Section 3

Collection System Analysis

The City of Yelm operates a wastewater collection system based on STEP technology. This section provides a map and inventory of the existing collection system, summarizes existing O&M activities, analyzes the capacity of the existing system, and identifies capital improvements that will be required to serve population growth and expansion of the collection system.

This section includes three business case evaluations (BCEs). A BCE is a structured economic analysis used to make decisions based on life-cycle costs and community, environmental, and risk considerations. “Life-cycle” means not only the costs to build an asset, but also the cost to operate, maintain, repair, and ultimately decommission and replace an asset while it is owned and operated by the City. The BCE tool is a repeatable, defensible, and quantitative decision-making process that provides a means of making a clear distinction between “wants” and “needs.”

The BCE process includes six steps, illustrated in Figure 3-1 and described in the following paragraphs:

1. **Form an expert team.** The team should be made up of a cross-functional group representing all levels of the organization that have a stake in finding a solution to the problem. For this GSP, the expert team consisted of City management, wastewater utility management, and the City’s consultants.
2. **Define the problem in terms of level of service and drivers.** Identify and clearly define the problem that creates the need for the project or policy revision. This is a critical step because the way in which an organization thinks about a problem could limit the solutions it considers. The goal in this step is to “step back” from the situation to understand the problem in a way that permits the formation of creative, alternative approaches to a solution. At this point, the primary drivers, or levels of service, should be identified. The level of service sets boundaries for the project solution and could include regulatory requirements, system capacity limitations, system reliability, efficiencies (cost savings), and/or aesthetic considerations.
3. **Collect data on the current situation.** Collect data around the problem and determine if the problem is an isolated problem or if solutions might affect other areas of the process or other projects.
4. **Prepare and screen alternatives.** Define alternative ways of addressing the problem. Again, this is a critical step and it is important to consider all prospective solutions. After alternatives are developed, they are screened for fatal flaws with regard to solving the problem, meeting the level of service required, or unacceptable levels of risk.
5. **Develop costs and analyze alternatives.** Each remaining alternative is evaluated by a life-cycle, present value, and benefit/cost analysis that considers not only budgetary impacts but also risks, environmental considerations, and applicable societal costs.
   - “Life cycle” means that benefits and costs are considered over a long period of time, generally 30 years in this GSP. To the extent possible, these benefits and costs are expressed in dollar terms. Risks, if present or if reduced by an alternative, are likewise expressed in dollar terms.
   - “Net present value” (NPV) means that the analysis takes the time value of money into account.
6. **Recommend and report.** The BCE recommendation is the alternative with the lowest life-cycle cost that meets the level-of-service requirements.

Two of the BCEs in this section evaluate potential repair and replacement (R/R) strategies for collection system equipment and a third evaluates alternative collection system technologies to serve future growth, not including the MPC. The three BCEs are summarized as follows:

- STEP pump R/R: Evaluation of potential pump R/R strategies, encompassing alternatives between proactive (based on fixed, time-based criteria) and reactive (at failure) maintenance.
- Shared STEP tanks: Evaluation of the cost of operating and maintaining existing STEP tanks shared between two or more single-family dwellings, compared to the cost of eliminating shared STEP tanks by installing STEP tanks on each individual property.
- Collection system technology for service area growth: Evaluation of the most appropriate collection system technology for collection system growth, including both infill inside the existing service area and expansion to new service areas.

3.1 Map and Inventory of Existing Collection System

This section presents a map and inventory of the existing collection system.

3.1.1 Collection System Map

A map of the existing collection system was compiled based on as-built data, previous GIS maps of the collection system, and a GPS survey conducted by the City. The map, showing pipeline diameters and STEP tank locations, is shown in Figure 3-2. This map also shows the approximate boundaries of the City's original STEP system, installed in 1994. A more detailed map, which includes collection system valves, is included in Appendix 3A.

3.1.2 Collection System Inventory

An inventory of collection system assets is provided in Section 1.6.1.

3.2 Existing System Modeling and Analysis

This section presents a description of the hydraulic model development, calibration, criteria, and results.

3.2.1 Model Development

A hydraulic model of the collection system was developed using Innovyze's InfoWater hydraulic modeling software. Each model element, including pipes and STEP tanks, is assigned a unique representation within the program. Each element is also assigned a number of attributes specific to its function and representation. Typical element attributes include spatial coordinates, elevation, sewer flow, pipe length, diameter, pipe friction factors, and pipe status (open or closed). Model input is accomplished through the creation and manipulation of these objects and their attributes.

Elevations for each customer were interpolated based on contour data provided by the Thurston County Geodata Center. Existing system flows were applied spatially in each zone based on patterns of winter water usage identified from billing records. This was then adjusted to meet the total metered flow at the WRF for the analysis period. A diurnal pattern for each customer was also developed by scaling flow to match the diurnal pattern of the influent flow at the WRF.

Seven representative STEP tanks were distributed throughout the collection system model, using typical tank sizes and pump curves. These representative tanks were used to evaluate pumping conditions at tanks throughout the system, rather than modeling more than 2,000 STEP pumps individually. The rest of the customer flows were modeled as nodes with negative demands.

3.2.2 Model Calibration

In order to calibrate the hydraulic model, the City installed and monitored eight pressure loggers on air release valves (ARVs) throughout the collection system from November 22 to December 5, 2011. The loggers recorded pressures every 3 minutes. The initial model was then run and compared to pressure logger data over the analysis period. Flows and pressures for Thanksgiving Day (November 24) 2011 were primarily considered because the highest peak flow occurred on this day. In order to achieve satisfactory calibration of the model, the pipe C factors, or roughness coefficients, were adjusted to a value of 70. This low value indicates that, over time, the internal condition of the pipe may have become rougher, or material such as grease may have accumulated in some pipes.

Calibration results are shown in Figure 3-3.

3.2.3 Criteria for Modeling

Based on the City development guidelines, collection system piping must have a pressure rating of 200 pounds per square inch (psi) for collection main piping and 280 psi for service lines. In order to determine the maximum allowable pressures for the collection system model, pump curves for the individual STEP pumps were examined. Based on these data, an upper limit of 100 psi was determined for modeling. An upper limit of 8 feet per second was used for maximum velocities.

