9 Distribution System Evaluation

SECTION 9

Distribution System Evaluation

This chapter describes the hydraulic modeling and other analyses that were performed to determine the adequacy of the distribution reservoirs, pump stations, and pipelines to meet current and projected future demands. Much of the analysis was performed using a computer model that simulates the movement of water throughout the distribution system.

Description of the Distribution System

Potable Water System

Exhibit 9-1 is a map of the current potable water distribution system showing the city limits, UGB, existing water lines and elevation ranges within the UGB. **Exhibit 9-2** provides a schematic diagram of the system that illustrates the reservoirs and treatment plant in relation to the customer service elevation range.

Reservoirs

In addition to the water treatment plant clearwell, which provides operating storage for the plant, the city's distribution system has two reservoirs. Both are located on hills. Each has an overflow elevation of 509 feet, and provides gravity storage for the city's customers. One reservoir is located south of the city on South 5th Street. It has a radius of 42.7 feet, height of 48 feet and was constructed in 1979. The other is located east of the river on East Grant Street. It has a radius of 52 feet, height of 32 feet and was constructed in 1962. Both are constructed of steel and have storage volumes of 2.0 MG.

Pump Stations

One pump station, located at the WTP, serves the Lebanon distribution system. This high-service pump station has four pumps with a total capacity of 7,500 gpm (10.8 mgd) and a firm capacity (largest pump out of service) of 4,500 gpm (6.5 mgd). A summary of the pumps and their capacities is provided below:

- Pump 1: 1,500 gpm
- Pump 2: 1,000 gpm
- Pump 3: 2,000 gpm
- Pump 4: 3,000 gpm

Service Zones

The area currently served by the city's water system has flat topography; the entire service area lies within one pressure zone. All customers are supplied by gravity storage from the two reservoirs.

As the city's water service expands to meet demands of a growing population, the city will need to develop upper pressure zones (above the 400 feet elevation contour) in several areas. Shown in blue on Exhibit 9-1, these areas are east of the South Santiam River and in the southwest region of the city's UGB.

Non-Potable Water System

In 1984 the City of Lebanon acquired a non-potable, fire protection water system located at the Santiam Canal Industrial Park (SCIP). This system was formerly owned by Crown Zellerbach (also listed as James River Corporation, now Fort James) and provided fire protection for a processing mill at the site. **Exhibit 9-3** is a map of the system. The City of Lebanon applied for, and received, funding to improve access to the industrial park, and the area became fully functional in 1986 with the construction of Industrial Way and a bridge over the canal.

The SCIP fire suppression system is fed via a pond that receives water diverted from the Santiam Canal. In 1991, the headgates were updated with automatic floats to regulate the diversion of water to the pond. Water rights (certificate 49335) previously owned by Crown Zellerbach were transferred to the City of Lebanon to continue the fire protection required by industrial users.

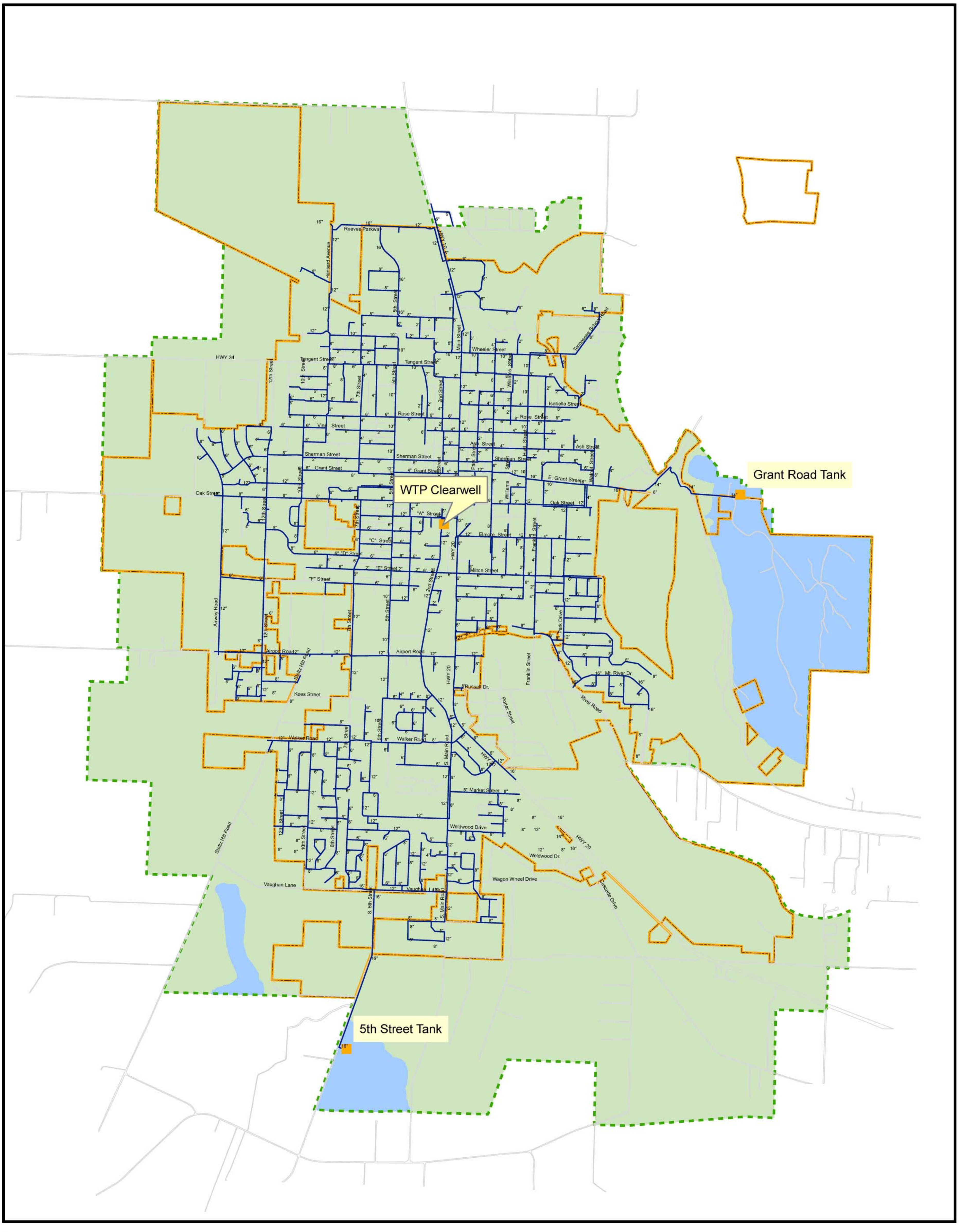
Water from the pond is delivered to a 122-foot, 75,000-gallon, steel water tower (overflow elevation = 461 ft) through 8-inch non-potable water lines by two pumps located in the pump house just northeast of the pond. Pump #1 is capable of delivering 350 gpm and pump #2 is able to produce 500 gpm. The water reservoir tower is located on the east side of the canal and south of Industrial Way. The reservoir feeds an approximately 2,350 lineal feet, looped 8-in pipe system. This system provides fire hydrants at 4 locations: 2 on the current Rick Franklin property, and two on an 8-in extension along Industrial Way.

Distribution Regulations

The distribution system must be capable of meeting the requirements for public drinking water systems.

The Oregon Department of Human Services Drinking Water Program (ODHS DWP) has regulatory authority over public water systems in Oregon. In general, the state's rules govern the quality of water and not the manner in which it is distributed. However, the rules do contain a limited number of standards for storage and piping criteria:

- Distribution piping shall be designed and installed so that the pressure measured at the property line of any user shall not be reduced below 20 psi (OAR 333-061-0050(9)(e)).
- Wherever possible, dead-ends shall be minimized by looping. Where dead-ends are installed, blow-offs of adequate size shall be provided for flushing (OAR 333-061-0050(9)(h)).
- Wherever possible, distribution pipelines shall be located on public property. Where pipelines are required to pass through private property, easements shall be obtained from the property owner and shall be recorded with the county clerk (OAR 333-061-0050(9)(a)).



