and subject to cancellation. Another complicating factor that arises from the "use it or loose it" doctrine is that appropriations allowed under a particular right must continue on a regular basis for the right to remain valid. In other words, water rights cannot simply be purchased and put in storage until needed. A continuous history of use must be demonstrated in order for the right to be transferable.

#### 6.2.3.4 Recommended Water Supply Strategy

Based on the above discussion, it is clear that the most cost-effective strategy for obtaining additional reliable water supplies is to obtain additional early water rights. The City is currently working toward defining a list of target water rights that are transferable and may be obtained at a reasonable cost. The end result of this work should be a plan for obtaining early water rights that targets several water rights as well as a step by step plan for purchasing, and transferring each water right as demand requires. A key element of this plan is the identification of how each right will be exercised from the date of purchase to the date of transfer to municipal use at the WTP. As previously mentioned, this work effort is currently underway. However, due to the importance of this work it is recommended that an additional $50,000 be reserved for the continued development of a water rights acquisition plan as well as for the purchase of the water rights.

## 6.3. Water Production Facilities

The City owns and operates two water production facilities. These are the Marys River Water Treatment Plant and the 11th Street Well. The 11th Street Well is intended as an emergency backup water supply only. Thus, for long range planning purposes, the Marys River Water Treatment Plant must be able to satisfy essentially all of the City's demands.

Common practice is to size water production facilities to meet or exceed maximum day demands. As discussed in **Section 5**, the existing maximum day demand is approximately 1.07 MGD. The nominal capacity of the Marys River Water Treatment Plant is approximately 1.0 MGD. Therefore, maximum day demands are approaching the capacity of the production facilities. This indicates that during peak days, water in the storage reservoir along with water from the 11th Street Well may be required to satisfy domestic demands leaving little reserve capacity in the event of a major fire. As such, additional water production facilities may be required early in the planning period.

Based on the previous discussion, the Marys River is the recommended water source to meet future demands. A new treatment plant would require the acquisition of a new plant site due to the fact that the existing plant must remain in service during the construction of the new facility. If the new plant were to be constructed near the existing facility, it could use the existing river intake structure. However, if the site were not relatively close to the existing river intake, a new intake would be needed. The construction of a new intake requires and extensive permitting process to perform the in-stream work as well as a water rights transfer for a new "Point of Diversion". This would add considerable expense, and permit acquisition time, to the overall project. As such, the logical alternative for increasing the City's production facility is the expansion of the existing Marys River Water Treatment Plant.

The projected peak day demand at the end of the planning period is approximately 1.80 MGD. The 11th Street well should remain as a backup water source to supply customers when the Marys River Water Treatment Plant must be removed from service. Therefore, the treatment plant expansion should be sized to meet all of the projected peak day demands. The existing plant utilizes two modular treatment units manufactured by Neptune Microfloc. For compatibility purposes, ease of operation, and equipment flexibility, the same treatment units should be used for the expansion. The proposed expansion includes the addition of two new modular treatment units. The addition of two new filter units will increase the production capacity to 2.0 MGD.

The existing treatment plant site can accommodate the proposed plant expansion. The existing river intake screen has a capacity of approximately 1,500 GPM with minimal headloss. Therefore the screen has adequate capacity for the proposed expansion. However, due to the age of the screen, minor repair work may be required and should be budgeted accordingly.

The existing plant has two treatment units with three raw water pumps (one pump being redundant) and a common raw water main to the plant. During recent years of plant operation, the operator has experienced difficulty in maintaining constant flow to each of the treatment units so that efficient dosages of treatment chemicals are obtained. To remedy this situation, the proposed improvements include the installation of four dedicated raw water pumps with four dedicated raw water mains (one pump and water main for each treatment unit). Individual chemical feed pumps for each raw water main would be installed so that flows and chemical dosages can be individually controlled, thus providing a more efficient treatment process.

The chemical storage building that currently houses liquid alum would be expanded to accommodate a new caustic soda storage tank and polymer feed assembly. This would allow the existing chemical feed room to be used to house the fluoride feed assemblies.

Each treatment chemical would have four individual chemical feed pumps for each treatment unit. Therefore, each treatment unit is a separate treatment process that can operate independently of the other units. This allows considerable flexibility meeting water demands and normal maintenance of the overall systems.

The existing clearwell would need to be expanded to accommodate the capacity increase. The new clearwell would be constructed and connected to the existing clearwell. Two finished water pumps would remain in the existing clearwell and two new finished water pumps would be installed in the new clearwell. This would allow the treatment facility to be operated at 50% capacity should repair or maintenance work be required on the remaining 50% of the treatment plant.

The clearwell expansion would be part of an overall building expansion to the north of the existing building that would house two new treatment units. The existing plant would remain in operation during the construction of the two new treatment units. The new treatment units will need to be operational prior to taking the existing units off-line. After the raw water pumps, new units, clearwell, and finished water pumps are operational, the existing units would be connected to the new dedicated raw water lines and chemical treatment processes.

