SECTION 6

Storage Alternatives

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Storage Need Analysis

As discussed in Section 5, Treatment Process Selection, the new WTP will require clearwell storage to meet needs for disinfection, backwashing of filters, pumping level fluctuation, short-term plant shutdowns, and in-plant water use. In addition to these needs at the treatment plant, municipal water systems also require storage within the distribution system to fulfill fire protection, emergency supply, and equalization needs. The criteria used to determine the City of Lebanon's distribution storage needs, and the required storage volumes were documented in the *Lebanon Water System Master Plan* (May 2007). **Exhibit 6-1** summarizes the storage criteria from this plan.

EXHIBIT 6-1
Distribution Storage Criteria (from Exhibit 9-4 in the *Lebanon Water System Master Plan*, May 2007)
City of Lebanon Water Improvement
Lebanon, OR

Category	Value	Discussion
Residential fire storage volume	210,000 gallons	Based on 1,750 gpm for 2 hours, which is the Insurance Services Office, Inc. (ISO) criterion
Non-residential fire storage volume	630,000 gallons	Based on 3,500 gpm for 3 hours, which is the ISO criterion
Equalization storage volume	25% of maximum day demand	This is a typical value for community water systems. It accounts for the diurnal demand fluctuation during the course of the day.
Emergency storage volume	Two times the average day demand	This is a typical value used for community water systems. It allows the city to supply customers for 2 days in the event of a complete supply interruption (if demands are at average levels).
Total distribution storage volume	Equals the sum of fire, equalization, and emergency values	This is a typical approach, although some systems based the total need on the sum of the equalization storage need plus the larger of the remaining two needs, fire or emergency
Used of closed-end pump stations in place of reservoir storage	Preference is to use these only for residential areas with 15 or fewer houses; acceptable for up to 30 houses maximum. Provide backup power and fire flow capability for closed-end pump stations.	
Reservoir design	Provide inlets and outlets that are separated horizontally and vertically from one another	Oregon construction standards for drinking water systems require separate inlet and outlet pipes; horizontal and vertical separation provides improved mixing and therefore, improved water quality

The city has two existing distribution storage reservoirs: 5th Street Reservoir and East Grant Street Reservoir. Both hold a maximum volume of 2.0 million gallons and have the same overflow elevation of 508.6 feet. The 5th Street Reservoir is located in the south of the city, just south of the intersection of 5th Street and Langham Lane. The Grant Street Reservoir is located on the east side of the South Santiam River. Its connecting pipeline crosses the river on the Grant Street Bridge.

According to the discussion presented in the 2007 master plan (Section 9, Exhibit 9-9), the total storage need for year 2010 is projected to equal 5.7 million gallons. This assumes that demand growth occurs as projected in the master plan and is based on summing the equalization, fire, and emergency needs. If a less conservative approach is used, that of summing the equalization need plus the larger of the fire or emergency need, the total need for 2010 is reduced to 5.1 million gallons. The city's system has a storage deficit of from 1.1 to 1.7 million gallons compared to the 2010 storage need.

The storage deficits for year 2025 and for buildout demands can be determined by following this same approach. **Exhibit 6-2** summarizes the deficit range for 2010, 2025, and buildout. The low end of the range is based on the sum of the equalization need plus the larger of the fire or emergency need. (The emergency need, at two times the average demand, is much larger than the fire storage need of 0.6 million gallons in all cases.) The high end of the range is based on summing all three needs for equalization, fire, and emergencies.

EXHIBIT 6-2
Lebanon Distribution Storage Needs (in million gallons)
City of Lebanon Water Improvement
Lebanon, OR

Year	Storage Deficit, Low End	Storage Deficit, High End
2010	1.1	1.7
2025	2.6	3.2
Buildout	9.7	10.3

Based on this analysis of storage needs, including a 2 to 3 million gallon storage addition as part of the water improvements project is recommended. Ideally, this storage would be included in the initial plant construction project. However, as the new plant will be more reliable than the existing plant and because the new plant will include a clearwell that provides some backup storage under most conditions, the city could delay adding the distribution storage for 5 to 10 years if budget constraints make that necessary.