Legend

Pressure Zone ID
- < 400-ft
- > 400-ft

- Urban Growth Boundary
- City Limits
- Streets
- Pipes
- Tanks

N

0 1,500 3,000 4,500
Feet

Exhibit 9-1
System Schematic

Lebanon Water Master Plan

CH2MHILL

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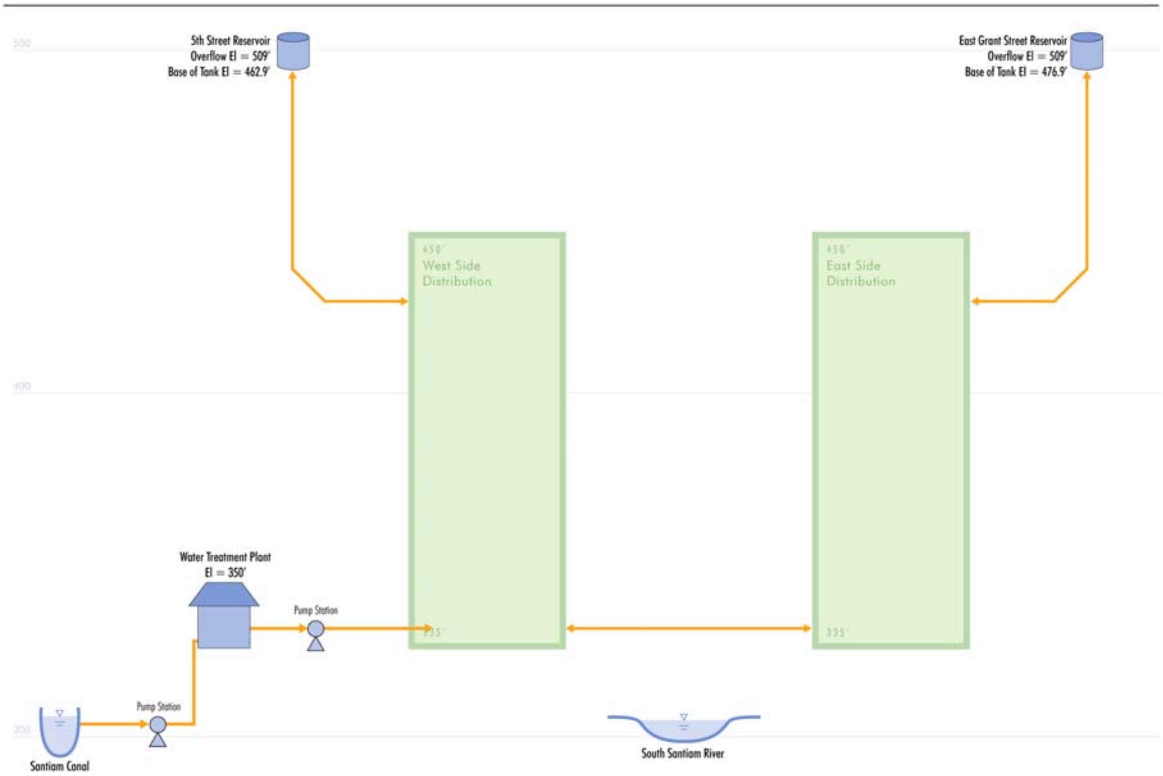

EXHIBIT 9-2
Lebanon Water Master Plan System Schematic
CH2MHILL

W062005003CVO-LWTP_103_01

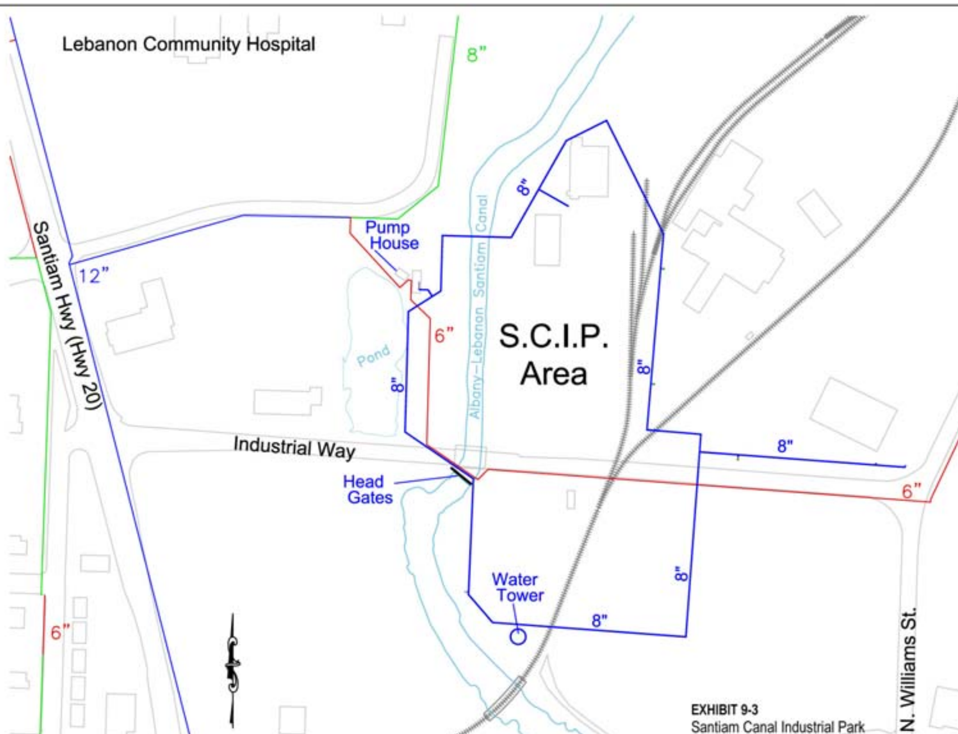

EXHIBIT 9-3
Santiam Canal Industrial Park
Non-potable Water System
Lebanon Master Plan
CH2MHILL

W062005003CVO-LWTP_110_02

- Wherever possible, booster pumps shall take suction from reservoirs to avoid the potential for negative pressures on the suction line, which could result when the pump suction is directly connected to a distribution main. Pumps that take suction from distribution mains shall be provided with a low-pressure cutoff switch on the suction side set at no less than 20 psi (OAR 333-061-0050(8)(a, b)).

ODHS' rules also include construction standards that must be met when new projects are designed and constructed. Construction standards are found in OAR 333-061-0050.

Distribution Planning Criteria

The criteria listed in **Exhibit 9-4** were used as a basis for evaluating the city's distribution system. Many of the criteria have been in effect for a number of years, although some were modified during the development of this master plan.

EXHIBIT 9-4
Distribution System Planning Criteria

Category	Value	Discussion
Residential fire storage volume	210,000 gallons	Based on 1,750 gpm for 2 hours, which is the 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	A typical value used for community water systems—accounts for the diurnal demand fluctuation during the course of a day
Emergency storage volume	Two times the average day demand	A typical value used for community water systems—city can supply customers for 2 days in the event of a complete supply interruption, if demands are at average level
Total storage volume	Equals sum of fire, equalization, and emergency values	Standard water system design practice
Pipe sizing	12-inch-diameter loop (for up to 1 mile square); 8-inch-diameter internal grid	Follows Washington Administrative Code and standard waterworks practice (Oregon does not have pipe sizing requirements in its regulations)
Operating pressures	40-80 psi	Oregon requires 20 psi at all times. The 40-80 psi range is a typical desired range for community water systems
Fire flow pressures	20 psi	Minimum zone pressure during fire flow event.
Reservoir design	Provide inlets and outlets that are separated horizontally and vertically	Oregon regulations require separate inlet and outlet pipes; horizontal and vertical separation provides improved mixing and, thus, improved water quality
Pump station sizing	Size for maximum day demand with largest pump out of service; provide minimum of three pumps	Standard waterworks practice; demands higher than maximum day are met through a combination of pumping and withdrawals from storage reservoirs

EXHIBIT 9-4
Distribution System Planning Criteria

Category	Value	Discussion
Use of closed-end pump systems 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 stations.	Although it is desirable to serve all customers with gravity storage, the cost for providing gravity storage is prohibitive unless the area will develop to a sufficient number of customers. In addition to cost considerations, using a storage reservoir for too few customers may result in water quality problems.

Model Development

The City of Lebanon provided geographic information system (GIS) shapefiles of the distribution system to CH2M HILL. The shapefiles included only pipe data and not pumping and storage facilities. The pipe shapefiles were imported into WaterGEMS software and the piping configuration around the reservoirs and the high service pump station were manually adjusted. High-service pump station operating information, including pump curve data, and reservoir dimensions were incorporated into the model. Elevations were applied using a digital terrain model (DTM).

Demand Allocation

System-wide water demands were developed from existing water use data and are discussed in Chapter 3. Existing demands were allocated to the water distribution system using information on current land use. Areas in which future growth is expected were identified through discussions with city staff. A Thiessen polygon method was used for the spatial allocation of current and future demands. Portions of the demand were allocated to individual model nodes based on the area and type of land use that each node serves. **Exhibit 9-5** summarizes the demands used for the modeling analysis.

Although the demand projections shown in Exhibit 9-5 were used to allocate demand throughout the system, the demand total is less important for distribution system analysis than the representation of the pipe network, often referred to as pipe connectivity, and the allocation of demand. Fire flows generally dictate the need for distribution improvements, and fire flows are dependent on the land uses within a service area and not customer demands.

EXHIBIT 9-5
Summary of Modeling Demands

Year	Average Day Demand (mgd)	Maximum Day Demand (mgd)	Peak Hour Demand (mgd)	Minimum Hour (Reservoir Refill) Demand (mgd)
2005 (existing)	1.93	3.53	4.94	1.77
2025	2.70	4.73	6.62	2.48

Calibration

The model was calibrated with field data to ensure that the model accurately predicted pressures in the distribution system. During hydrant flow tests on April 11 to 14, 2005, six hydrants in the distribution system were flowed while flow rate and system pressure data were collected at sampling stations distributed throughout the system and shown in **Exhibit 9-6**. Additional system data, including water levels in the Grant and 5th Street Reservoirs, and pump station operating status and discharge pressures, were collected to define the system boundary conditions.