With the treatment plant capacity doubling, the backwash water settling ponds would also need to be expanded. The current area of the backwash water ponds is sufficient to double the size of the ponds by constructing concrete basins in each of the two existing basins. The discharge of the ponds would be directed eastward to the slough area for further settling prior to discharging to the Marys River.

Although the new treatment plant would meet the requirements to provide a 2.5-log removal credit in regards to disinfection, the chlorine contact basin must be expanded to supply adequate detention time to meet the Oregon Health Division 0.5-log removal requirement. Based on a flow of 1,400 gpm and a chlorine residual of 0.6 ppm, the total contact volume required is 77,000 gallons. An additional 724 feet of 24-inch diameter pipeline must be added to the existing contact chamber to provide the required contact volume.

The treatment plant expansion would also require additional parking area, landscaping, fencing, etc. and should be budgeted accordingly.

As described in Section 3, the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) will be adopted by the OHD in the coming years. Under the LT2ESWTR, systems initially conduct source water monitoring for *Cryptosporidium* to determine their treatment requirements. Filtered systems will be classified in one of four risk bins based on their monitoring results. Systems classified in higher risk bins must provide 1 to 2.5-log additional reduction of *Cryptosporidium* levels. Since the LT2ESWTR has not been adopted, the City has not been required to perform the source water monitoring. Prior to undertaking the treatment plant upgrades, it is recommended that the City complete the required monitoring and design the plant to provide the necessary treatment levels required by the LT2ESWTR. To allow for treatment plant upgrades required by future regulation an allowance of $150,000 is included in the construction budget for the treatment plant expansion project.

The estimated overall project cost of the treatment plant expansion is $3,252,000. A detailed breakdown is included in **Appendix E**.

## 6.4. Water Storage Facilities

Water system storage serves three purposes: it equalizes daily variations between supply and use; it provides a reserve for fire fighting; it provides a reserve that can be used during an emergency interruption of supply. The total recommended storage in the system is the sum of the operational, fire, and emergency storage.

### 6.4.1 Equalizing Storage

Equalizing storage must supply the volume of water consumed during periods when system demands exceed supply capabilities. Philomath's present supply capacity is approximately 1 million gallons per day. This does not include the production capacity from the 11th Street Well. The City would like to continue to use the 11th Street Well as an emergency backup water supply only. Therefore, the production from the well was not considered in the analysis of the required equalization storage.

Since demands vary during the course of a day, there are periods when amounts greater than the production capacity (currently 1 MGD) are consumed. Hourly demand data is not readily available for Philomath. However, based on commonly accepted peaking factors, one can estimate peak demands throughout the day. As discussed in **Section 5**, the existing peak hour demand is approximately 2.45 MGD. Short duration peaks above the supply capacity of 1 MGD are met by equalization storage.

Daily demand fluctuations are influenced by weather and the mix of residential, commercial and industrial use. Commercial and industrial use tends to be more constant throughout the day than residential use. Therefore, if the proportion of residential use increases in coming years, the relative value of peak hour use to maximum day can be expected to increase.

The equalization storage volume required is typically determined as either percentage of the maximum day demand (typically 20 to 40%), or by determining the deficit between the peak hour demand and the available supply over a given time period. As previously stated, hourly data is not readily available for Philomath. Therefore, it is difficult to determine the deficit between peak hour demands and supply. As such the former method must be used to estimate the required equalization storage. Since Philomath is a relatively small community, the hourly fluctuations in water usage are likely to be higher than for larger communities. In larger communities, commercial and industrial users tend to dampen hourly variations. Whereas in smaller communities, hourly usage patterns are primarily influenced by residential users. Based on this reasoning, equalization storage in the amount of 40% of the maximum day demand is recommended.

### 6.4.2 Fire Storage

The required fire storage is determined by the single most severe fire flow demand on the system. As discussed in **Section 5**, industrial areas require the greatest fire flow. Per City standards, the fire flow requirement for industrial areas is 4000 gallons per minute for four hours. This equates to a total fire flow volume of 960,000 gallons.

### 6.4.3 Emergency Storage

Emergency storage is often provided to supply water from storage during emergencies such as pipeline failures, power outages, or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability. Provisions for emergency storage in other systems vary from none to a volume equal to the maximum day demand or higher. In short, the criteria for determining the amount emergency storage are somewhat subjective.

Since the City has two sources (the $11^{th}$ Street Well and the Marys River) there is some redundancy in the supply system. In the event of a treatment plant failure, the $11^{th}$ Street Well may be used to supply water on an interim basis. The most likely events that could disrupt the City's water supplies include power outages, contamination of the Marys River, or the loss of a pipeline between each source and the distribution system.