Alternatives Evaluation

Location Evaluation

There are two alternative locations for adding distribution storage. The first location is at the 5th Street Reservoir site. The city is currently purchasing additional property to provide space for a second tank. The second option is to include additional storage at the WTP site.

An advantage of the 5th Street location is that it is elevated, and therefore provides gravity flow to the city's distribution system. Water must be pumped to the site so there is no energy savings compared to locating storage at the WTP site. The gravity flow out of a tank at 5th Street makes the supply reliable for fire fighting or emergency conditions. A disadvantage to gravity storage is that it is less flexible than storage provided at the WTP. The rate of flow out of a 5th Street tank depends on customer demands within the system and the resulting hydraulic grade line. Ensuring high enough rates of withdrawal from the tanks to achieve adequate turnover of the stored water may be difficult. Without adequate turnover, water quality problems may result.

The system performance resulting from additional storage at the 5th Street location was examined using the system hydraulic model. Withdrawal rates were determined for both average (winter-time) and maximum (summer) demands. The nighttime refill rate was also evaluated. Adding storage at the 5th Street location to meet near-term demands is a feasible alternative. However, careful management of flows would be required to ensure adequate turnover. The operators would need to limit pumping from the WTP during some periods of the day to allow sufficient volumes of water to be withdrawn from the 5th Street tanks. If this procedure is followed, only a slight increase in water age will result.

Locating additional storage at the WTP may be cost effective because a single, larger clearwell can be constructed, providing economy of scale for construction cost. Also, since all water delivered to the system passes through the WTP clearwell, this location achieves an adequate turnover rate. The disadvantage of the WTP site is that this storage does not flow into the system by gravity. Water from the clearwell is pumped into the city's system. This makes it less reliable than a gravity supply. However, if the finished water pump station includes a backup power supply, the risk of relying on pumps for fire flows or emergencies is minimized.

Configurations for Additional Storage Located at the WTP

The configuration of added storage at the WTP depends on the selected treatment process. If a conventional media filtration process is selected, the clearwell tank will be mostly below grade to accommodate gravity flow through the treatment processes. In contrast, if the pressure membrane treatment process is selected, the clearwell will be a ground-level tank. In a pressure membrane treatment process, water is pumped through the membranes and having a positive pressure remaining as the flow exits the membranes is desirable. For the preliminary site plan and costing for the membrane treatment option, a ground level clearwell tank with a 32-foot water depth was assumed.

Only concrete can be used for a below grade clearwell, because the other material option, steel, is not suitable for long-term burial. A ground level tank can be constructed of either concrete or steel. In the volume range of 2 to 5 million gallons, steel tanks have a lower first cost and generally a lower life cycle cost than concrete tanks. A steel tank requires repainting on a 20-25 year cycle whereas a concrete tank requires virtually no maintenance. The repainting of a steel tank is considered in the life cycle analysis, but generally does not add enough to the present worth, for this size range, to make steel more expensive than concrete. The cost estimates prepared for the membrane treatment option have assumed the use of steel.

Storage Addition Alternatives

Five options for providing an additional 2 million gallons of distribution storage were identified:[1]

1. Add a 2 million gallon steel tank at the 5th Street location
2. Conventional media filtration plant: Expand the volume of the buried concrete tank at the WTP from the 2 million gallons needed for disinfection and plant uses to a total of 4 million gallons to provide the additional 2 million gallons for distribution needs
3. Pressure membrane filtration plant: Install a second 2 million gallon steel tank at the WTP so that the plant has two 2 million gallon ground level tanks. This approach allows either tank to be removed from service for future repainting.
4. Pressure membrane filtration plant: Expand the size of the steel clearwell from 2 to 4 million gallons to provide an additional 2 million gallons for distribution needs. This arrangement requires the city to install a second tank within about 20-25 years, to allow the original tank to be removed from service for repainting.
5. Pressure membrane filtration plant: Expand the size of the clearwell from 2 to 4 million gallons to provide an additional 2 million gallons for distribution needs and use prestressed concrete rather than steel. Because the tank will not require painting, this arrangement avoids the need for the city to construct a second tank

