8 Groundwater Analysis

SECTION 8

Groundwater Analysis

This chapter summarizes an evaluation of developing a groundwater supply for the City of Lebanon. The complete groundwater evaluation, prepared by Golder Associates Inc., is presented in **Appendix C**. It describes three potential groundwater supplies:

- Develop groundwater supply wells at previously identified locations near the south and southwest portions of the service area (Shannon and Gill sites) as a supplemental groundwater supply to help meet peak summer demands and provide an emergency backup to the surface water supply.
- Develop river bank wells that target higher permeability sediments near the South Santiam River as a replacement to the city's existing raw water supply on the Santiam Canal.
- Develop an aquifer storage and recovery (ASR) system that stores treated drinking water delivered from the existing water treatment plant during the low demand winter period in an aquifer beneath the city. During peak demand summer months this water could be pumped to supplement the city's existing supply.

Background

In response to a recommendation included in the 1989 *City of Lebanon Water Facility Study* (KCM, 1989), work began in 1993 to evaluate the optimal number, location, and depth of proposed new groundwater supply wells. Studies were focused on developing a 500-gpm groundwater supply, with the primary objectives of identifying locations that would provide a safe and reliable additional source of drinking water for the city, and limiting the potential for a Division 9 review to determine whether the pumping would create excessive interference with nearby surface water. As a result, the locations for the wellfields were selected to be upgradient of known groundwater contamination sources in downtown areas, and greater than 1 mile from the South Santiam River. Two sites were identified and investigated: the Gill site (identified early as the Stoltz Hill site), and the Shannon site (formerly known as the 5th and Vaughn site).

Groundwater Supply Development: Shannon and Gill Sites

Previous investigations identified and evaluated two properties near the south and southwestern portion of the service area: the Shannon and Gill properties. Through discussions with city staff, capacity of 1,200 gpm, or two thirds of the average day demand at the end of the planning period (2025), was established as an appropriate target rate for a supplemental groundwater supply.

Supply Rate

Both sites appear capable of supplying approximately 250 to 300 gpm with two wells at each site. Each site would target wells in both the intermediate and deep zones to produce blended groundwaters to improve delivered quality (described below). Although the Shannon site is constrained, the Gill site appears to have sufficient available space to add additional wells while maintaining site setback requirements. Two additional wells could increase the site capacity to approximately 500 gpm, resulting in 750 gpm total from both sites. Two production wells were previously installed at the Gill site, so an additional four wells (two at Shannon, and two at Gill) are required to achieve this capacity. To meet the 1,200-gpm target for the groundwater supply option, at least one additional property with similar hydraulic characteristics would be required for well development. However, no promising property was found.

Water Quality

Groundwater quality is good at both the Gill and Shannon sites, with the exception of elevated manganese concentrations and the presence of radon. The deeper zone at each location has manganese concentrations that slightly exceed the secondary maximum contaminant level (SMCL), while the intermediate zone concentrations are below the SMCL. (Secondary standards are based on aesthetic and not health-related criteria.) At both locations two wells, one in the intermediate zone and one in the deep zone, would be necessary to blend water from both zones to achieve manganese concentrations below the SMCL. Because of the presence of radon above drinking water quality criteria, water produced from the two sites could not be added directly to the distribution system. Instead, groundwater would be pumped directly through new delivery piping to either an existing or new reservoir. At the reservoir, the water would be directed to a splash plate or baffle to aerate and remove radon prior to delivery.

Groundwater plumes associated with chlorinated solvents have been identified in all zones (shallow, intermediate, and deep) beneath downtown, and contaminated industrial sites are present farther to the north. A description of the Oregon Department of Environmental Quality (DEQ) -identified contaminated sites is given in Appendix C. The closest contaminated site (5th and Maple) is approximately 2.6 miles north/northeast of the Gill site, and 3.6 miles north of the Shannon site. Oregon law allows for environmental liability to be assigned to a party that either knowingly or unknowingly influences the distribution of pre-existing contamination by initiating pumping at a new well. The Jacob-Theis Equation (1946) was used to estimate the radius of influence of wells located at the Shannon and Gill sites. Although this analysis indicated that either new well site has the potential to create a hydraulic influence at the contaminated site downtown, because the wellfield locations are upgradient of the contaminants, the wells are unlikely to induce a significant change in flow fields or contaminant distribution. The most likely effect of pumping at the Gill and Shannon sites would be to slow the downgradient migration of contaminated groundwater.