Calibration of the existing model was performed by comparing steady-state and fire flow model runs with the field data. Calibration verifies proper connectivity and demand allocation of the model for simulation of the actual system.

The following steps were performed to improve model calibration.

1. The pump station was simulated as a source during steady-state conditions; field pressures were compared to those generated using the model.
2. Fire flow for each hydrant location was simulated in a separate scenario; field and model-predicted pressures were compared.

Exhibit 9-7 shows a sample of the field and model-predicted pressures for all monitoring locations for the fire flow test at Stolz Hill Road and Walker Road. **Exhibit 9-8** shows the percent difference between the field and model-predicted pressures for all calibration runs. The model matched field pressure measurements well; only one data point had a model-predicted pressure that was greater than 10 percent different from the field-measured value, and only five data points were greater than 5 percent different. Model error within 10 percent is typically considered acceptable. The similar results between modeling and field data show that the model is reliable for evaluating system performance.

EXHIBIT 9-7
Field and Model Measurements Sample Comparison

	Fire Flow at Stolz Hill Rd. and Walker Dr.			
	Residual Pressure (psi)			
Location	Field (Measured)	Model (Predicted)	Pressure Difference	Percent Difference
1. 5th Street	69	71	2	3%
2.Milton	64	65	1	1%
3. Maple	68	69	1	2%
4. 6th Street	67	69	1	2%
5. Pennington	71	72	1	2%
6. Hospital	68	70	2	3%
7. Isabella	64	67	3	5%
8. Oak	64	65	1	2%
9.Violet	60	61	1	1%

EXHIBIT 9-7
Field and Model Measurements Sample Comparison

	Fire Flow at Stolz Hill Rd. and Walker Dr.			
	Residual Pressure (psi)			
Location	Field (Measured)	Model (Predicted)	Pressure Difference	Percent Difference
10.12th Street	64	65	1	2%
11. Walker	0	57		
12. Kees	63	64	1	2%
13. Steelhead Court	61	62	1	1%
14. Oak Terrace	58	59	1	1%
15. Jadan	59	61	2	3%
16. Carolina	68	69	1	1%
Average Percent Difference				**2%**

System Evaluation Results

The evaluation of the water distribution system is divided into three sections in this chapter: storage, pumping, and piping. The storage analysis evaluates storage capacity against required storage volume for emergency, equalization, and fire flow. The pumping capacity analysis evaluates pumping capacity to meet MDD in all zones. The pipe network analysis evaluates the pressure in the system and identifies locations where pipes may be undersized.

Storage Evaluation

Distribution storage is necessary to satisfy three uses: equalization, fire fighting, and emergency. Equalization storage provides the water to compensate for the difference between the PHD and the supply (which is designed to meet MDD). Fire fighting storage provides a reserve for the high flows needed by the fire department to fight fires. Emergency storage provides a reserve to supply customers during times when the supply is interrupted. Such interruptions might be caused by a mechanical system failure at the WTP, a power system failure, or a chemical spill into the canal. Storage volume planning criteria were presented in Exhibit 9-4.

EXHIBIT 9-8
Summary of Field and Model Calibration Percent Difference

	Steady State	Fire Flows					
Location		**Stolz Hill Road & Walker Drive**	**Hansard Ave. & Reeves Pkwy.**	**Vine Street & 9th Street**	**WWTP at Entry Road**	**915 Mountain River Road**	**Weldwood Dr. & Main Street**
1. 5th Street	1%	3%	12%	3%	4%	4%	1%
2.Milton	0%	1%	2%	2%	3%	1%	1%
3. Maple	2%	2%	3%	4%	0%	1%	2%
4. 6th Street	1%	2%	5%	9%	1%	2%	1%
5. Pennington	2%	2%	9%	5%	4%	4%	2%
6. Hospital	0%	3%	5%	5%	2%	2%	3%
7. Isabella	5%	5%	5%	9%	6%	5%	6%
8. Oak	0%	2%	3%	3%	0%	2%	1%
9.Violet	2%	1%	1%	1%	0%	0%	0%
10.12th Street	0%	2%	3%	4%	2%	2%	2%
11. Walker	2%	---	3%	1%	0%	0%	2%
12. Kees	1%	2%	2%	3%	1%	2%	3%
13. Steelhead Court	0%	1%	2%	2%	1%	4%	1%
14. Oak Terrace	0%	1%	1%	2%	0%	1%	1%
15. Jadan	0%	3%	2%	4%	2%	1%	4%
16. Carolina	0%	1%	4%	4%	3%	1%	1%
Average Percent Difference	**1%**	**2%**	**4%**	**4%**	**2%**	**2%**	**2%**

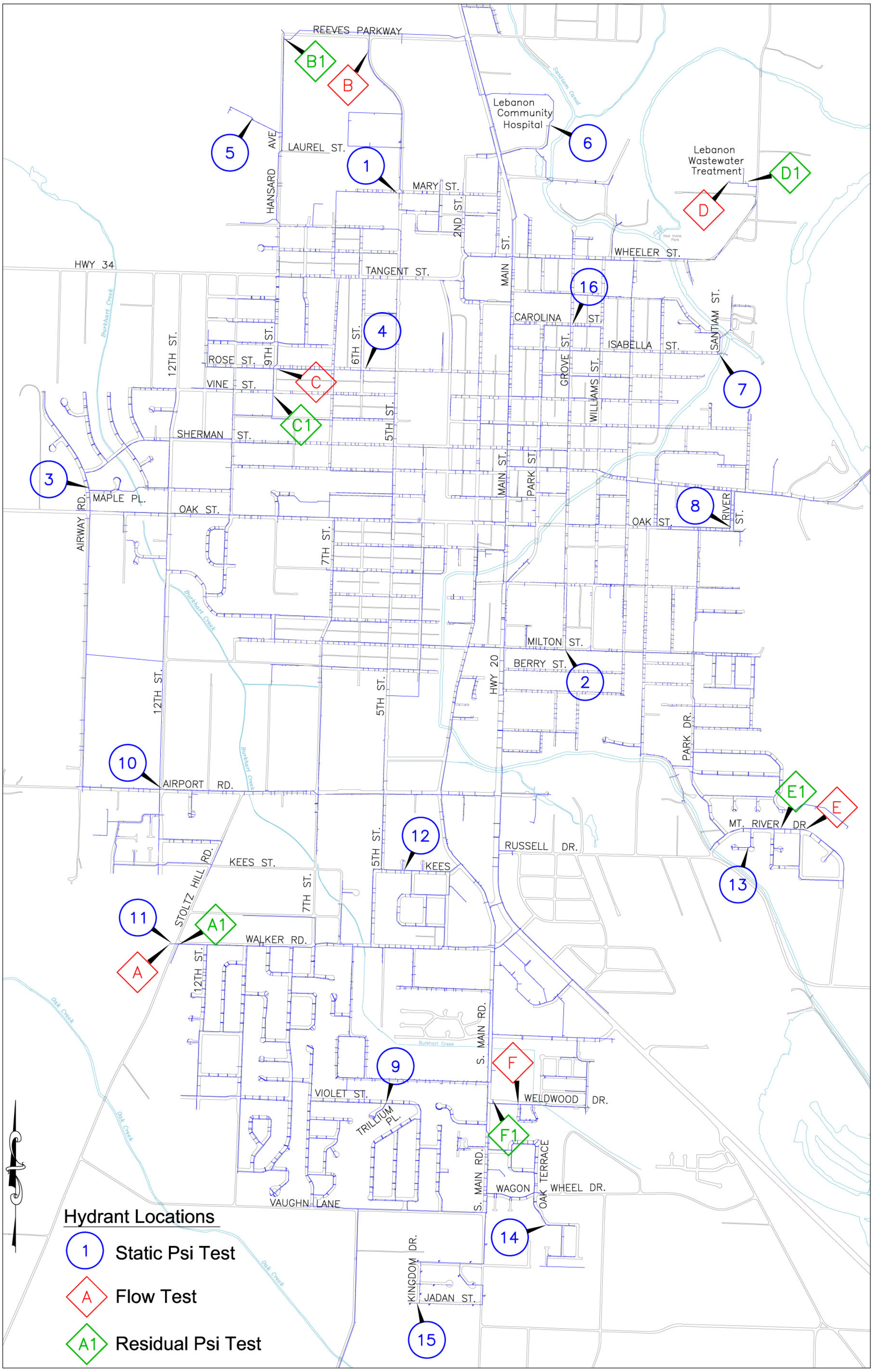

EXHIBIT 9-6
City FH Flow Testing
Lebanon Master Plan

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Both the equalization and emergency storage components are directly related to demands. As demands increase, these components increase. The fire component depends on land use, building types, and building spacing within the service area. For example, service areas that are strictly residential require a lower fire flow for a shorter duration than a service area that includes commercial buildings or schools. Because the city's current system is entirely within a single service zone, the highest fire flow criterion applies: this is the fire flow needed for commercial/industrial/habitational building customers. New service zones at higher elevations are likely to require only residential fire flows.