3.2.4 Model Results: Existing System

Model results for the existing system indicated that all pressures were between 0 and 47 psi at peak 2011 flows. Velocities were also very low, ranging from 0 to 2.2 feet per second. In general, pressures were the lowest in the center of town around Yelm Avenue, averaging approximately 11 psi. Pressures were higher in the north parts of town, on Rhoton Road and in the residential area between Burnett Road and Mountain View Road, averaging approximately 29 psi. Figure 3-4 shows the results of peak hour modeling for existing conditions. While there are no demonstrated issues within the system related to velocity or pressure currently, there are areas where problems may need to be addressed in the future. Section 3.3 identifies these areas.

3.3 Future Collection System Modeling and Analysis

This section describes how the calibrated model was used to model future conditions to identify where collection system improvements should be planned. The model of future conditions incorporates findings of the BCEs described in the following subsections. Necessary improvements to address problem areas are described in detail in Section 3.6.

3.3.1 Allocation of Future Growth

In order to allocate future growth of the City's collection system, the existing and future service areas were divided into sewer basins. The sewer basins were developed based on existing collection system configuration and existing land development patterns, as well as future zoning, future schools, and projected residential development. Future growth throughout the sewer basins was then allocated by the Yelm Community Development Department for projected residential development, non-residential development, and schools. Figure 3-5 shows the future sewer basins and summarizes the growth allocation by basin.

3.3.2 Future Collection System Modeling Results

Hydraulic modeling of the future sewer system was completed with future growth allocations described above and assuming expansion of the STEP system to serve the entire service area. Future flows were allocated to existing pipelines at points where future growth was projected to occur or where a future basin was projected to be connected to the system. Figure 3-6 shows the load points for the future flow allocations. Future flows, by basin, are summarized in Appendix 3B. Modeling was performed for both the 2020 and 2030 planning horizons, as summarized in the following sections.

3.3.2.1 Model Results for 2020

Modeling for the 2020 planning horizon indicated that pressures will exceed 100 psi in several areas of town, including areas in Basin 5 in the northwest part of city limits. Upsizing pipes in Longmire Street and Mountain View Road will correct these pressure issues. The planned improvements are described in detail in Section 3.6. Figures 3-7 and 3-8 show modeling results before and after improvements have been made, respectively.

3.3.2.2 Model Results for 2030

Modeling for 2030 identified areas in the north, central, and west parts of town with pressures in excess of 100 psi. Improvements identified in Section 3.6 and Figure 3-12 address these excessive pressures. Figures 3-9 and 3-10 show modeling results before and after improvements have been made, respectively.

3.4 Existing Operation and Maintenance Analysis

This section describes existing O&M activities for the collection system. O&M program costs, including an evaluation of potential staff additions, are discussed in Sections 7 and 10. The cost information used in the BCEs presented in this section is based upon estimates provided by the City of maintenance duration for each activity and a per hour staff cost of $40[1].

3.4.1 Existing Operation and Maintenance Summary

The City owns, operates, and maintains the entire wastewater collection system, as discussed in Section 3.1.2, including the STEP tanks, STEP pumps, collection system pipelines, and associated valves and appurtenances. The City currently employs two full-time operators dedicated to maintaining the STEP collection system. In addition, the City contracts with DrainPro to vacuum-pump, haul, and dispose of septage from the STEP tanks. In 2011, the contract cost of septage handling pumping, hauling, and disposal was $0.24 per gallon (plus tax at 8.5 percent). Total septage handling costs for 2011 were $66,100, representing 245,820 gallons pumped. Septage hauling costs vary from year to year, depending on the number of STEP tanks requiring pumping. In 2010, 386,400 gallons were pumped at a cost of $100,400.

Operation and maintenance of the existing collection system falls under three main categories; new tank startup, routine (scheduled) maintenance, and non-routine maintenance calls, which generally occur due to mechanical failure of a STEP system component. O&M services are logged in a database (see Section 3.4.2). Additional information related to each O&M category is summarized below:

- **New tank startup** events have been logged for most new STEP tanks installed since 2004, but were not logged consistently in the City's O&M database prior to 2004. From 1994 to 2011, 857 new tank startups have been logged, which accounts for about 60 percent of the approximately new 1,375 STEP tanks installed since 1994.
- **Routine maintenance** currently occurs approximately every 4 years for most residential STEP tanks and more frequently for commercial customers. The City's goal is to inspect each residential STEP tank at 3-year intervals. Based upon experience, the City has developed a separate maintenance schedule for tanks that require higher-frequency inspection/pumping (mostly commercial tanks). This schedule includes 7 tanks inspected/pumped quarterly, 21 semiannually, and 27 annually.

  During scheduled maintenance inspections, an operator measures the sludge and scum depth in the STEP tank, logs the number of pump starts/stops, logs the pump run hours, visually inspects the

[1] Current average staff salaries and benefits are approximately equal to $38 per hour. An assumption of $40 per hour provides for some escalation in salaries over the BCE evaluation period.

floats, cleans the vault and pump screens, inspects the pump, inspects electrical components and connections in the tank junction box and pump control panel, tests float controls for proper operation, and makes general observations of the condition of the STEP tank and equipment.

City staff routinely exercise collection system valves and ARVs. Staff have indicated that many of the ARVs have become corroded and do not function properly. Replacement of these valves is included on the CIP presented in Section 8.

City staff visually inspect approximately 50 grease traps at commercial connections twice per year. The City would like to develop a more formalized program for grease trap pretreatment facilities, including revision of the City's Development Standards.

- Non-routine maintenance is required when a STEP system failure triggers an audible alarm and the customer calls the City. In the past 2 years (2010 and 2011), the City has received approximately 250 service calls. The City does not currently use standardized logging procedures for non-routine maintenance so classification of alarm calls by review of database records is difficult. However, a majority of the current alarm calls appear to be related to float or other electrical system/wiring malfunctions. Very few alarms have been related to STEP pump operation.

  The City also responds to customer calls for plugged/damaged side sewers for some of the older STEP tanks within the system. However, due to the small number of these connections, annual service effort is minimal (less than 10 hours).