The WTP and $11^{th}$ Street well do not have back up power generation capabilities. Therefore, both are susceptible to service interruption resulting from power outages. In recent years, the City's power supply has been relatively stable with only a few outages of relatively minor duration. It is difficult to predict the future reliability of the power supply to the City's treatment facilities. With the construction of the auxiliary power units discussed above, emergency storage in the event of power outages will become less of an issue.

Contamination of the extent that would interfere with a public water supply system generally means a chemical spill directly into the river. These events are not as rare as one might think as evidenced by the January 2001 diesel spill into the nearby Yaquina River along Highway 20. It is difficult to determine a reasonable duration of such an event without a clear understanding of the nature and volume of the contaminate. Clearly one can envision a scenario where the Marys River is unavailable for several weeks. However planning for such an event is cost prohibitive. Should such an event occur, it is likely that temporary facilities could be constructed to pump water from the City of Corvallis to Philomath. The old intertie between the City of Corvallis' Rock Creek Transmission Main and the City's system could be used for this purpose. A more detailed discussion on refurbishing the intertie is presented in **Section 4.2.4**.

The length of pipelines in which a failure would sever the connection between the two sources and the distribution system is relatively small. Therefore, the risk of such a failure is relatively low. Should such a failure occur, it is likely that repairs could be made within a day or two.

Based on the above discussions, an emergency supply of 48 hours is recommended. In the event of such an emergency, it is likely that customers would respond within 12 hours to a public announcement to reduce water usage. If the emergency occurred during a high demand day, it is expected that usage would be reduced from the maximum day demand MDD to average day demand ADD after a 12-hour period. During an emergency event of the nature proposed herein, it is also likely that the 11th Street Well will be available on a 24-hour basis throughout the emergency. For the relatively short duration of the emergency event envisioned herein, the firm capacity of the 11th Street Well may be increased to 320 gallons per minute or 0.460 MGD. Therefore, the basic emergency scenario is defined as a 48-hour failure of the WTP during the maximum day of water usage. The emergency storage volume is therefore determined by the following equation.

$$\text{Emergency Storage [MGD]} = (0.5 * \text{MDD}) + (1.5 * \text{ADD}) - (2 * 0.460)$$

### 6.4.4 Storage Analysis

Based upon the criteria discussed above, the storage requirements were determined through the planning period. The results of this analysis is presented in **Table 6-1.**

**TABLE 6-1**
**FINISHED WATER STORAGE ANALYSIS**

| Year | | 2003 | 2005 | 2010 | 2015 | 2020 | 2025 | 2029 |
|---|---|---|---|---|---|---|---|---|
| Population | | 4100 | 4220 | 4739 | 5322 | 5977 | 6712 | 7365 |
| Avg. Day Demand (ADD) | mgd | 0.488 | 0.502 | 0.564 | 0.633 | 0.711 | 0.799 | 0.876 |
| Max. Day Demand (MDD) | mgd | 1.005 | 1.034 | 1.161 | 1.304 | 1.464 | 1.644 | 1.804 |
| Equalization Storage Required | mg | 0.402 | 0.414 | 0.464 | 0.522 | 0.586 | 0.658 | 0.722 |
| Fire Storage Required | mg | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 | 0.960 |
| Emergency Storage Required | mg | 0.313 | 0.349 | 0.505 | 0.680 | 0.877 | 1.099 | 1.295 |
| Total Storage Requirement | mg | 1.674 | 1.722 | 1.929 | 2.162 | 2.423 | 2.716 | 2.977 |
| Storage Provided | mg | 1.250 | 1.250 | 1.250 | 1.250 | 1.250 | 1.250 | 1.250 |
| Storage Deficit | mg | 0.424 | 0.472 | 0.679 | 0.912 | 1.173 | 1.466 | 1.727 |

### 6.4.5 West Side Reservoir

Based on the storage analysis presented above, a new 1.75 million gallon reservoir is recommended. The City currently has a site identified for this reservoir in the hills west of town. The site is located on the west side of the extension of Dampier Street planned as part of the Starlight Village Phase IIA development. The site is approximately four acres in size. The terrain is sloping and appears to be at a suitable elevation for the construction of a reservoir. The reservoir should be designed so that the floor and overflow elevations are the same as the Neabeack Hill Reservoir. This will result in a wall height of approximately 40 feet. The inside diameter of the new reservoir will be approximately 90 feet. For a reservoir of this size and wall height the most economical structure over the life of the facility is a prestressed concrete tank meeting the requirements of AWWA D110. Prestressed concrete tanks are less susceptible to leakage than conventionally reinforced tanks. Reinforced concrete tanks also do not require recoating and the corrosion control efforts associated with steel tanks. Therefore, reinforced concrete tanks require less maintenance than both conventionally reinforced tanks and steel tanks. In addition, reinforced concrete tanks typically have a longer design life than conventional concrete and steel tanks. As a result, the lifecycle cost for reinforced concrete tanks is typically the lowest of the three alternatives. The total project cost for the reservoir is estimated to be approximately $2,835,000. A detailed cost breakdown is included in **Appendix E**.