Storage Evaluation Findings

Exhibit 9-8 provides an evaluation of overall storage needs. The evaluation is based on providing the sum of the equalization, emergency, and fire storage volumes. As indicated in this table, the system has a current (2005) deficit of 1.3 MG. This deficit is expected to increase to 3.2 MG by year 2025 and to 10.3 MG at buildout demand conditions.

EXHIBIT 9-9
Overall Storage Needs Evaluation

				Storage Needs (MG)				
Year	Projected ADD (mgd)	Projected MDD (mgd)	Existing Storage Volume (MG)	Emergency = two x ADD	Equalization = 0.25 x MDD	Fire [1]	Total Need[2]	Storage Surplus (+) or Deficit (-)[3]
2005	1.9	3.4	4	3.9	0.8	0.6	5.3	-1.3
2010	2.1	3.7	4	4.2	0.9	0.6	5.7	-1.7
2015	2.3	4.0	4	4.6	1.0	0.6	6.2	-2.2
2020	2.5	4.3	4	5.0	1.1	0.6	6.7	-2.7
2025	2.7	4.7	4	5.4	1.2	0.6	7.2	-3.2
Buildout	5.6	9.8	4	11.2	2.5	0.6	14.3	-10.3

[1] Fire criteria are listed in Exhibit 9-4.
[2] Total required storage equals that needed for emergency uses plus equalization plus fire.
[3] A storage deficit occurs when existing storage is less than total need.

Exhibit 9-10 provides an evaluation of storage needs by service zone. Standard water system design practice calls for providing equalization, emergency, and fire storage for each separate service zone. The total buildout deficit for the current service zone, labeled as less than 400 feet elevation, equals 9.0 MG.

In general, the most cost-effective approach for the construction of storage reservoirs is to size storage for long-term needs. One reason is that it may be difficult for the city to purchase land that is at the correct elevation and is zoned to allow construction of a tank. A second reason is that the incremental additional cost for building a larger tank to meet long-term demands is relatively small. The recommendation for the base service zone is to add a reservoir that is at least sized to meet the 2025 demands. This volume equals 2.6 MG. (Refer to the year 2025 row in Exhibit 9-9 for the less than 400 feet elevation zone.)

EXHIBIT 9-10
2025 and Buildout Storage Needs by Zone

Criteria:			
	Residential Use as % of Total Demand	56%	
	< 400 feet Buildout Population	32,580	83.1%
	> 400 feet Buildout Population	6,630	16.9%
	Total Buildout Population	39,210	100.0%

					Storage Needs (MG)				
Zone	Time Frame	Projected ADD (mgd)	Projected MDD (mgd)	Existing Storage Volume (MG)	Emergency = 2 x ADD	Equalization = 25% of MDD	Fire (3500 gpm x 3 hr)	Total Need	Storage Surplus (+) or Deficit (-)
Total	Buildout	5.6	9.8	4	11.2	2.5	0.6	14.3	-10.3
Total	2025	2.7	4.7	4	5.4	1.2	0.6	7.2	-3.2
< 400 feet	Buildout	5.1	8.9	4	10.1	2.2	0.6	13.0	-9.0
< 400 feet	2025	2.4	4.3	4	4.9	1.1	0.6	6.6	-2.6
> 400 feet (A)	Buildout	0.2	0.3	0	0.4	0.1	0.2	0.6	-0.6
> 400 feet (B)	Buildout	0.2	0.3	0	0.4	0.1	0.2	0.6	-0.6
> 400 feet (C)	Buildout	0.2	0.3	0	0.4	0.1	0.2	0.6	-0.6

Notes:
1. > 400 ft zone will have residential customers, only. Its fire flow requirement = 1750 gpm for 2 hr.
2. The 2025 demands for the < 400 zone assume that all growth between 2005 and 2025 occurs within this zone. Even if a minor amount of growth occurs in the > 400 zone, this is still a reasonable approximation.
3. The > 400 zone includes areas on the south end of the city and areas east of the river. Sizing of storage will need to consider the number of customers in each section of the > 400 ft zone. If more than one > 400 ft zone tank is constructed, each will need to supply the fire storage amount. The table illustrates storage needed if there are three > 400 ft zones.

The number of service zones to be developed on the land within the UGB that is above 400 feet elevation is uncertain. Service zones are generally limited to approximately 100 feet, which corresponds to a pressure range of approximately 40 psi. Therefore, 100 feet pressure zones can be designed to provide static pressures ranging from 40 to 80 psi, which equals the city's design criterion for pressure. Depending on the highest elevations at which new houses are constructed, there may be a need for more than one zone above 400 feet. This is very possibly the case on the east side of the river. If two zones are constructed on the east side (that is, a 400-500 zone and a 500-600 zone) plus one higher elevation zone on the south end of the city, then it may be necessary to add three reservoirs to serve these areas. This scenario is illustrated in Exhibit 9-9, which assumes that the above 400 feet elevation demand is divided equally among three higher elevation zones. This scenario is only for illustration purposes—the actual storage needs of the above 400 feet zones depends on the manner in which development occurs in these areas. Because of this uncertainty, no reservoirs for the above 400 feet elevation zone are included in the CIP.

As described in Exhibit 9-4, the recommended practice is to use a closed-end pump station in place of gravity storage for areas serving 15 or fewer customers. Closed-end systems are acceptable for up to 30 customers.

Reservoir Condition Assessment

CH2M HILL recommends that both reservoirs be inspected for structural integrity, paint condition, and seismic stability. Visible moss growth and evidence of exterior paint wear indicate that both reservoirs may need to be repainted in the near future. The condition of the tank interiors was not investigated as part of this master plan. The 5th Street Reservoir, constructed in 1980, has never been repainted and should be the first priority of the two tanks. A seismic upgrade would probably include the addition of tie-down chains to connect the tanks to their concrete foundations. CH2M HILL also recommends that the cathodic protection systems installed at both reservoirs be calibrated professionally on a regular basis. Security at both reservoirs could be increased by improving vent and hatch covers and improving the ladder guards. Alternatively, the access ladders could be removed entirely. The tanks are also

Pump Station Evaluation

As described on page 9-1, with the largest pump out of service, the firm capacity of the WTP finished water pump station is 4,500 gpm (6.5 mgd). This firm capacity exceeds the projected MDD for 2025 of 4.7 mgd, and is only slightly below the 2025 projection of 6.7 mgd that includes a 2-mgd industrial allowance. Therefore, the pump station capacity is sufficient through 2025. Operators consider the pumps to be in good condition, but would like to add variable speed drives to allow better refinement of operation to save energy.

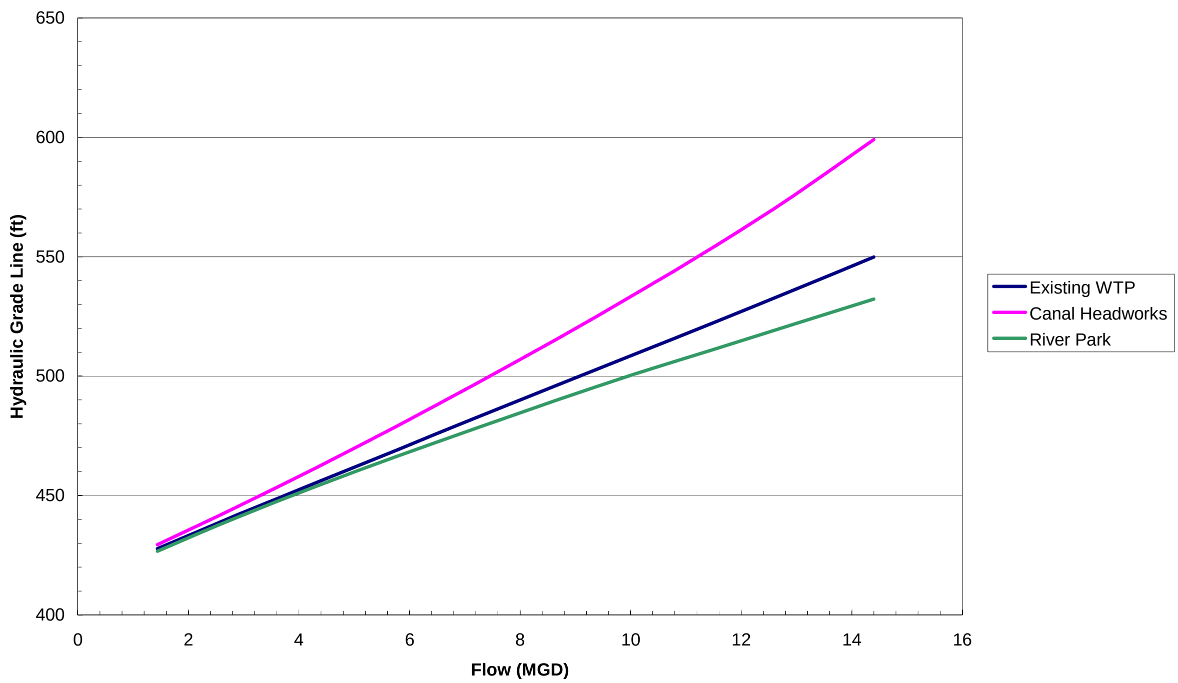
As discussed in the storage analysis section, growth of the city will extend into areas above the limits of the low pressure zone. Growth in the high zone (above 400 feet elevation) may occur in two separate locations, one in the southern portion of the city and the other on the east side of the river. Pump stations will be needed in each of these areas to lift water from the base zone (below 400 feet elevation zone) into zones that serve customers located above 400 feet elevation.