3.4.2 Existing Operation and Maintenance Database

For every alarm call response, scheduled inspection, or new STEP tank startup, operators fill out a paper inspection form, which is then entered into a Microsoft Excel spreadsheet. Between 1994 and 2011, approximately 9,650 service calls were logged in the database. The O&M database includes information such as tank identification data (account number, address, volume, etc.), scum and sludge measurements, pump run data, and alarm/service comments.

While providing useful and electronically accessible information, the City recognizes several limitations of the current system for keeping records of maintenance services and scheduling future maintenance. As a record-keeping tool, the database is limited by the quality and detail of input information. The existing system is not currently structured such that different types of service calls (routine, non-routine, and startup) can be easily queried. Additionally, it is cumbersome to query non-routine calls by standardized service descriptions (e.g., float fail, pump fail, tank pumping, electrical, etc.). Furthermore, the existing database is not tied to a calendar and is not intended for scheduling functions. Therefore, more detailed scheduling of routine maintenance requires the use of additional software (Outlook).

3.4.3 Operation and Maintenance Improvements

The City will develop a computerized inventory tracking and maintenance system to better organize system record-keeping, track regularly scheduled maintenance tasks, manage spare parts, and generate reports on system operating parameters. The City has already proposed such an asset management strategy for the potable water system (see Section 6.5 of the WSP). Wastewater asset management will be developed in conjunction with the potable water system to minimize development effort and ensure consistency across City utilities. Software combining record-keeping and scheduling functions will save time and effort for City staff and will become more critical as the collection system grows and ages. The City is currently investigating the compatibility of using the existing billing software program to track O&M activities.

The City does not currently have a formalized pretreatment program for inspection, maintenance, and potential enforcement actions for grease interceptors. FOG that enters STEP tanks from connections that are not properly equipped with grease interceptors or where the interceptors are poorly maintained result in greater O&M frequency. The City will develop and implement (in the City's Development

Guidelines and YMC) a revised pretreatment standard based upon Chapter 10, Traps and Interceptors, of the Uniform Plumbing Code (UPC). The pretreatment standard will include the following components:

- Design criteria and installation requirements per the UPC
- Minimum owner maintenance frequency
- Record-keeping and other owner responsibilities
- City inspection/compliance evaluation procedures
- Sampling frequency, locations, and acceptable limits (to include a high FOG surcharge)
- Administrative enforcement and owner petition procedures

Appendix 3D contains potential language for grease interceptor pretreatment facilities that may be used as the basis of the City's pretreatment standard.

3.5 Repair and Replacement Analysis

This section describes the City's existing R/R strategy and presents BCEs for several R/R alternatives.

3.5.1 Existing Repair and Replacement Strategy

In the past, the City's strategy for repair and replacement of collection system components has been to repair/replace at failure or imminent failure. The strategy was generally reactive to a failure condition rather than proactive in anticipation of potential failure based on equipment age or performance metrics. The City does not currently have the asset management tracking software in place to effectively implement a proactive maintenance schedule for the various equipment components within each STEP tank. Currently, collections system staff make decisions in the field regarding the need for equipment replacement or repair. This system is informal, but is consistent with other small utilities operating STEP collection systems. Furthermore, this strategy (replace/repair at failure) generally maximizes the service life of equipment. However, reactive maintenance exposes the City to risk costs related to potential property damage resulting from system component failure.

The existing reactive R/R strategy can be enhanced by making each scheduled STEP tank inspection (at 3-year intervals) an opportunity to perform a detailed evaluation of equipment condition and performance. During each inspection, pump run time records will be evaluated and the condition of pump, screen, float, and wiring equipment assessed. Field staff then have the option, based upon their experience and performance metrics (such as pump run time, harsh operating conditions, etc.), to replace equipment components, repair parts as necessary, or leave equipment as is until the next scheduled inspection. Some of this "enhanced" strategy is already being performed by field staff. By formalizing the STEP tank inspection process (including development of detailed inspection records) and relying on staff expertise, the City will benefit from the advantages of both proactive (minimize risk) and reactive (maximize service life) strategies. Additionally, the City will begin establishing reserve funds in order to prepare for the possibility of a large number of STEP tanks failing.

The "enhanced" reactive strategy discussed above is evaluated in comparison to purely reactive or proactive maintenance strategies in the BCE presented in the following section.

3.5.2 Business Case Evaluations

This section presents two BCEs for the repair and replacement of collection system components. The first BCE evaluates R/R strategies for STEP pumps, comparing proactive and reactive maintenance. The second BCE evaluates the potential separation of 149 shared STEP tanks that serve multiple residential homeowners. The shared STEP tanks result in maintenance and reliability concerns, and require greater administrative time (cost) as compared to un-shared tanks.

3.5.2.1 Business Case Evaluation: STEP Pump Repair/Replacement Strategy

A BCE was completed to evaluate alternatives for R/R of STEP pumps currently in service within the collection system. The collection system includes approximately 2,125 STEP pumps, many of which were installed in the 1990s and are nearing the end of their design life. The following sections summarize the BCE development and findings.

3.5.2.1.1 Problem Statement

Approximately 40 percent[2] of the STEP pumps currently in operation within the collection system have been in use for nearly 20 years, the typical design life cited by the pump manufacturer (Orenco). The City has not implemented a structured, proactive pump replacement program. Although the current reactive pump replacement strategy (reactive repair or replacement) maximizes service life, there is a potential for a large number of simultaneous failures as the pumps age, resulting in staffing and budgetary issues that could result in poor public perception.

3.5.2.1.2 Identify and Analyze Alternatives

Three potential pump replacement strategies, encompassing the range of potential actions between proactive and reactive maintenance, were evaluated. The three alternatives are summarized as follows:

- Alternative 1. Proactive strategy: Replace STEP pumps proactively based upon pump age.
- Alternative 2. Reactive strategy: Replace or repair STEP pumps at failure.
- Alternative 3. Enhanced reactive strategy: As discussed in Section 3.5.1, a reactive strategy can be enhanced by performing a full evaluation of a STEP tank and STEP equipment during each scheduled inspection. Based upon their experience, field staff would make the decision to repair/replace equipment or delay further action until the next inspection.