### 6.4.6 Neabeack Hill Storage Reservoir

The existing storage reservoir at Neabeack Hill is in relatively good condition with the exception of some leaks around the exterior of the tank. In a past effort to control leakage, the City has hired a contractor to inject epoxy grout into the cracks. This technique was successful. However, subsequent to this repair new leaks have occurred. Leak repair is likely to be an ongoing maintenance requirement throughout the life of the tank. In recent years, new waterproofing technologies have been developed. One such technology is a surface applied product that generates a non-soluble crystalline formation within the pores and capillary tracts of the concrete. This works to seal the concrete against the penetration of water. One such product is Xypex manufactured by the Xypex Chemical Corporation. For best results this product should be applied to the interior of the tank. This will require draining the tank and removing it from service. Since the Neabeack Hill Reservoir is the only storage reservoir in the City's system, it cannot easily be removed from service until the new tank is constructed.

Some additional minor modifications to the existing tank will be required when the new tank is constructed. The existing check valve on the tank inlet line must be replaced with an altitude valve that includes a check feature. Since water is fed into the distribution system from multiple locations, and the friction losses between the sources and the tanks is not the same, altitude valves are required to enable operators to completely fill both tanks. An altitude valve typically requires a sensing line from the reservoir that initiates closure. A new wall penetration will be required to install the sensing line.

Due to the need to remove the existing reservoir from service, the recommended repairs cannot be made until the new reservoir is online. As such, it is recommended that the modifications to the Neabeack Hill Reservoir be incorporated into the new west side reservoir project. The total estimated construction cost for the Neabeack Hill Reservoir Improvements is approximately $245,000. A detailed cost breakdown is included in **Appendix E**. This includes the construction of an auxiliary power generator to supply power to the Neabeack Hill Domestic Pump Station located at the reservoir site. The need for auxiliary power is discussed below.

## 6.5. Pumping Facilities

As described in **Section 4**, the City owns and operates three pump stations. These are the Neabeack Hill Domestic Pump Station, the Neabeack Hill Fire Pump Station, and the Starlight Village Pump Station. All three facilities are relatively new, and in good working condition. All have the capacity to meet domestic and fire demands for their current service areas. Only routine maintenance of the mechanical and electrical systems is anticipated during the planning period. The primary shortcoming of each facility is the lack of auxiliary power. In the event of a power failure, domestic and fire demands in the areas served by these facilities cannot be met. Therefore, the installation of a permanent auxiliary power generator with automatic transfer switch is recommended at each facility.

The auxiliary power generator for the Neabeack Hill Domestic Pump Station should be sized to provide backup power for the pump station as well as all facilities located at the Neabeack Hill Reservoir. The two Neabeack Hill Pump Stations are in relatively good working order, and should require only routine maintenance and replacement during the planning period. The estimated project cost for the installation of an auxiliary power generator at the Neabeack Hill Domestic Pump Station is included in the Neabeack Hill Reservoir Project as discussed above. The estimated project cost for the Neabeack Hill Fire Pump Station improvements is $146,000. A detailed cost breakdown is included in **Appendix E**.

The Starlight Village Pump Station is located in a subsurface vault. The vault is a confined space and subject to the corresponding OSHA regulations. The location also does not provide for easy access to the various equipment items. The control panel and variable frequency drives are located in the vault. This is a demanding environment for equipment of this nature. The City has expressed a desire to address these issues. The recommended improvements include the construction of a CMU block building over the existing vault. The vault lid should be removed and the building should be constructed over the vault. Walkways will likely be required to access the vault floor from the building door. The building should be heated and ventilated to protect the piping and electrical equipment from extreme temperatures and to eliminate confined space issues. These improvements should be included with the installation of an auxiliary power generator. Together these two elements will be called the Starlight Village Pump Station Phase 1 Improvements. The estimated project cost for the Starlight Village Pump Station Phase 1 Improvements is $268,000. A Detailed cost breakdown is included in **Appendix E**.

In addition to the Starlight Village Development, the Starlight Village Pump Station will eventually serve the entire contiguous portion of the upper service level on the western edge of the UGB (See **Figure 6-1**). The pump station currently lacks the capacity to serve the entire area. As such, upgrades will become necessary as development continues. It is anticipated that these capacity increases will not be necessary for many years. By the time the upgrades are required, it is likely that the existing pumping facilities will be near the end of their useful life. Therefore, a complete replacement of the pump station is envisioned. Since the need for the upgrades is driven by growth, it is expected that a significant portion of the costs will be borne by private developers. The pump station will feed into a transmission main that generally runs in a northeasterly alignment across the service area. This transmission main is included in the distribution system improvements discussed below. It is envisioned that a new pump station will be constructed adjacent to the original pump station. An above grade structure will house the pump station and controls. The estimated project cost for the Starlight Village Pump Station Phase 2 Improvements is $470,000. A Detailed cost breakdown is included in **Appendix E**.