The capture zone of a well is typically much smaller than the radius of influence, and extends predominantly in the upgradient direction. Consequently, it is very unlikely that contaminants at the identified sites could be captured by the groundwater supply wells. Permitting agencies (OWRD and DEQ) are likely to require a capture zone and influence analysis be completed with a simple analytical flow model to assess the potential hydraulic effects in the vicinity of the chlorinated solvent contamination downtown.

Water Rights

Both the Shannon and Gill sites are located at distances far enough from the South Santiam River that they are not eligible to be considered as additional points of diversion for surface water rights. Consequently, an application for new groundwater rights would be required. The radius of influence of pumping includes two small creeks in the vicinity of the Gill site, and one at the Shannon site. As part of the water right permitting effort, OWRD will require a review to determine if pumping groundwater has the potential to impair flows at these locations and impact either aquatic habitat or senior water rights holders.

Recommendations for Groundwater Supply Development

It does not appear feasible for the city to develop a 1,200-gpm supplemental groundwater supply. The city may be able to develop a 750-gpm supply from the Shannon and Gill sites. However, river bank wells (discussed next) may provide many of the benefits of a groundwater supply without the drawback of manganese and radon contamination.

River Bank Wells

River bank wells located near the South Santiam River would be designed to induce surface water flow from the river to the wells. Water obtained through river bank wells, with appropriate treatment, could serve to meet the 1,200-gpm emergency or supplemental supply requirements of the city. If sufficient capacity is available, river bank wells potentially could replace the Santiam Canal as the city's raw water source.

Supply Rate

River bank wells completed near a surface water feature generally exhibit higher yields for two reasons:

1. Pumping induces flow from the nearby surface water feature, which provides a continuous supply of water to the aquifer and thereby limits drawdown in the well.
2. The chances of encountering shallow higher permeability sand and gravel associated with stream channel deposits increases near the active channel.

River bank wells would be required to be relatively shallow at 50 to 100 feet. Wells screened beneath the clay confining layers are unlikely to be in sufficient hydraulic connection with the river to induce adequate flow to increase well yield.

To evaluate the potential for river bank wells, well logs for the area south of Lebanon near the Santiam River between Cheadle Lake and the Santiam Canal diversion were collected and analyzed. The logs (available on-line from the OWRD) encompassed Township 12, Ranges 1 and 2 West. Of 1,034 well records with a reported yield, only 18 listed yields in excess of 200 gpm. The high-yield wells (> 200 gpm) were distributed through the area from downtown Lebanon just north of Cheadle Lake south to Sodaville. There is no apparent correlation between distance from the river and yield, or between depth and yield. Four of the five wells with reported yields of 500 gpm and greater were completed at depths between 50 and 100 feet. Most of these are near Sodaville, one is near the former Cascades Plywood plant near Cheadle Lake, and another is north of the river and completed in basalt.

The review of well logs does not identify a specific area or zone of high permeability sediments (other than near Sodaville) within the service area close to south Lebanon. Although the River Mountain School area appears promising from a location standpoint, the well drilled for the school is relatively shallow, sited as far from the river as property boundaries will allow, and yields approximately 50 gpm. This provides little information that will allow an assessment of how a new well would perform closer to the river.

The variability of reported well yields reflects the variability of the stream deposits in the vicinity of the river. This review did not identify high-yield wells in the area, and therefore does not allow an estimate of the maximum potential well yield on a particular site. The variable nature of the depositional environment results in variable thicknesses of high permeability sands and gravels within a relatively small area. Evaluation of permeability and hydraulic connection with the South Santiam River through a geophysical survey, followed by a drilling and testing program, would be necessary to provide an estimate of well yield at a selected location.