The cost information and/or assumptions used as input values for the BCE include the following.

<u>Capital Costs</u>

Capital costs include pump R/R costs. Capital costs for replacing a pump, including the pump equipment and installation, are $600, as provided by the pump manufacturer and confirmed by the City. Pump repair costs are estimated to be $200.

Because the BCE is based upon NPV calculations that encompass a number of years, pump R/R schedules were developed for each of the alternatives. Alternative 1 assumes that the original pumps installed in 1994 would be replaced over 2 years (2013 and 2014). Pumps installed in subsequent years would be replaced at 20 years of service life. Alternative 2 assumes a surge in replacement at a later time (between 2017 and 2020), corresponding to pump service life of approximately 25 years. Alternative 3 uses the same curve as Alternative 2, but assumes that only 25 percent of the pumps need full replacement, while 75 percent can be repaired or refurbished at a lower cost. The assumed pump R/R schedules are as shown in Figure 3-11.

<u>Operation and Maintenance Costs</u>

Alternatives 1 and 2 were assumed to include a 2-hour inspection (at $40 per hour for one field staff member) every 3 years, or approximately $27 per year per tank. In addition, Alternative 2 includes additional reactive service calls because the pumps are allowed to run until failure. Due to aging pumps, it is assumed that continued reactive maintenance for pumps will result in three times the current number of STEP failure service calls. Based upon current service call records (125 calls per year at $80 per call), future reactive service calls are assumed to be approximately $15 per year per tank.

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[2] It is estimated that 720 STEP tanks were installed with the initial collection system in 1994, with an additional 140 STEP tanks installed over the next 3 years. Fewer than 10 STEP pumps have been replaced over the life of the collection system.

Alternative 3 assumes a 3-hour inspection every 3 years, or approximately $40 per year per tank. The additional inspection time allows for more detailed evaluation of the pump equipment and determination of repair and or replacement needs.

Risk Costs

Alternative 1 has a risk of wasting service life for the pump if it is replaced before it has failed. This risk cost is implicit in applying the full replacement cost at the identified replacement schedule.

Alternative 2 has a risk of pump failure leading to property damage. It is assumed that two failures per year each result in property damage of $5,000. In addition, the failures lead to poor public perception. It is assumed that City staff effort is an additional $3,000 per year to respond to and/or address the pumps failures.

Alternative 3 minimizes the risk of pump failures, but does not eliminate failures. It is assumed that one pump failure resulting in $5,000 of property damage occurs every 2 years. Additional staff effort to respond to and/or address the pump failures is $1,000 per year.

3.5.2.1.3 Summary of BCE Inputs

Table 3-1 summarizes the inputs for each alternative.

Table 3-1. Summary of STEP Pump Repair/Replacement BCE Alternatives

BCE input	Alternative 1: Proactive replacement strategy	Alternative 2: Reactive replacement strategy	Alternative 3: "Enhanced" reactive replacement strategy
Capital costs	• $600 per pump replacement. Assumed schedule of replacement, based upon 20-year service life, as shown in Figure 3-11.	• $600 per pump replacement. Assumed schedule of replacement, based upon 25-year service life, as shown in Figure 3-11.	• Assumed schedule of R/R based upon 25-year service life, as shown in Figure 3-11. 25% of pumps replaced at $600 each, the remainder are repaired at $200 each.
	• Total capital cost: NPV calculation of pump replacement schedule	• Total capital cost: NPV calculation of pump replacement schedule	• Total capital cost: NPV calculation of pump R/R schedule
O&M costs	• 2-hour inspection every 3 years ($27 per tank per year) • Current level of service calls ($5 per tank per year)	• 2-hour inspection every 3 years ($27 per tank per year) • Increased service calls ($15 per tank per year)	• 3-hour inspection every 3 years ($40 per tank per year • Current level of service calls ($5 per tank per year)
	• Total annual O&M: $32 per tank	• Total annual O&M: $42 per tank	• Total annual O&M: $45 per tank
Risks	• Potential waste of pump service life	• Pump failure leading to property damage • Poor public perception	• Pump failure leading to property damage (less risk than Alternative 2) • Poor public perception (less risk than Alternative 2)
	• Total annual risk: Risk cost implicit in applying full replacement cost at the identified schedule	• Total annual risk: $13,000	• Total annual risk: $3,500

3.5.2.1.4 BCE Results and Selected Alternative

Results of the BCE analysis are summarized in Table 3-2. As shown in this table, the alternative with the most favorable NPV (least negative) is Alternative 3.

Table 3-2. Results of STEP Pump Repair/Replacement BCE [a]					
Alternative	Description	Capital outlays	O&M costs	Risk costs	NPV
1	Proactive maintenance: replace on 20-year schedule	$1,275,000	$1,224,000	$0	($2,230,000)
2	Reactive maintenance: replace at failure (assumed to be 25 years)	$1,275,000	$1,606,500	$234,000	($2,855,000)
3	"Enhanced" reactive maintenance: repair/replace as needed based upon scheduled inspections	$637,500	$1,721,250	$63,000	($2,217,500)

a. *BCE evaluation period: 2013–30.*

Based upon the results of the BCE, the City has implemented the "enhanced" reactive maintenance approach for all collection system maintenance. The additional time required at each scheduled maintenance event to thoroughly inspect the STEP tank equipment maximizes equipment service life and minimizes risk by utilizing field staff expertise to make judgment decisions on equipment condition and determine the need for R/R.

3.5.2.2 Business Case Evaluation: Shared Step Tanks

A BCE was completed to evaluate alternatives for the future operation and maintenance of shared STEP tanks that serve multiple single-family dwellings. The following sections summarize the BCE development and findings.

3.5.2.2.1 Problem Statement

The City receives additional service calls that are directly attributed to operation of the shared STEP tanks and must expend greater administrative time (cost) as compared to un-shared tanks. The City also currently maintains 35 electrical meters for shared tanks where at least one home is vacant or has failed to pay utility bills, or where the home does not meet requirements defined in the City electrical code.