Based on current projections, the buildout MDD east of the river is approximately 450 gpm (0.7 mgd). The elevation range of the developable area is 400 feet to 554 feet. Additional land east of the river is currently designated undevelopable because of steep slopes or other constraints. City staff indicates that this designation may change in the future. The highest elevation in this area is approximately 1,200 feet. Depending on the actual location of the development, a series of closed-end pump stations may be needed to serve this area. No specific pump station projects are presented in the CIP because the development timing and extent of the upper elevation areas are uncertain.

A booster pump station will also be needed if development occurs in the southern portion of the UGB that is located above 400 feet elevation. The buildout MDD for this area is approximately 800 gpm (1.2 mgd), and the projected elevation range is 400 feet to 670 feet. This elevation range would require two sequential pump stations. It would be desirable to have the lower pump station service the lower half of the elevation range and pump into a storage tank. This tank would supply the upper pump station. Refer to the discussion in the reservoir section. If the number of customers is small, it may be acceptable to serve them from a closed-end system, with no gravity storage.

A pump station analysis was also conducted for the pumping requirements at several potential new WTP locations. System curves were developed for each location to evaluate the head requirements and piping improvements needed for each location. The MDD capacity needed for 2025 is 4.7 mgd, although this could increase to 6.7 mgd if significant industrial development also occurs. Analysis of the new WTP locations assumed that the existing WTP and high-service pump station is not in service, and all other recommended system improvements are accomplished. The resulting system curves for each pump station location are show in **Exhibit 9-11**. These are approximate only. Confirmation of the flow and head requirements will be needed at the time when a new WTP is designed. However, they do illustrate that locating the plant at the canal headworks results in a higher head requirement for the finished water pump station, meaning that ongoing energy costs will be greater for this location.

EXHIBIT 9-11
System Curves for Three Alternate Pump Station Locations
(Assumes all system improvements are completed.)



Pipe Network Evaluation

The hydraulic model was used to evaluate the sufficiency of the piping throughout the distribution system to serve customers under a range of flow conditions. Specifically, undersized pipes were identified by the model as having low pressure. Low pressures occur as a result of excessive head loss from high flow velocities through small pipes.

The scenarios that were evaluated included the following:

- Reservoir refill—Criteria were to limit maximum pressures to 80 psi and to evaluate storage fill rates during diurnal low maximum day demands.
- Peak hour—Criteria were to maintain a minimum pressure of 40 psi, a maximum of 80 psi, and to evaluate storage contributions to meet peak hour demands.
- Fire flow—Criteria were to maintain minimum residual pressure of 20 psi when fire flows were superimposed on MDD, and to supply appropriate fire flow rate depending on land use (residential or non-residential)

Findings for Current (2005) System

In general, the current Lebanon system operated well under each scenario evaluated. The pressures in the system during all scenarios were between 40 and 80 psi.

The system performed well under reservoir refill conditions with all pumps running during the diurnal minimum under maximum day conditions. The diurnal low flows of the maximum day condition resulted in the Grant and 5th Street reservoirs filling at 1990 gpm and 2080 gpm, respectively. This shows that there is sufficient pumping and piping capacity to refill reservoirs after serving peak hour demands on a maximum day.

However, during PHD conditions, the reservoirs did not contribute as much water to the system as expected or desired. A relatively large portion of the peak demand was met from the finished water pump station at the WTP rather than from storage.

The current WTP high-service pump station has a capacity of 6.5 mgd, which is higher than the MDD of 3.3 mgd. The other factor is the small clearwell at the WTP. It is necessary to adjust production at the WTP to match hourly demands because it is not possible to store much water at the plant when production exceeds demands. Because the distribution reservoirs contribute little during peak demands, the city may experience problems associated with excessive water age. Water age in the distribution system is a concern because "old" water can lead to deteriorated water quality because of the loss of a chlorine residual and biological regrowth. Lebanon has not identified age-related water quality problems based on measurements of bacteria levels, chlorine residuals, or DBPs. However, reservoir level fluctuations should be monitored and controlled to achieve periodic (ideally within 3 to 5 days) "turnover," or water replacement. Further, operational strategies related to water age will need to be modified as new reservoirs are added to the system, and as demands change within the system.

The minimum level in the reservoirs needed to maintain a system pressure of 40 psi under peak demand conditions was evaluated. It is necessary to maintain a water depth of 5 feet in the Grant Reservoir and 17.5 feet in the 5th Street Reservoir. As an operating guideline, it is suggested that these values set the minimum normal tank levels. During fires or emergency conditions, the levels can be drawn below these levels, but during normal operations the water surface should be kept above these levels.

Fire Flow Analysis for Current System

To evaluate the system's ability to deliver fire flows, the hydraulic model was used to predict hydrant flows at each demand node while maintaining a minimum 20 psi pressure in the system. Each fire flow analysis had the following assumptions:

- A single hydrant provided fire flow.
- Fire flow occurred in addition to MDD to simulate a fire on a summer day.
- Both reservoirs were filled to 503 feet.
- Finished water pumps 1 and 2 were operated.

Exhibit 9-12 shows the fire flow currently available at each of the demand nodes. The majority of the system is capable of supplying adequate fire flows; however, several locations in the system have less than the required 1,750 gpm residential fire flow. Most of the locations that provide less than 1,750 gpm are located at dead-end sections of pipe.

No specific pipe replacement is recommended to meet system-wide fire flow requirements. However, as other improvements such as road replacement, renewals, and main rehabilitation are accomplished, replacement of smaller-diameter mains with at least 8-inch pipe is recommended to improve fire flow availability throughout the system. The city should also take advantage of opportunities to increase looping of pipes to eliminate dead-end segments.

Findings for 2025 System

The 2025 system was analyzed to evaluate proposed locations for a new WTP, the piping requirements as demands increase, and locations for new storage. **Exhibit 9-13** shows distribution system improvements needed to accommodate growth if the WTP remains at the existing site. Primarily residential growth is expected for areas in the south and west, and in areas above 400 feet in elevation east of the river. Commercial/industrial growth is expected in the northwestern portion of the city.

WTP Location

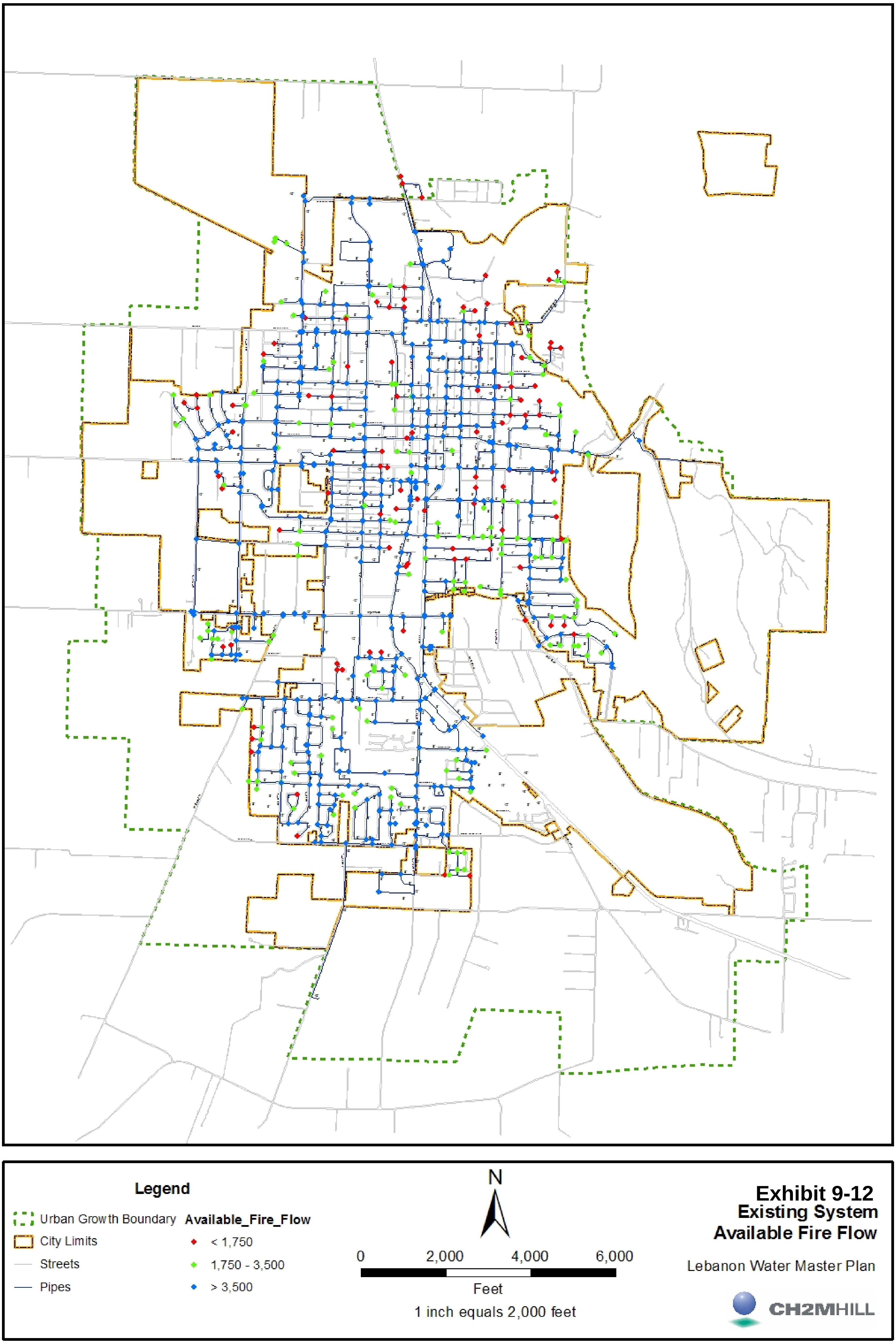
Three options for the new WTP location were examined:

- Location 1: at the existing WTP site
- Location 2: near the South Santiam River at River Park
- Location 3: along the Santiam Canal or South Santiam River, upstream of the existing WTP

As shown in Exhibit 9-13, no additional piping would be required to connect a new WTP at the existing site (Location 1) to the distribution system. However, additional piping would be needed to integrate a new WTP into the distribution system at either Location 2 or Location 3. As shown in **Exhibit 9-14,** three sections of new pipe are recommended to connect a new WTP at Location 2 near River Park: approximately 1,900 feet of 24-inch pipe along Ash St. from the WTP to Hiatt Street, 1,500 feet of 12-inch pipe along Ash Street from Hiatt Street to Main Street, and 800 feet of 16-inch pipe along Walnut Street from Hiatt Street to East Grant Street.

As shown in **Exhibit 9-15,** Location 3, near the Santiam Canal headworks, requires approximately 9,900 feet of 24-inch water line along Russell Road and River Road to connect the WTP to the existing distribution system at South Main Street. In addition, 1,300 feet of 12-inch line is recommended along Franklin Road from Russell Road to River Road.

System statistics for pressures and velocities under each WTP location scenario are summarized in **Exhibit 9-16**. The conclusion from the modeling is that any of the proposed WTP locations will work effectively for the Lebanon water distribution system.



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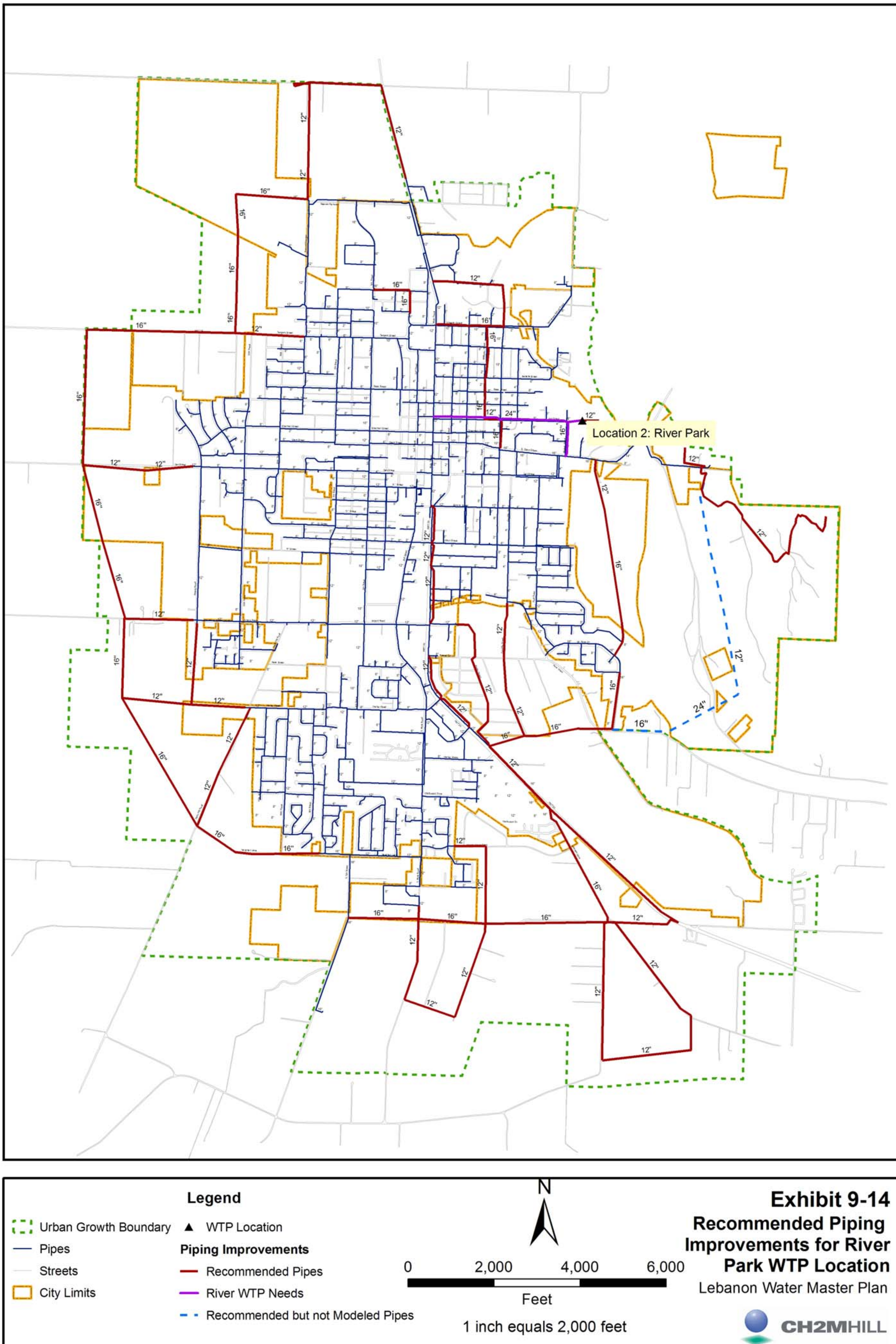

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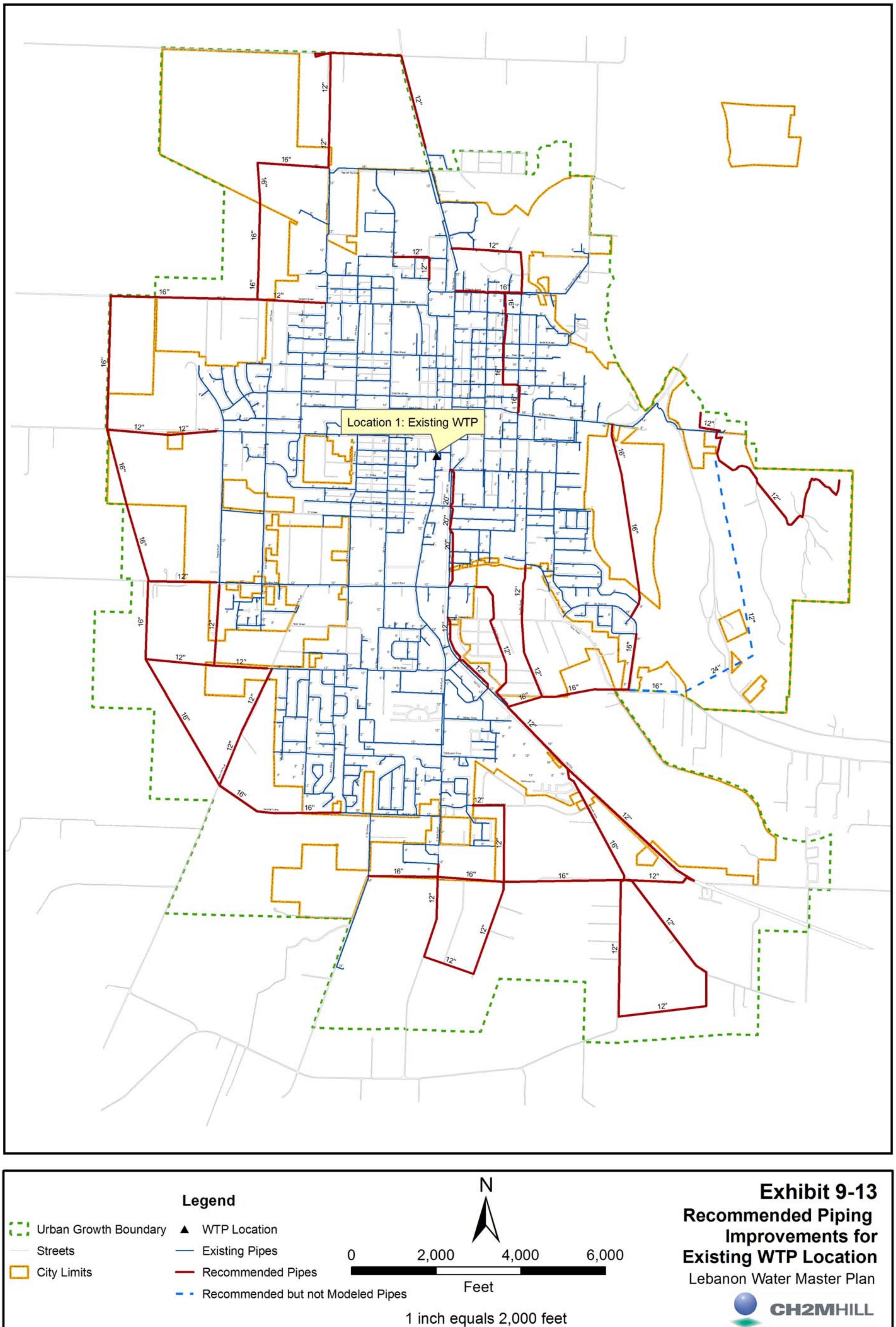