Water Quality

A portion of the water captured by a river bank well will be groundwater from the aquifer system upgradient of the well. As a result, a well sited near the South Santiam River would capture some groundwater, possibly influenced by the radon and manganese concentrations present in the Lebanon area. However, the relative proportion of groundwater to surface water should reach 1:4 or 1:5 after several days (or hours) of pumping, and the overall product should primarily exhibit the water quality characteristics of the South Santiam River.

As noted above, the drawdown in a river bank well is limited at a given production rate. Therefore, the capture zones that extend into the aquifer system away from the river also are limited, and the potential for capture of contaminated groundwater is reduced. However, because the river bank wells will be relatively shallow, captured groundwater is likely to originate in an unconfined aquifer. Lebanon will need to institute a wellhead protection program and exercise vigilance to help prevent contamination of the aquifer from activities on the ground surface.

As surface water passes through the subsurface to the river bank wells, suspended material (turbidity, pathogens, color-causing particulates) and dissolved organic compound concentrations may be reduced. To determine the level of treatment required prior to distribution, a microscopic particulate analysis (MPA) must be conducted. If removal of surface water pathogens to Safe Drinking Water Act (SDWA) standards is demonstrated, disinfection is the only treatment requirement prior to distribution; otherwise, river bank well water must be treated as any other surface water source.

As noted, river bank wells have the potential for removing suspended material from source water. This is a positive attribute, but over time the capacity of river bank wells can be reduced as material accumulates in the aquifer. Periodic reconditioning of the wells may be necessary to maintain the desired capacities.

Water Rights

Because river bank wells induce flow from a surface water source, water produced by the wells is considered surface water, and a surface water right is required. The likelihood of using the city's existing surface water rights to allow this withdrawal, and the necessary actions to achieve this, are discussed in Chapter 5.

Recommendations for River Bank Well Development

To further address the supply capacity and water quality associated with developing river bank wells, the following steps are recommended:

1. Identify properties that have potential for use as a new city wellfield and evaluate ownership and the possibility of acquiring access for site testing.
2. Review the Oregon DEQ environmental cleanup site (ECSI) database to evaluate the presence of known releases in the site vicinity.
3. Complete a surface geophysical survey to identify the presence, depth, thickness and extent of higher-permeability gravels on the selected site(s).
4. If an existing well is available, evaluate the well log to assess well construction. If the well is completed in the target zones, develop a testing program using the existing well to assess hydraulic connection with the river and potential site yield.
5. If the geophysical survey indicates the presence of gravel layers or significant lenses beneath the site and no existing well is available, drill a small-diameter test well at each selected location and complete site testing to evaluate permeability, hydraulic connection with the river, and likely well (and combined site) yield. Use results to develop a recommendation for installing a larger-diameter production well.
6. Select a site, negotiate property acquisition or utility easements, drill, construct, and permit a high-capacity well.
7. Complete an MPA testing program to confirm that the delivered water meets filtration requirements and can be disinfected and added to the city's supply system.
8. Perform the water rights actions as described in Chapter 5.

Aquifer Storage and Recovery

ASR systems usually are operated to take advantage of available WTP capacity during winter months to store treated water in a suitable aquifer system, and to recover that water through wells during the summer months to help meet peak demands. Aquifer storage displaces the native groundwater and effectively creates an underground reservoir of water that can be recovered for a variety of applications. The number of active ASR projects in Oregon has increased from 0 in 1995 to 10 in 2005, with at least 20 wells in use or under development.

In addition to providing a source option, four additional potential benefits of a Lebanon ASR system were identified:

- The water recovered from an ASR well will primarily reflect the water produced by the WTP. ASR could be used to mitigate the radon and manganese concentrations in native groundwater.
- WTP capacity can be optimized. Recovered water can be used to meet peak demands and extend the length of time before a water treatment facility expansion is required.
- Storage capacity can be added at locations within the water supply system where demand is increasing, where there is a benefit to enhancing chlorine residuals, or where there is a benefit to delivering water directly to different pressure zones.
- Environmental benefits are created through reduction of stress on water-related habitats during dry periods.