3.5.2.2.2 Identify and Analyze Alternatives

Three potential alternatives for separation of the shared STEP tanks were evaluated. Separation would be accomplished by installing a new STEP tank and modifying existing piping to allow each dwelling to be served by a single STEP tank. The alternatives, as summarized below, are differentiated by the number of shared STEP tanks addressed over the next 10 years:

- Alternative 1: Continue current operation and maintenance of shared STEP tanks.
- Alternative 2: Separate all shared STEP tanks over a 10-year period.
- Alternative 3: Separate only the most problematic shared STEP tanks over a 10-year period. The City identified five shared STEP tanks that contributed to a majority of the field/administrative concerns.

The cost information and/or assumptions used as input values for the BCE include the following.

<u>Capital Costs</u>

Capital costs for installation of a new STEP tank and separation of the shared configuration is approximately $7,000 per tank, including the following:

- $5,000 per tank, for the tank itself, STEP equipment, and installation
- $1,000 per tank for site restoration and piping modifications to the existing tank
- $1,000 per tank for City administration and engineering (10 hours at $100 per hour)

<u>Operation and Maintenance Costs</u>

The City receives approximately 10 to 15 calls per year directly related to the shared STEP tanks. For the analysis, it is assumed that 2 hours of field/administrative effort is required for each of 15 calls annually. Alternative 2 would eliminate all of the 15 service calls. Alternative 3 is assumed to eliminate 12 of the service calls, by addressing the most problematic shared STEP tanks.

Installation of 149 new STEP tanks (Alternative 2) or 5 new STEP tanks (Alternative 3) would result in additional O&M needs for the collection system. For this analysis, it is assumed that each of the new tanks would be inspected on a rotating 3-year schedule as described in the STEP Pump Repair/Replacement BCE in Section 3.5.2.1 ($40 per year per tank).

The City currently maintains (pays for) the electrical meter for approximately 35 of the shared STEP tanks. Average monthly utility bills are $10 per month, or $120 per year. Alternative 1 assumes continued City maintenance of the electrical meters for these locations. Alternative 2 would eliminate City maintenance of the electrical meters. For Alternative 3, it is assumed that the City will add a surcharge to the sewer utility bills of these locations and effectively eliminate added electrical utility costs.

Risk Costs

The risks for Alternative 1 are related to potential STEP tank failure due to the lower reliability of shared STEP tanks. It is assumed that a failure causing $15,000 of property damage occurs once every 5 years.

The risks for Alternative 2 are related to the disturbances caused by STEP tank construction and restoration, and the potential impact to the homeowners and/or public. It is assumed that the City would spend $10,000 over a 10-year period for construction, public outreach, meetings, etc. related to the impacts on affected homeowners.

The risks of Alternative 3 are reduced compared to effects of the risks identified for Alternatives 1 and 2. Although the most problematic shared STEP tanks would be removed, potential failures could still occur, but at a lower frequency rate (assumed to be every 15 years). Furthermore, some lesser degree (assumed to be $2,000) of public outreach would be required for the five shared STEP tanks that are replaced.

3.5.2.2.3 Summary of BCE Inputs

Table 3-3 summarizes the inputs for each alternative.

Table 3-3. Summary of Shared STEP Tank BCE Alternatives

BCE input	Alternative 1: Continued operation of shared STEP tanks	Alternative 2: Separate all shared STEP tanks	Alternative 3: Separate most problematic STEP tanks
Capital costs	• None	• $7,000 per STEP tank separation. Assumed schedule includes 15 tank installations per year for 10 years.	• $7,000 per STEP tank separation. Assumed schedule includes 1 tank installation every 2 years for 10 years.
	• Total capital cost: None	• Total capital cost: NPV calculation of STEP tank installation schedule	• Total capital cost: NPV calculation of STEP tank installation schedule
O&M costs	• 15 annual service calls ($1,200) • Electrical utility costs for 35 electrical meters ($4,200)	• O&M for 149 new STEP tanks at $40 per tank per year	• 3 annual service calls ($240) • O&M for 5 new STEP tanks at $40 per tank per year
	• Total annual O&M: $5,400	• Total annual O&M: $5,960	• Total annual O&M: $440
Risks	• STEP tank failure leading to property damage	• Need for public outreach to address homeowner disturbance	• STEP tank failure leading to property damage (lower risk than Alternative 1) • Need for public outreach to address homeowner disturbance (lesser need than Alternative 2)
	• Total annual risk: $3,000	• Total annual risk: $1,000	• Total annual risk: $1,200

3.5.2.2.4 BCE Results and Selected Alternative

Results of the BCE analysis are summarized in Table 3-4. As shown in this table, the alternative with the most favorable NPV (least negative) is Alternative 3.

Table 3-4. Results of Shared STEP Tank BCE [a]

Alternative	Description	Capital outlays	O&M costs	Risk costs	NPV
1	Continue current O&M of shared STEP tanks	$0	$54,000	$30,000	($79,700)
2	Separate all shared STEP tanks	$1,050,000	$59,600	$10,000	($1,062,600)
3	Separate only problematic shared STEP tanks	$35,000	$4,400	$12,000	($49,000)

a. *BCE evaluation period: 2013–22.*

Based upon the results of the BCE, the City will move forward with separation of the most problematic shared STEP tanks. This alternative minimizes the risks of tank failures and lowers administrative/field staff effort without extensive capital outlays. The schedule for separating the five currently identified problematic shared STEP tanks will be prioritized to address the most O&M-intensive STEP tanks based upon City experience.

3.5.2.3 Business Case Evaluation: Future Collection System Growth

This section presents a BCE for collection system growth that evaluates three potential collection system technology alternatives: STEP, grinder pumps, and gravity sewers. The BCE alternatives would serve collection system growth due to both infill inside the existing service area and expansion to new service areas other than the Thurston Highlands MPC. Infill and expansion were evaluated separately, but the advantages, disadvantages, and fatal flaws for the alternatives were determined to be so similar that the discussion in this section presents a combined BCE for infill and expansion growth.