## 6.6. Water Distribution Facilities

An analysis of the existing distribution system was performed to assess its ability to maintain adequate pressures under peak domestic and fire demands. A hydraulic network analysis computer program was used for this purpose. WaterCAD software was used to develop a computer model of the City's water system. This software enabled both steady state and extended period simulations. The model was used to simulate peak domestic demand and fire events. These simulations were analyzed to determine if the system was capable of providing the required flows at acceptable pressures. The analysis enabled the identification of system shortcomings. The model was also used to develop proposed collection system improvements to address these shortcomings. Alternatives for Long-range distribution system improvements were simulated and analyzed to develop a recommended set of distribution system improvements.

### 6.6.1 Model Development

As stated above, WaterCAD software was used to develop a hydraulic network analysis computer model of the City's water system. At the most basic level, the model consists of links and nodes. Nodes represent the various elements of the system including water sources, pumps, pipe connections, and storage tanks. The links define the relationship between each node. In other words, the links are used to depict the way in which the nodes are connected. In water systems, links are almost always used to represent the distribution pipes.

The existing distribution system maps were used as a base to develop the model. The layout of the various nodal elements and the links between each element were based directly on the collection system maps. Data for each node and link (e.g., pipe diameter, pipe length, reservoir size and shape, pump curves, elevations, etc.) was entered into the model based upon available City records and field investigations.

The model was calibrated using flow data collected by Westech personnel during the summer of 2003. Flows and pressures were measured at approximately 18 hydrants throughout town. Model results at these locations were compared to the flow data. The Hazen-Williams roughness coefficients were adjusted and the model was re-run with the new roughness coefficients. This process was continued in an iterative fashion until the model provided reasonable agreement with the data. The error between the model and the field measurements ranged from less than 1% to a maximum of 12% with an average error of less than 6%.

### 6.6.2 Model Simulations

The calibrated model was used to investigate a number of conditions to determine the adequacy of the existing system. Both steady state and extended period (i.e., dynamic) model simulations were performed. In particular the conditions investigated include the following.

1. Existing peak hour demands.
2. Existing maximum day demands.
3. Fire flows to each model node in combination with the existing maximum day demand.

The model was also used to simulate various improvements to the distribution system to identify the most cost-effective solutions to the system deficiencies. Simulations with several combinations of the improvements listed below were analyzed. The improvements considered are listed as follows.

1. Addition of a storage reservoir on the west side of town.
2. Completion of a large diameter transmission main through the center of town.
3. Increasing WTP production.
4. Completion of a large diameter transmission main around the northern perimeter of town.
5. Completion of a large diameter transmission main around the southern perimeter of town.
6. Miscellaneous waterline size increases in various portions of the existing system.

The results from the previous simulations were used to develop a list of long-range improvements required to address system deficiencies and to serve the City through the planning period. Two timeframes were considered. Since transmission pipelines are not well suited for incremental expansion, it is cost effective to size the pipes for fully built-out conditions. Water production and storage facilities, on the other hand, are more suited for incremental expansion. Therefore, it makes sense to design these facilities based on 20-year projections rather than projections at build-out. Steady state simulations of the future system at buildout were performed to determine the required size of the transmission mains. The following simulations were performed.