Supply Rate

An ASR well will deliver water at the rate associated with any appropriately designed water supply well. The target aquifer systems are usually confined systems, both to provide a groundwater protection benefit, and to limit the potential for the interaction with nearby shallow domestic wells and surface water features. Consequently, Lebanon-area ASR wells would have the same location targets and potential yields as the groundwater supply well options (Shannon and Gill sites) unless exploration for higher-permeability sites identified better targets. ASR wells would be sited to avoid the locations preferred for river bank wells to avoid the potential for loss of stored water to the South Santiam River.

Based on the evaluation of the Shannon and Gill sites, the most likely yield of any new ASR well would be near 300 gpm. The well log review indicates that where wells encounter greater thickness of higher-permeability gravels, well yields are substantially higher. Most of the higher yield wells in the Lebanon area are south and east of the service area. However, similar conditions are likely to exist closer to town. The locations where higher-permeability layers are present are difficult to discern from available well logs. The majority of the wells in the Lebanon area are relatively shallow wells drilled for domestic supply use, and consequently were not extended further into the aquifer system than was necessary to obtain 5 or 10 gpm.

Because recharge rates are typically held to 75 percent of the production rates, a 300 gpm production well would recharge at approximately 225 gpm. Over a 6-month recharge period, approximately 58 MG would be stored in the subsurface. If 90 percent of this volume were recovered to the system with a single well, it would require approximately 4 months to recover.

Water Quality

Recovered water quality in most ASR systems generally reflects the source water, although some mixing with native groundwater does occur. Early in the recovery period the percentage of stored water returning to the well is highest, trending toward a greater proportion of native groundwater with additional pumping time. If necessary, the degree of mixing can be lessened with alternative storage zone development approaches. ASR could be used to mitigate the manganese and (with less certainty) radon concentrations in water supply wells in the Lebanon area.

ASR operations reduce the potential for pumping to interact with areas of known groundwater contamination because the wells do not induce movement continuously toward the wellfield. If the ASR system is operated annually to recover the stored water, it is easily demonstrated that the recharge and recovery operations create offsetting directional flow vectors at distance from the ASR facility, resulting in no net change in year-to-year groundwater movement. An evaluation of the influence of ASR operation on existing contaminant plumes would be required by the permitting process.

Water Rights

The permitting process requires a valid water right to appropriate the source water for storage, and an assessment of the potential for impacts to nearby groundwater users. Because ASR systems typically operate in a fashion that has no net impact on the annual groundwater budget, it is more likely that an ASR system would be viewed as having less impact on nearby surface water features (for example, Oak Creek) and groundwater supplies than a groundwater extraction wellfield. Consequently, ASR permitting is likely to be less costly, require less stringent mitigation planning, and has a greater chance of success than obtaining a new groundwater right.

Recommendations for ASR Development

The city is unlikely to pursue this supply option unless water rights restrictions limit the preceding alternatives' feasibility. The following steps are necessary to evaluate the feasibility of developing an ASR operation in Lebanon:

- Determine whether ASR development costs at the Shannon and Gill sites are higher or lower than the costs to build onsite reservoirs or dedicated piping to existing reservoirs for radon management.
- Evaluate whether there are portions of the service area that could benefit from additional pressure, chlorine residual, or supply.
- Evaluate the benefit of having an additional water source in the event of a WTP shutdown.

Conclusions and Recommendations

The three groundwater-focused supply options are summarized in **Exhibit 8-1**.

The option of using new groundwater wells was investigated as a possible approach for obtaining a supplemental supply for the city. However, wells are unlikely to yield the 1,200 gpm target capacity without identifying, testing, and developing sites in addition to the Shannon and Gill properties. Likewise, although ASR may provide several water management benefits, this option shares the disadvantage of likely requiring an additional wellfield location to meet the 1,200 gpm target capacity. No other favorable wellfield locations were identified in this analysis.