The potential sewer collection alternatives are briefly described as follows:

- STEP: The City's existing STEP collection system is discussed in detail in Section 3.1.
- Grinder pump: Like a STEP system, wastewater flows are pumped from each individual sewer connection. However, grinder pumps are located in small-volume sumps that are not intended to store solids. The grinder pumps are designed to pump solids after grinding them. The small-diameter sewers installed in the existing STEP collection system are suitable for conveying flows from grinder pumps.
- Gravity sewer: Wastewater flows by gravity through a series of sloped pipes either to intermediate pump stations or all the way to the treatment facility.

Although the gravity sewer alternative was evaluated for both collection system infill and expansion, it was eliminated prior to full BCE analysis. The gravity sewer collection system alternative was eliminated from further consideration (fatally flawed) because it does not make use of existing collection system infrastructure, would require WRF modifications such as odor control, and would result in a second set of maintenance procedures. Furthermore, additional solids screening and handling equipment could potentially be required at the WRF to handle greater solids loads from gravity sewers. It would be impractical and ultimately not cost-effective to implement a gravity collection system for infill development. Even for expansion to new service areas (other than the MPC), where there is no existing infrastructure, no areas of projected growth are large enough to justify the additional capital and O&M expenses associated with a gravity collection system.

3.5.2.3.1 Problem Statement

The City wastewater service area will continue to expand, and infill within the existing service area will also occur. This BCE evaluates which collection system technology should be implemented to serve City growth at the lowest combined capital and operating cost, while also accounting for risks and benefits of the technology.

3.5.2.3.2 Identify and Analyze Alternatives

Although the STEP and grinder pump collection systems have many similarities and could use the same collection system piping, there are important differences as well. Grinder pumps will deliver a greater solids load to the WRF, resulting in higher solids handling costs, but also potentially reducing the need for organic (BOD) and supplemental carbon addition (see Section 4) that will be necessary in order to meet permit limits for the production of reclaimed water. Grinder pumps are larger/heavier and tend to have a shorter service life due to more harsh operating conditions. Although grinder pumps eliminate the need for septage hauling, they also have very little storage volume, which would become a major concern during a power outage[3]. Lastly, due to the transport of solids through the collection system, grinder pump collection systems can have grease accumulation and odor issues. Table 3-5 summarizes the advantages and disadvantages of STEP and grinder pump collection systems.

Table 3-5. Advantages/Disadvantages of STEP and Grinder Pump Collection Systems

Alternative	Advantage	Disadvantage
STEP collection system	Staff is familiar with STEP equipment and related O&M	Contract hauling of septage is required
	No modifications at the WRF	Supplemental carbon source costs to produce reclaimed water will be required in the future
Grinder pump collection system	Potential source of additional carbon for treatment process	Capital cost of WRF modifications: odor control risk
	No contract hauling of septage	New equipment learning curve and additional spare parts inventory required
		More expensive pumps and greater maintenance/replacement frequency
		Potential grease accumulation issues in collection system
		Greater concern during power outages
		Increased WAS hauling costs
		Higher power costs for customers due to higher-horsepower pumps

The advantages and disadvantages in Table 3-5 were evaluated in terms of cost (risk/benefit) and combined with capital and O&M cost assumptions to compare overall costs of the STEP and grinder pump alternatives. The cost information and assumptions used as input values for the BCE include the following.

[3] STEP technology may also be a concern during a power outage, but the STEP tanks provide much greater capacity to store wastewater until power is restored. Still, during a 3–4 day power outage in January 2012, the City required four vactor truck crews to pump STEP tanks for 2 full days. Despite these efforts, two tank overflows occurred.

Capital Costs

The analysis does not include capital costs related to initial equipment and installation. It is assumed that initial capital costs for collection system extensions will be borne by the developer. It is further assumed that there are no capital costs related to upsizing of the collection system to accommodate infill growth. Allocation of growth within the collection system is discussed in Section 3.3.1.

Initial equipment and installation costs for STEP and grinder pump systems are very similar: approximately $5,000 per connection. STEP systems would likely have higher site restoration costs due to the larger disturbance associated with the septic tank installation.

Operation and Maintenance Costs

The City's current O&M costs for the STEP collection system are approximately $39.60 per connection per year, based upon current salaries/wages and STEP tank maintenance procedures. These costs include scheduled (proactive) maintenance for STEP tanks, valves, and grease interceptors as well as reactive service calls at a rate of approximately 125 calls per year. This BCE assumes a higher per connection cost ($57.00) based upon the "enhanced" reactive maintenance strategy (see Sections 3.5.1 and 3.5.2) and an assumed salary/wage rate of $40 per hour. Approximately $52.00 per connection of the total O&M cost is attributed to proactive maintenance, while the remainder ($5.00 per connection) is attributed to reactive maintenance. It is assumed that grinder pump O&M would utilize the same proactive maintenance schedule, but service calls would increase approximately 25 percent due to more harsh operating conditions for the pumps.

Solids disposal costs at the WRF related to the transport of waste activated sludge (WAS) to Tacoma and tipping fees for disposal vary depending upon the solids load of the influent at the WRF. Existing solids loading from the STEP collections system was compared to assumed grinder pump effluent BOD and TSS concentrations of 350 milligrams per liter (mg/L). WAS produced at the WRF was estimated using standard literature values for transformation of BOD/TSS to biomass. The total gallons of WAS produced was then multiplied by the WAS transport cost ($0.10 per gallon) and tipping fee ($0.0974 per gallon) to determine per connection fees related to WAS disposal. Table 3-6 compares WAS volumes and disposal costs for STEP versus grinder pump collection systems.

Table 3-6. WAS Volume and Disposal Cost Comparison for Collection System Alternatives

	STEP collection system	Grinder pump collection system
Annual WAS volume (gallons)	378,385	710,815
Annual hauling and disposal fee [a]	$74,700	$140,330
Hauling and disposal per connection [b]	$35.30	$66.30

a. *Total hauling and disposal fee of $0.1974 per gallon.*

b. *Assumed current population of 6,350 and three people per connection.*

For the STEP alternative, septage hauling was calculated to be $41.66 per tank per year. Septage hauling costs assume a 1,200-gallon tank (actual pumped volume equal to 800 gallons) pumped at 5-year intervals at a cost of $0.24 per gallon with 8.5 percent tax.