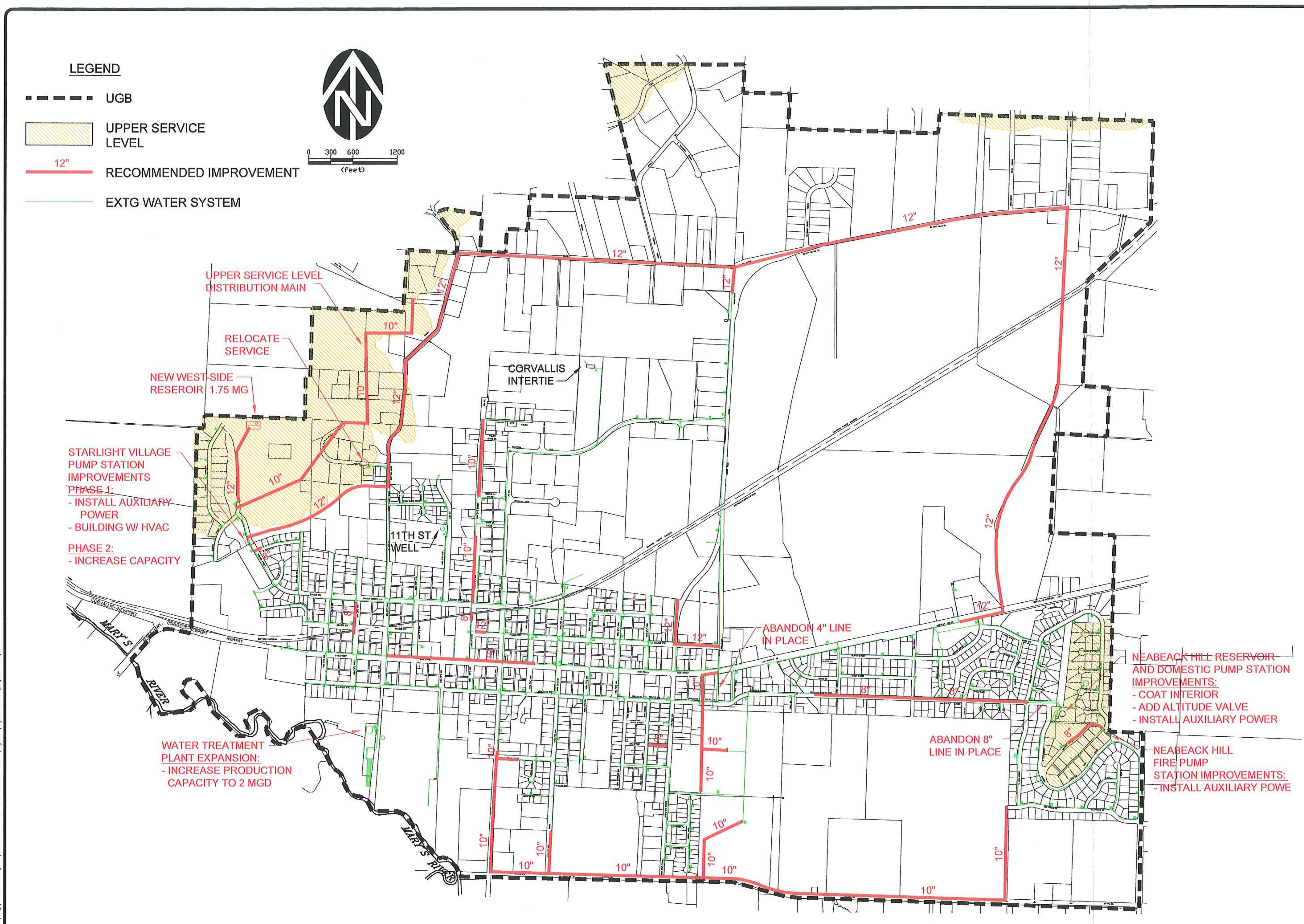
1. Peak hour demands at build-out.

2. Peak day demands at build-out.

3. Fire flows to each model node in combination with the existing maximum day demand at build-out.

### 6.6.3 Recommended Distribution System Improvements

The primary problem with the exiting distribution system is the inability to deliver adequate fire flows to large portions of the City. OAR 333-61-025 requires public water suppliers maintain a minimum pressure of 20 PSI at all service connections at all times. The current distribution system is incapable of delivering fire flows while maintaining 20 PSI at the highest service connections. The western most water service on Marylin Drive is located above the top of the main Philomath gravity service level. The top of the service level is defined by the 388 foot elevation contour. This particular service is located at an elevation of approximately 400 feet. Since this is the highest connection in the service level it controls the available fire flow to much of the City. This problem may be corrected by moving the service downhill to the east along Marylin Drive. As demonstrated above, the City's system currently lacks adequate storage capacity. Therefore, a primary element of the distribution system plan includes the addition of a storage reservoir on the west side of town. The addition of this reservoir significantly improves the available fire flow through much of the City. The recommended plan also includes the construction of arterial transmission mains around the north and south perimeters of town as well as some miscellaneous line upsizing and extensions. The plan also includes replacing some old waterlines that have a demonstrated history of repeated failures. The recommended distribution system improvements together with the recommended water supply, storage, and pumping improvements are shown in **Figure 6-1**. When completed, the recommended distribution system improvements should result in a system capable of delivering the fire and domestic demands discussed above. The individual projects are listed together with cost estimates in **Table 6-2**. Detailed cost breakdowns are included in **Appendix E**.




VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

| NO. | DATE | DESCRIPTION | BY |
|---|---|---|---|
| 1 | | | |
| | | REVISIONS | |

DSN. CB
DRN. TMT
CKD. CB
DATE: March 04


WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com


CITY OF PHILOMATH
2004 WATER MASTER PLAN

# RECOMMENDED WATER SYSTEM IMPROVEMENTS

FIGURE
6-1

JOB NUMBER
960.4140.0

Aug 30, 2005 - 9:58am
R:\Dwg\Philomath City of\2004 Water Master Plan 960.4140.0\Figures\Fig 6-1.DWG (Layout1 tab)