River bank wells may provide an alternative to replace the city's existing supply on the Santiam Canal. This may fit with the city's overall supply development and treatment goals as discussed in Chapter 7 of this report. River bank wells may be favorable because of the following advantages:

- Relatively higher per-well yield, and therefore lower development costs
- The greatest potential for high-quality delivered water
- The least potential to interfere with contaminants in other areas

The city has identified several sites with the potential for river bank well development. The recommended approach for evaluating the best site is to rank them on the basis of site investigations to identify hydraulic and subsurface characteristics. Site investigations will include the following procedures:

- Electrical resistivity surveys at each location to evaluate the presence of shallow bedrock and permeable gravels at depths likely to be in hydraulic connection with the South Santiam River.
- An evaluation of aquifer hydraulic properties using an existing onsite well (if available) or adjacent irrigation well (if available and access permits).
- If the geophysical surveys indicate positive stratigraphic relationships, a test well will be drilled at each location to confirm the subsurface stratigraphy, and to complete an aquifer test to assess the following:
  - Aquifer hydraulics
  - Hydraulic connection to the nearby river
  - Likely yield of a production well
  - Likely well interference, appropriate spacing, and wellfield capacity of a river bank well system installed at the selected site

With this information, the city will be able to decide whether river bank wells are the best option for a replacement or backup water supply. If feasible, the site-specific information could then be used to design the river bank well system to provide the optimal well yield while maximizing the potential for sufficient removal for filtration credit. If achieving sufficient supply appears feasible, the city could complete an analysis that will lead to development of engineering, site acquisition and development, permitting, drilling, testing, and construction costs for the project.

EXHIBIT 8-1
Groundwater Alternatives Comparison

Groundwater Supply Option	Supply Capacity	Water Quality	Water Rights	Relative Advantages	Relative Disadvantages	Primary Uncertainties	Relative Cost Comparison
Option 1: Groundwater Backup (Consumptive)	200 - 300 gpm/well 400 - 500 gpm Gill site 300 to 500 gpm Shannon site At least 3 sites required to supply 1,200 gpm target.	Multiple depth wells required for blended water below manganese SMCL. Radon exceeds action levels, delivery to storage tank required for aeration.	New groundwater rights required.	Two sites have been identified and evaluated. Two wells exist at the Gill site. Observation wells exist at both sites.	Water quality issues increase development costs. Groundwater/surface water interference will increase permitting effort. Groundwater modeling likely required to address plume movement.	Obtaining new groundwater right will require detailed evaluation of surface water impacts, Willamette Basin water rights, and radius of influence assessment. Site acquisition status unknown. Additional (third and perhaps fourth) site required. Limited potential to influence contaminant distribution.	Site development costs greater than Options 2 and 3 because of dedicated piping/reservoirs. Permitting cost greater than Option 2
Option 2: River Bank Wells	Unknown. Site-specific investigation required. Likely greater than deeper groundwater wells.	Would primarily reflect South Santiam River. Some blending with groundwater, but manganese and radon concentrations likely to be low. Unlikely to capture or influence downtown area contaminant plumes.	Use surface water rights.	Could yield greater volume with fewer wells. Water may not require filtration.	Site investigation required to define rates/volumes and filtration.	Site acquisition. Field testing required to determine site-specific aquifer permeability, hydraulic connectivity, and yield. MPAs could identify need for treatment if filtration is inadequate. If treatment required, not favorable for emergency backup. Some water rights issues. Need to consider river bank wells in light of the city's overall water supply and treatment options, as discussed in Chapter 6 of this master plan.	Site development costs less than Options 2 and 3 because fewer number of wells and sites are likely necessary. Lowest permitting cost.
Option 3: Aquifer Storage and Recovery	200 - 300 gpm/well 500 - 600 gpm/site At least 3 sites required to supply 1,200 gpm target.	Primarily reflects treated surface water. Blending and aeration not likely necessary. Unlikely to capture or influence downtown area contaminant plumes.	ASR permitting process required.	Same as Option 1, with improved water quality, easier permitting.	ASR permitting process more involved than Option 2.	Uncertain whether radon can be displaced by stored water. Additional (third) site required to meet target rate.	Roughly equivalent to Option 1.