For the grinder pump alternative, it was assumed that additional staff time ($15,000 per year or 0.25 FTE) would be dedicated to additional operations and maintenance related to grease accumulation. The cost of additional staff time was divided over 4,580 connections[4].

Additional O&M costs include the electrical power required to run the STEP and grinder pumps; however, it is assumed that these costs are borne by the homeowner. For reference, approximate annual per connection STEP and grinder pump electrical costs are $13.80 and $53.50, respectively. The primary difference in cost is due to the larger size of the grinder pumps: 2 hp for grinder pumps versus 0.5 hp for STEP pumps.

Equipment Repair and Replacement Costs

R/R costs are included at the manufacturer-recommended cost and schedule. Per the STEP pump replacement BCE (see Section 3.5.2.1) it is assumed that only 25 percent of the pumps are replaced at the 20-year interval at a cost of $600, while the remainder of the pumps are repaired/refurbished at a cost of $200. The average R/R cost for the STEP pumps is $300.

The R/R costs and schedule for STEP and grinder pumps systems are summarized below:

- STEP alternative:
  - Pump R/R ($300) at 20-year interval
  - Float replacement ($100) at 10-year interval
  - Misc. component replacement ($100) at 10-year interval
- Grinder pump alternative:
  - Pump replacement ($1,500) at 20-year interval
  - Pump repair ($800) at 20-year interval (repair pump at 10 years and replace at 20 years)
  - Float replacement ($100) at 10-year interval
  - Misc. component replacement ($100) at 10-year interval

Risk Costs

The risks of the grinder pump alternative were quantified as follows:

- Equipment learning curve and need for additional spare equipment: Assume $25,000 for training and additional spare equipment spread out over the first 3 years of operation. Costs were divided among 4,580 new connections to develop per connection costs consistent with the rest of this section. However, in practice, this cost is more appropriately applied to the first connections made during initial conversion to a grinder pump collection system.
- Odor control risk at the WRF: Assume a 20 percent chance that a $100,000 odor control system is needed, plus $10,000 annually for operation of the system. Costs were divided among 4,580 new connections to develop per connection costs.
- Extended power outages: Although costly, and potentially infeasible, it was assumed that one portable generator ($1,000 for a 6,500-watt (W) generator) would be on hand for each 20 connections. Furthermore, assume an additional $500 in additional labor and diesel fuel costs per 20 connections for an extended power outage every 5 years.

The risk of an extended power outage for a STEP collection system is smaller, and was quantified assuming the actual City response to a recent 3–4-day power outage. Four pumping crews operated for 2 days (9 hours per day) at $120 per hour per crew. The risk cost per connection for a power outage was

[4] Assuming a population increase of 13,750 in 2030 for the “without MPC” scenario in Section 2 and assuming three people per connection.

calculated based on a total cost of $10,000 for approximately 2,150 existing connections, and applied once every 5 years.

Benefit Costs

Additional solids and organic loading from a grinder pump collection system would reduce supplemental carbon requirements by discharging additional readily degradable BOD to the WRF (see Section 4). At the present service area population of 6,350, supplemental carbon savings are approximately $60 per connection per year. The benefit would not continue indefinitely with each person connected, as the carbon deficit would eventually be met. However, for the purposes of this analysis, the benefit was assumed to continue for the 20-year analysis period.

3.5.2.3.3 Summary of BCE Inputs

Table 3-7 summarizes the inputs for each alternative.

Table 3-7. Summary of Future Collection System Growth BCE

BCE input	Alternative 1: STEP collection system	Alternative 2: Grinder pump collection system
Capital costs	• Capital costs borne by the developer and/or homeowner	• Capital costs borne by the developer and/or homeowner
	• Total capital cost: None	• Total capital cost: None
O&M costs	• Annual proactive maintenance: $52 per connection • Annual reactive maintenance: $5 per connection • Annual septage hauling fees: $41.66 per connection • Annual WAS disposal fees: $35.30 per connection • Electrical utility costs are borne by the homeowner ($0)	• Annual proactive maintenance: $52 per connection • Annual reactive maintenance: $6.25 per connection • Annual Grease O&M: $3.28 per connection • Annual WAS disposal fees: $66.30 per connection • Electrical utility costs are borne by the homeowner ($0)
	• Total annual O&M: $134 per connection	• Total annual O&M: $128 per connection
Equipment R/R costs	• Pump R/R ($300) at 20-year interval • Float replacement ($100) at 10-year interval • Misc. equipment replacement ($100) at 10-year interval	• Pump replacement ($1,500) at 20-year interval • Pump repair ($800) at 20-year interval (repair at 10 yrs and replace at 20 yrs) • Float replacement ($100) at 10-year interval • Misc. equipment replacement ($100) at 10-year interval
	• Total annual R/R: NPV calculation of equipment R/R schedule	• Total annual R/R: NPV calculation of equipment R/R schedule
Risks	• Emergency pumping during power outage: $10,000 for approximately 2,125 connections. Applied once per 5 years.	• Equipment learning curve and additional spares: $25,000 for first 3 years (divide among 4,580 connections) • Odor control at WRF: 20% risk of 100,000 odor control system plus $10,000 per year odor O&M (divide among 4,580 connections) • Emergency power: $1,000 generator for each 20 connections plus $500 for labor/fuel for each 20 connections every 5 years to account for extended power outage
	Total annual risk: $5 per connection once every 5 years	• Total annual risk: Risk costs vary by year depending on the schedule of risks above
Benefits	None	• Reduced need for supplemental carbon adds a benefit of $20 per person per year
	Total annual benefit: $0	• Total annual benefit: $60 per connection

3.5.2.4 BCE Results and Selected Alternative

Results of the BCE analysis are summarized in Table 3-8 based upon per connection costs. As shown in this table, the alternative with the most favorable NPV (least negative) is Alternative 1, continued use of STEP collection system technology.