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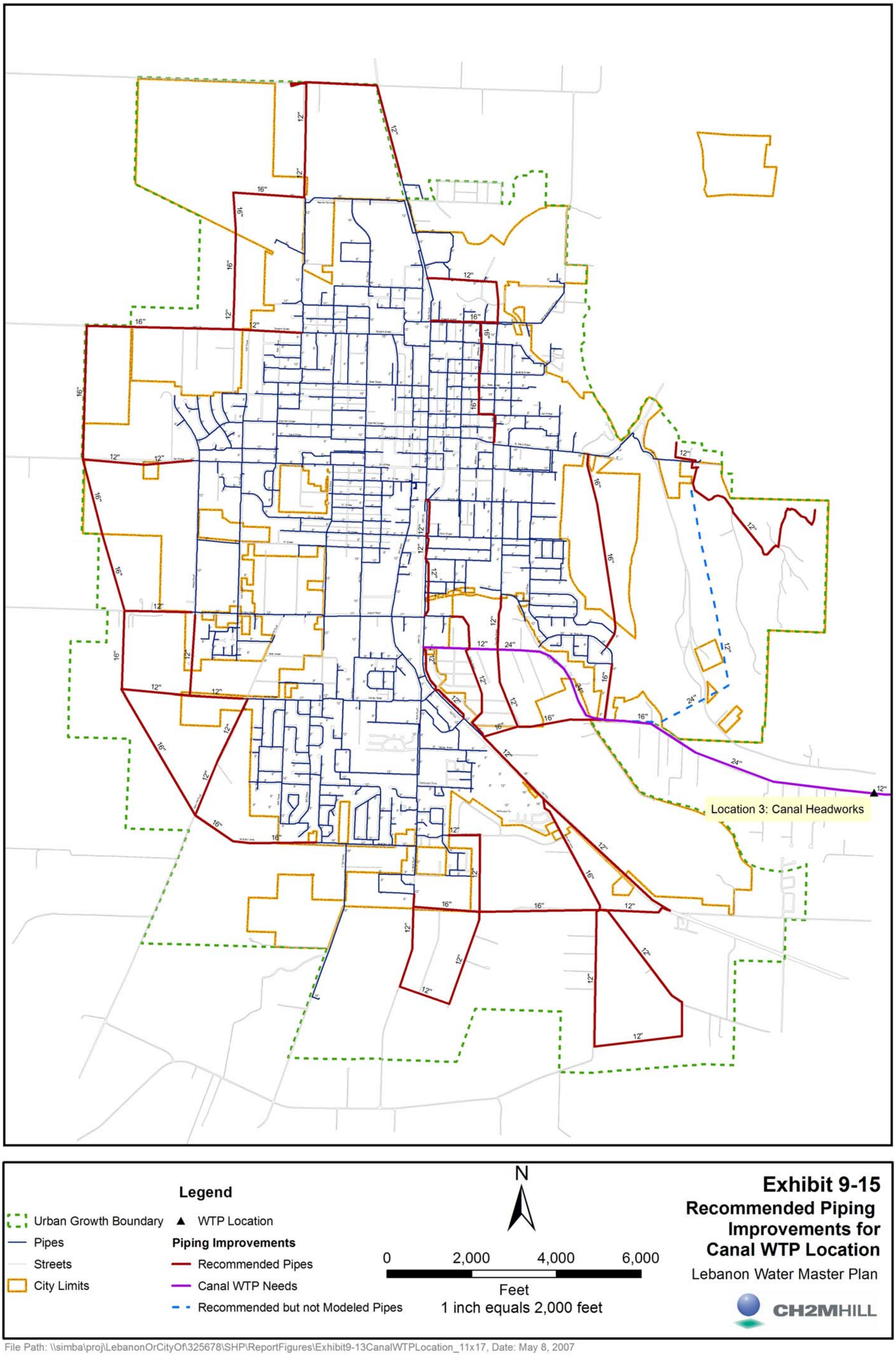

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EXHIBIT 9-16
Model Performance Summary
For maximum day demand (MDD), peak hour demand (PHD), and reservoir refill (RR)

	Scenario								
	Existing WTP Location			River Park WTP Location			Canal Headworks WTP Location		
	MDD	**PHD**	**RR**	**MDD**	**PHD**	**RR**	**MDD**	**PHD**	**RR**
Minimum Pressure (psi)	46	40	44	46	44	43	42	40	42
Maximum Pressure (psi)[1]	95	94	97	97	96	97	96	96	97
Maximum Velocity (ft/sec)	5.6	5.5	5.3	4	4.5	4.3	4.7	4.7	4.4

[1]The maximum pressure for each scenario is at the boundary between the existing pressure zone and the undeveloped pressure zones in the southern portion of the system. The next highest pressure in the system was 78 psi, which is below the recommended pressure for the distribution system.

Fire Flow Improvements

Fire flow analyses were also conducted for the 2025 system, incorporating proposed system improvements for the WTP evaluation. **Exhibit 9-17** shows the available fire flow for each demand node in 2025. The results are similar to those for the existing system, and relatively independent of new WTP location. Low fire flows occur on dead-end sections of pipelines.

Storage

The storage analysis shows that an additional 2.6 MG of storage will be needed by 2025 to serve the zone below 400 feet. A new storage site must be at an elevation of at least 460 feet to provide the required pressure in the below 400 feet pressure zone. Available sites are limited by a lack of suitable locations at this elevation.

Two proposed locations were near each of the existing reservoirs. Locating a reservoir at the existing East Grant Street Reservoir site would be difficult because of steep slopes and space limitations. However, another area east of the river would have the advantage of being near projected growth in the above 400 feet elevation zone. Additional transmission and distribution piping to serve a new reservoir east of the river will be required, and at least temporarily, over 50 percent of Lebanon's storage will be located on the east side of the river, with only a single pipe across the Grant Street Bridge serving the area on the western side. To provide greater redundancy, an additional river crossing and transmission lines east of the river are recommended. Possible locations for these lines are indicated by dashed lines in Exhibits 9-13 through 9-15, 9-17 and 9-18. These pipelines have not yet been included in the hydraulic model.

A moderately-sized new reservoir could be located on the same site as the existing South 5th Street Reservoir. Advantages of this site include existing transmission and distribution pipelines, and proximity to areas of projected growth. The city should consider purchasing adjacent properties for future storage expansion.

Summary of Recommended Distribution System Improvements

WTP Location

As stated above, any of the proposed locations for a new WTP will work effectively for the city's distribution system. Expanding the WTP at the existing location would be difficult because of limited land availability and site constraints. As described in Chapter 7, CH2M HILL recommends short-term improvements to insure continued operation of the existing WTP. CH2M HILL also recommends that the city investigate development of river bank wells while maintaining flexibility to pursue a surface water source if necessary. Cost considerations, land availability, and the location of a raw water source (river bank wells, or a surface water intake) will dictate the ultimate WTP location.

Storage

Because development east of the river is imminent, CH2M HILL recommends that the city acquire property in proximity to the East Grant Street Reservoir, and build a new 2.6 MG reservoir to serve 2025 storage needs.

Pipelines

Exhibit 9-18 shows one conception of how the distribution system may look as it expands toward the UGB. Actual expansion will depend on the specific needs and timing of development. In Exhibit 9-18, the recommended distribution system improvements are grouped into eight areas: Central, Central-East, East, Northeast, North, Southeast, Southwest, and West.

Recommended piping improvements for each area are summarized in **Exhibit 9-19**. A more detailed breakdown of system improvements is presented in the CIP in Chapter 10.

EXHIBIT 9-19
Summary of Recommended Piping Improvements

Area	Diameter (in)	Approximate Total Length (ft)	Service Notes
Central	20	2,800	Includes replacement of existing 6- and 8-inch lines.
Central East	12 & 16	17,000	Provides primarily residential service. Includes service to residential customers within the UGB but outside city limits
East	12 & 16	6,700	Serves residential customers in the > 400 ft service zone east of the Santiam River.
Northeast	12 & 16	8,900	Accommodates residential growth and provides transmission line loop around the city.
North	12 & 16	12,300	Serves projected commercial/industrial customers.
Southeast	12 & 16	43,400	Accommodates primarily residential growth.
Southwest	12 & 16	14,200	Serves primarily residential customers. Approximately half of pipes will serve the > 400 ft elevation service zone.
West	12 & 16	18,000	Serves projected commercial/industrial customers.