| TABLE 6-2<br>RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS | | | | |
|---|---|---|---|---|
| Location | Existing Size (inch) | Recommended Size (inch) | Length (feet) | Total Project Cost |
| **Dampier Street (Pioneer Street to West Reservoir)** | NA | 12 | 1100 | $142,000 |
| **Marylin Drive Service Relocation** | NA | NA | NA | $4,000 |
| **20th Street Waterline Extension (Main to Applegate)** | NA | 10 | 640 | $74,000 |
| **High School Site Waterline Extension (Applegate to end)** | NA | 10 | 1580 | $183,000 |
| **Ash Street Waterline Extension (19th to 18th)** | NA | 8 | 280 | $29,000 |
| **Main Street Waterline Replacement (9th to 14th)** | 8 | 8 | 2020 | $234,000 |
| **Applegate Street Waterline Replacement (Newton Creek Bridge to 30th Street)** | 8 | 8 | 2860 | $292,000 |
| **Canberra Street (connect to 12" in Pioneer St.)** | NA | 8 | 35 | $4,000 |
| **College Street (12th to 13th)** | NA | 12 | 200 | $26,000 |
| **12th Street (Pioneer to College)** | NA | 8 | 120 | $12,000 |
| **8th Street (Main to Pioneer)** | NA | 8 | 500 | $51,000 |
| **College Street (19th to 20th)** | 6 | 12 | 620 | $80,000 |
| **19th Street (College to End)** | 6 | 12 | 600 | $78,000 |
| **12th Street (Monroe to Houser)** | 4 | 10 | 1050 | $121,000 |
| **12th Street (Pioneer to Grant)** | 2 | 10 | 900 | $104,000 |
| **Benton View Drive Waterline Extension** | NA | 8 | 600 | $61,000 |
| **Upper Philomath Service Level Transmission Main (Pioneer Street to end)** | NA | 10 | 4600 | $532,000 |
| **Middle School Site Waterline Extension (From existing FH to Chapel Drive)** | NA | 10 | 1120 | $129,000 |
| **North Arterial Transmission Main** | | | | |
| Pioneer Street to 9th Street | NA | 12 | 2200 | $291,000 |
| 9th Street to Hills Road | NA | 12 | 3400 | $439,000 |
| Hills Road to Existing System in Green Road | NA | 12 | 4200 | $543,000 |
| Green Road to Boulevard Street | NA | 12 | 4550 | $588,000 |
| Boulevard Street to Corvallis-Newport Highway | NA | 12 | 6050 | $861,000 |
| **South Arterial Transmission Main** | | | | |
| 13th Street to Chapel Drive | NA | 10 | 1950 | $225,000 |
| Chapel Drive to 19th Street (Including 15th Street) | NA | 10 | 2450 | $283,000 |
| 19th Street to Southwood Drive | NA | 10 | 4950 | $576,000 |

## 6.7. Supervisory Control and Data Acquisition (SCADA) System

A SCADA system is needed to monitor and control the major components of the Water System. At a minimum, the system should monitor the Neabeack Hill Reservoir, the proposed west side reservoir, the 11th Street Well, the Neabeack Hill Domestic Pump Station, the Neabeack Hill Fire Pump Station, and the Starlight Village Pump Station. Recommended conditions/alarms at each facility include the following. This list is preliminary and subject to change. For example, if during the design of the facilities a natural gas powered generator is selected, low fuel alarms are no longer applicable.

**Neabeack Hill Reservoir/West Side Reservoir**

- Reservoir Level
- Low water Alarm
- High water Alarm
- Overflow Alarm
- Facility Security Alarms

**11th Street Well**

- Well Pump Run
- Well Pump Fail
- Well Level
- Loss of Control Power
- Low Well Level
- Discharge Rate
- Facility Security Alarms

**Neabeack Domestic Pump Station**

- Domestic Pump Run (2)
- Domestic Pump Fail (2)
- Loss of Power
- Generator Run
- Generator Fail
- Generator Low Fuel
- Facility Security Alarms

**Neabeack Fire Pump Station**

- Fire Pump Run
- Fire Pump Fail
- System pressure
- Loss of Power
- Generator Run
- Generator Fail
- Generator Low Fuel
- Facility Security Alarms

**Starlight Village Pump Station**

- Domestic Pump Run (2)
- Domestic Pump Fail (2)

- Fire Pump Run
- Fire Pump Fail
- System Pressure
- Discharge Rate
- Loss of Power
- Generator Run
- Generator Fail
- Generator Low Fuel
- Facility Security Alarms

**Water Treatment Plant**

- Raw Water Turbidity
- Finish Turbidity Combined
- Filter Finish Turbidity (4)
- pH Raw
- pH Final
- Raw Water Flow (4)
- High Service Pumps off/on/fail (4)
- Filter Backwash (4)
- Clarifier Flush (4)
- Low Filter Level (4)
- High Filter Level (4)
- Chemical Pump Fail (12)
- Facility Security Alarms

The costs for the new SCADA system are included in the electrical and control estimates for the water treatment plant expansion.