Costs

Cost comparisons for the five options were developed using CH2M HILL's water treatment costing software and by considering project costs for recently completed steel and concrete tanks for Albany, The Dalles, Lincoln City, and Dallas. **Exhibit 6-3** summarizes the cost estimates. Similar to other estimates presented in this report, the costs are order of magnitude level. The cost estimate for the 5th Street location does not account for property purchase cost and assumes an average level of site development costs. The actual topography and site development needs for this location are unknown.

The least cost option is to expand a steel tank (appropriate only for the membrane treatment process option) from 2 to 4 million gallons. This has an estimated incremental cost of $0.8 million. The drawback to this option is that it will force the city to add another tank to the WTP within 20-25 years to allow for the original tank to be removed from service for the three to four months required for repainting. If the city's population and water demands continue to grow, adding additional storage may not be a significant drawback because the city will be considering expansion of the WTP. If demand growth is lower than projected, the city may be forced to expand the clearwell prior to a WTP expansion.

The next least costly option is to add a second 2 million gallon tank as part of a membrane treatment plant construction. This has an incremental cost addition of $1.9 million. This is $0.8 million less expensive than adding storage at the 5th Street location.

[1] A storage volume of 2 million gallons was arbitrarily selected for conceptual design. As the city approaches final design, larger storage volumes could be considered.

EXHIBIT 6-3
Lebanon Distribution Storage Needs (in million gallons)
City of Lebanon Water Improvement
Lebanon, OR

Option No.	Description	Incremental Cost (for 2 MG Tank or for Expansion of Clearwell by 2 MG)
1	2 MG tank at 5th Street location	$2.7 million
2	Expansion of buried concrete clearwell from 2 to 4 MG at the WTP site	$3.3 million
3	Addition of a second 2 MG tank at the WTP site	$1.9 million ($3.8 million for two 2 MG tanks)
4	Expansion of the steel clearwell tank from 2 to 4 MG at the WTP site	$0.8 million ($2.7 million for one 4-MG tank)
5	Construct the clearwell tank at the WTP using prestressed concrete; expansion of the clearwell tank volume from 2 to 4 MG	$3.9 million

Recommendations

Although the city needs additional distribution storage, to help control initial costs and provide project phasing, construction of a single 2 million gallon steel tank at the WTP site is recommended. A second 2 million gallon steel tank can be added to provide distribution storage within approximately 5-10 years. As noted, steel tanks must be repainted every 20 to 25 years, and must be out of service for up to four months. The second clearwell will be needed to allow the plant to continue operating while the first tank is painted.

If the city's funding was sufficient for the initial project to include an additional 2 million gallons of storage to address distribution needs, we recommend that this storage be added at the WTP rather than at the 5th Street location. The WTP site is preferred because of lower cost and less operational complexity. Additional storage at 5th Street will require more careful management of filling and emptying the reservoir to control water age and protect water quality.

Two options could be considered if the city includes the additional 2 million gallons as part of the initial WTP project. Designing both options, and bidding one as part of the base bid and one as a bid alternative, may be beneficial because the city could make a final decision based on firm prices. Option one is to include two 2 million gallon steel tanks. Option two is to replace the two steel tanks with a single 4 million gallon prestressed concrete tank. A concrete tank does not require periodic repainting, so two tanks are not necessary. As noted in **Exhibit 6-3**, the costs for the two options are similar. Two 2 million gallon steel tanks are estimated to cost $3.8 million and a single prestressed concrete tank is estimated to cost $3.9 million. At this level of cost estimation, the costs for each option are essentially equal. Depending on material costs and the bidding climate, one option or the other may provide cost savings to the city. Because of the difference in maintenance requirements for the two materials, a life cycle cost analysis should be performed as part of the competitive bid.