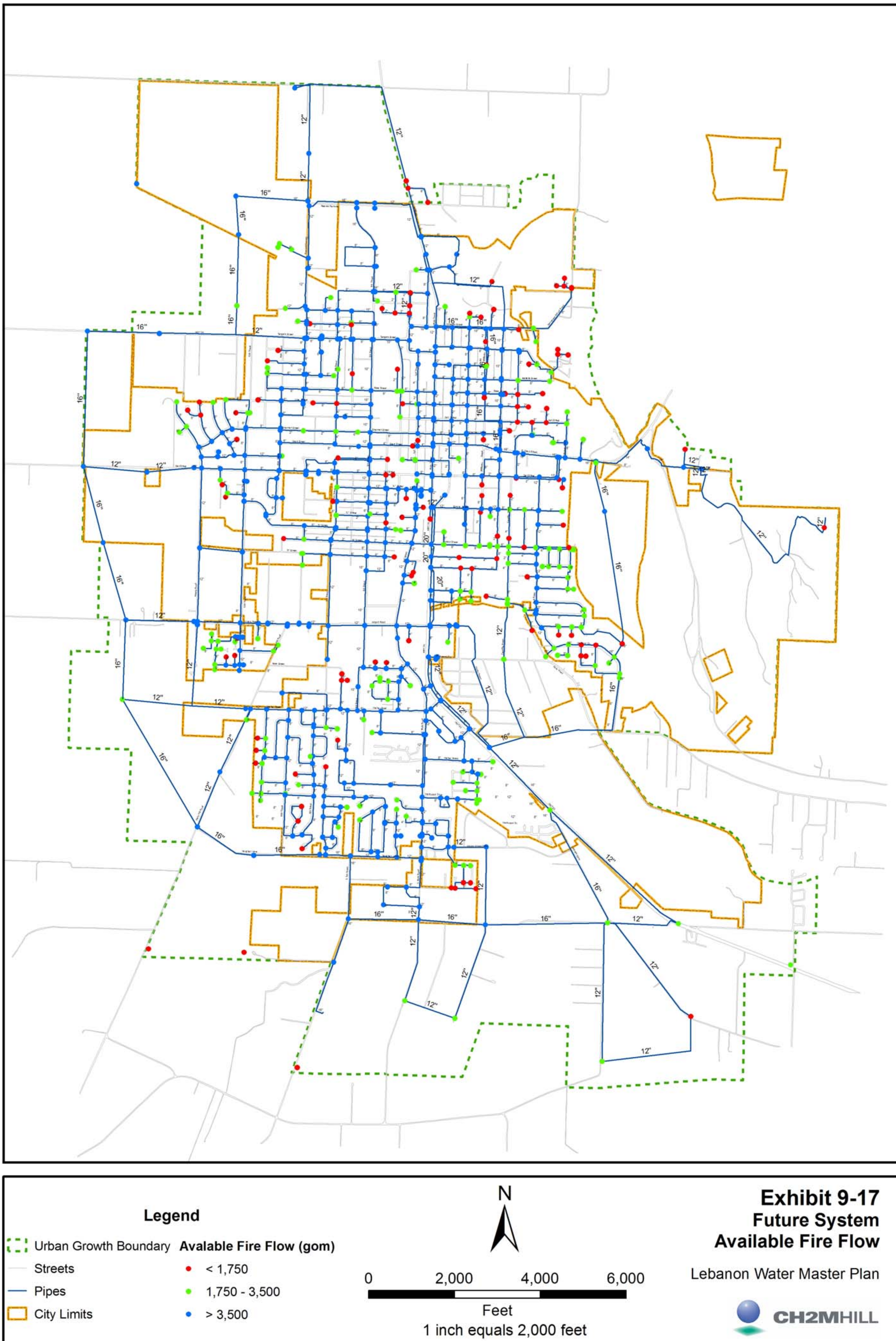

Exhibit 9-17
Future System Available Fire Flow

Lebanon Water Master Plan

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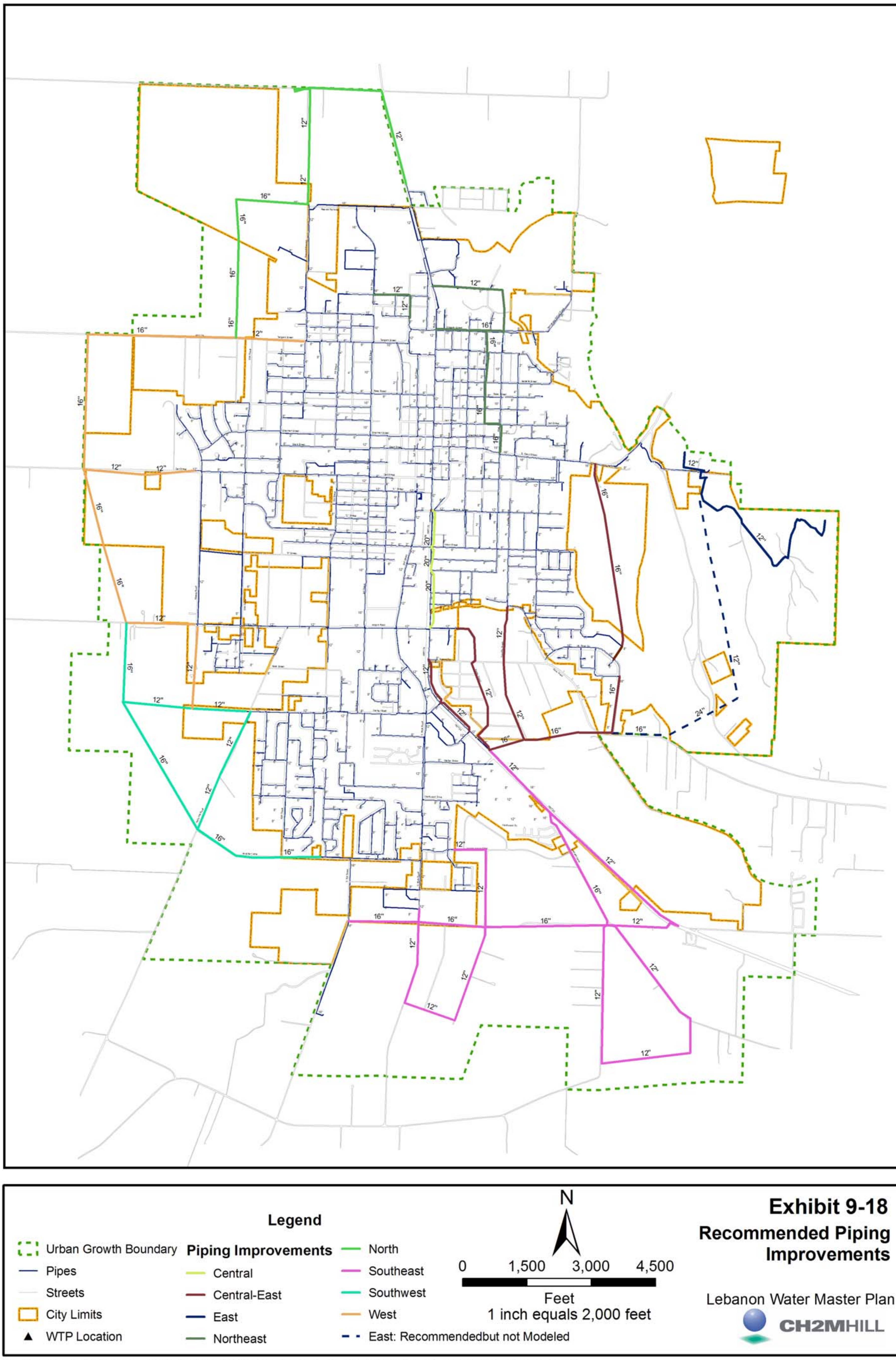

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Improvements to the existing distribution system that are recommended for implementation in the near future are located in the areas designated “Central” and “Central-East” in Exhibits 9-17 and 9-18. These improvements include replacement of the 6-inch and 8-inch lines along Main Street from Elmore Street to Airport Road with 20-inch-diameter pipeline, and the extension of an existing 12-inch line along Main Street from Russell Drive to Division Way. The total length of these improvements is approximately 5,000 feet.

Other recommended system improvements create a loop around the city that provides a backbone for transmission and system redundancy. The looped system should be constructed in accordance with the ultimate system improvements plan as development warrants.

There are over 23 miles of asbestos cement pipe in the existing distribution system. To date, the city has not experienced failure problems with this pipe material, nor has the pipe contributed asbestos fibers to the drinking water at a level that exceeds drinking water quality standards. Many cities target replacement of asbestos cement pipe because it is prone to failures and because special precautions must be undertaken by employees or contractors when repairs are made. This may be a program that Lebanon wishes to schedule in the future if failures begin to occur at unacceptable rates. However, for the current CIP, it does not appear necessary to include this pipe replacement program.