## 6.8. System Operation and Maintenance

This section discusses the need that exists in all water systems for system maintenance and outlines some of the basic elements necessary for all such maintenance programs. We have found that even for systems with good maintenance programs, providing the following general overview is useful in refining and periodically evaluating the ongoing maintenance program. The following discussion first addresses system-wide preventative maintenance, then outlines some general recommended approaches to system maintenance.

### 6.8.1 System-Wide Preventative Maintenance

Maintenance of water systems is necessary to insure the proper operation of the facilities and to obtain the full useful life of those facilities. Water systems represent significant investment of public capital. If a water system is allowed to fall into disrepair because of the lack of maintenance, it will not operate efficiently or as designed. Health problems and property damage may result from leaking mains or services, mainline breaks, inoperable valves or fire hydrants, etc. Repair of failed portions of a public water system are costly, quite often equaling or exceeding the original cost of construction. Because of this, it is imperative that municipalities consistently provide adequate maintenance funding to protect their investment in the water system. System maintenance can be separated into two types: preventive and corrective.

Preventive maintenance involves scheduled inspection of the system and data gathering to identify problem areas and analysis of this data so that scheduled maintenance can be targeted at specific problems. As a general rule, as preventative maintenance increases, the amount of corrective maintenance required decreases.

Corrective maintenance, often referred to as emergency maintenance, is typically performed when the water system fails, such as leaking mainlines, inoperable pumps or fire hydrants, etc. Corrective maintenance requires immediate action, and the City will typically pay a premium to have this work performed on an emergency basis.

### 6.8.2 Operation & Maintenance Recommendations

Overall, the City's current O&M practices are very good. The City normally replaces approximately five hydrants per year. The City also has in place an ongoing water meter replacement program. City crews also have the ability repair mainline and service line breaks as they occur. All of these activities are included in the City's current O&M budget. Listed below are some general recommendations that will further improve the reliability of the water system and assist significantly with future planning efforts. These items do not require much operator time once set up and help a great deal in examining and determining the water system's future needs.

#### 6.8.2.1 Pump Station Monitoring

All pumps should be exercised on a regular basis. This is particularly true for the fire pumps serving the Neabeack Hill and Starlight Village service levels. These pumps perform a critical emergency function. Should these pumps fail to start during a fire, significant property damage may occur. We recommend these pumps be started and put through a rigorous exercise program on a quarterly basis as a minimum.

#### 6.8.2.2 Hydrant and Valve Exercising and Maintenance

Based upon our observations around the water distribution system, it appears that many of the valves and fire hydrants are exercised or operated on a regular basis. However, our experience indicates that water system operators in small communities commonly have more tasks than time available. We have found that a standardized schedule and forms for valve and hydrant operation to be helpful in making sure that the tasks continue to be accomplished on a routine basis. We also find it helpful for the Fire

Department to perform some of the work such as hydrant inspection, maintenance and repair.

#### 6.8.2.3 Record Keeping

Complete record keeping will help assist operators in tracking trends and allow more time for the City to respond to meet the City's growing needs. At a minimum, it is recommended that the City maintain the records listed below. Some of the records listed below are already being maintained by the City. The City may wish to maintain additional records at their discretion.

a) WTP and 11th Street Well Production

The production from the WTP should be recorded on a daily basis including the quantity of water used for backwashing purposes. Upon completion of the new telemetry system, the City should also begin collecting hourly production data from both sources. Due to the volume of hourly data, we recommend collection and storage on an electronic basis.

b) Reservoir Level

Upon the completion of the new telemetry system, the City should begin collecting hourly reservoir level data. This data should be collected at the same time as the production data.

c) Water Consumption

The City should verify the accuracy of consumption records by performing a water audit on at least an annual basis. All meters should be read as close to the same date every month so that the period of record remains as uniform as possible from year to year.

## 6.9. Master Plan Update

As described in previous sections, water master planning is typically done at 20-year intervals. In the case of Philomath, these intervals have coincided with the need for new facilities. For example, the existing water storage and production facilities are reaching their capacity. This should be expected since these facilities were designed nearly 20 years ago to meet projected demands over a 20-year planning period. This current master planning effort is being undertaken at almost the same time that the new facilities are needed. This creates a cash flow problem since it does not provide sufficient time for the community to build reserve funds. One purpose of the master plan is to identify system needs and recommend capital improvements. This information is used to adjust user rates or to set savings goals for capital improvement budgets. Since in the case of Philomath, major projects are needed relatively soon, there is little time for the City to make spending or rate adjustments. The end result of this timing issue is that the City may be forced to borrow money to pay for the improvements rather than save money for future improvements. The latter alternative is always preferred since it allows for interest to accrue on the money in savings. In an attempt to avoid this situation during the next planning period, it is recommended that the City update this master plan at the halfway point of the current planning period. A budget of approximately $40,000 should be established for this purpose. This should make it easier for the City to adjust user rates, SDC fees, and spending as needed so that sufficient capital reserves are available to fund the necessary improvements at the time they are needed.