Table 3-8. Results of Future Collection System Growth BCE (per connection) [a]

	Capital cost	O&M cost	R/R cost	Risk cost	Benefit cost	NPV
Alternative 1: STEP	$0	$2,679	$700	$20	$0	($3,039)
Alternative 2: Grinder pump	$0	$2,556	$2,700	$169	$1,200	($3,697)

a. *BCE evaluation period: 2013–32.*

The O&M costs for STEP and grinder pump systems are nearly identical because the benefit of eliminating septage hauling costs is negated by increased WAS disposal costs and grease accumulation O&M. The higher equipment R/R costs and the potential risks of the grinder pump system, especially concerns during an extended power outage, outweigh the potential benefit of the additional carbon load provided by a grinder pump system. Therefore, the City will continue to use STEP technology for collection system growth.

3.6 Summary of Identified Improvements

Cost estimates and schedules for identified improvements associated with the collection system are described in detail in Section 9. A summary of the improvements identified in this section is presented below:

- **Computerized inventory tracking and maintenance system:** The City will develop a computerized inventory tracking and maintenance system in conjunction with the potable water system’s upgrades. This system is described in more detail in Section 3.4.3.
- **Development of pretreatment program:** As described in Section 3.4.3, the City will develop and implement a revised pretreatment program.
- **STEP tank pump repair and replacement:** STEP tank pumps will be repaired or replaced as needed, based upon scheduled inspections described in the BCE in Section 3.5.2.1.
- **Reserve fund for STEP tank replacement:** Set up reserve for repair of major STEP tank failure. In order to prepare for the possibility of a large number of STEP tanks failing, the City will begin establishing reserve funds. The schedule and amount to be placed into reserve is described in Section 9.
- **Convert shared STEP tanks to individual STEP tanks:** Based upon the results of the BCE presented in Section 3.5.2.2, the five most problematic shared STEP tanks should be converted to separate STEP tanks. This includes tanks at the following addresses:
  - 306 Solberg Street SW has a 3,000-gallon STEP tank in its back yard that serves 306 Solberg Street SW, 308 Solberg Street SW (3 feet higher finished grade than 306 Solberg Street SW), and 412 Mosman Street SW (4 feet higher finished grade than 306 Solberg Street SW). The houses at 308 Solberg Street SW and 412 Mosman Street SW should be disconnected from the system at 306 Solberg Street SW, and two new 1,200 gallon STEP tanks should be installed at these addresses.
  - 203 McKenzie Court has a 1,500-gallon STEP tank that is shared with 205 Longmire Street SW. According to the as-built drawings, the finished grade elevation at 203 McKenzie Court is

approximately 5 feet lower than the finished grade elevation at 205 Longmire Street SW.A 1,200-gallon STEP tank will be installed at 205 Longmire Street SW to serve that residence.

  - 204 McKenzie Court has a 1,500-gallon STEP tank that is shared with 110 Washington Court SW. According to the as-built drawings, the finished grade elevation at 204 McKenzie Court is approximately 7 feet lower than the finished grade elevation at 110 Washington Court SW. A 1,200-gallon STEP tank will be installed at 110 Washington Court SW to serve that residence.
  - 205 McKenzie Court has a 1,500-gallon STEP tank that is shared with 109 Washington Court SW. According to the as-built drawings, the finished grade elevation at 205 McKenzie Court is approximately 5 feet lower than the finished grade elevation at 109 Washington Court SW. A 1,200-gallon STEP tank will be installed at 109 Washington Court SW to serve that residence.
  - 117 Circle View Drive has a 1,500-gallon STEP tank that is shared with 113 Circle View Drive. According to the as-built drawings, the finished grade elevation at 117 Circle View is approximately 5 feet lower than the finished grade elevation at 113 Circle View Drive. A 1,200-gallon STEP tank will be installed at 113 Circle View Drive to serve that residence.

- **Replace ARVs:** As summarized in Section 3.4.1, many of the ARVs in the distribution have become corroded. All 116 existing ARVs in the collection system will be replaced according to the schedule presented in Section 9.
- **Collection system upgrades:** Collection system upgrades are shown in Figure 3-12 and summarized below:
  - Prior to 2020:
    - Longmire Street replacement: Replace approximately 800 linear feet (LF) of 2- and 3-inch-diameter piping with 4-inch-diameter piping on Longmire Street.
    - Yelm Avenue replacement: Replace 120 LF of 3-inch-diameter pipe downstream of 4-inch-diameter pipe on Yelm Avenue. Also replace approximately 200 LF of 3-inch-diameter pipe downstream of a 2- and 4-inch-diameter pipe intersection in Yelm Avenue.
    - Mountain View Road replacement: Replace approximately 3,000 LF of 3-inch-diameter pipe with 6-inch-diameter pipe on Mountain View Road SE and Yelm Avenue.
  - Prior to 2030:
    - Main sewer line replacement: Replace approximately 3,800 LF of 8- and 6-inch-diameter pipe with 10-inch-diameter pipe through the main sewer line in Yelm Avenue, Cullens Street, NW Jefferson Avenue, NW Solberg Street, and Coates Road. Also replace approximately 525 LF of 4-inch-diameter pipe with 6-inch-diameter pipe on the line across Yelm Creek.
    - Rhoton Road replacement: Replace approximately 1,500 LF of 8-inch-diameter pipe with 10-inch-diameter pipe on the mainline into WRF.
    - Mill Road replacement: Replace approximately 130 LF of 4-inch-diameter pipe with 6-inch-diameter pipe on Mill Road.

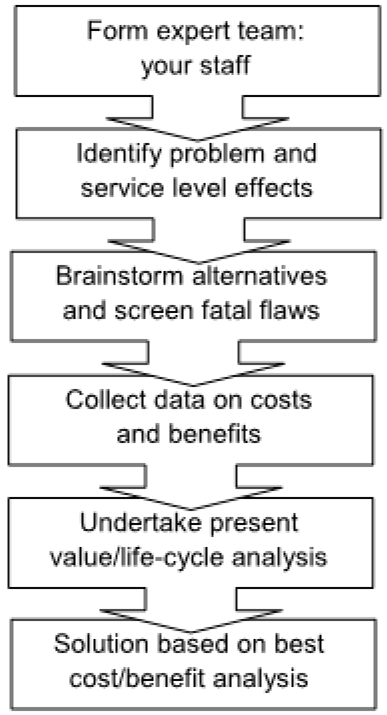

Figure 3-1. BCE process overview

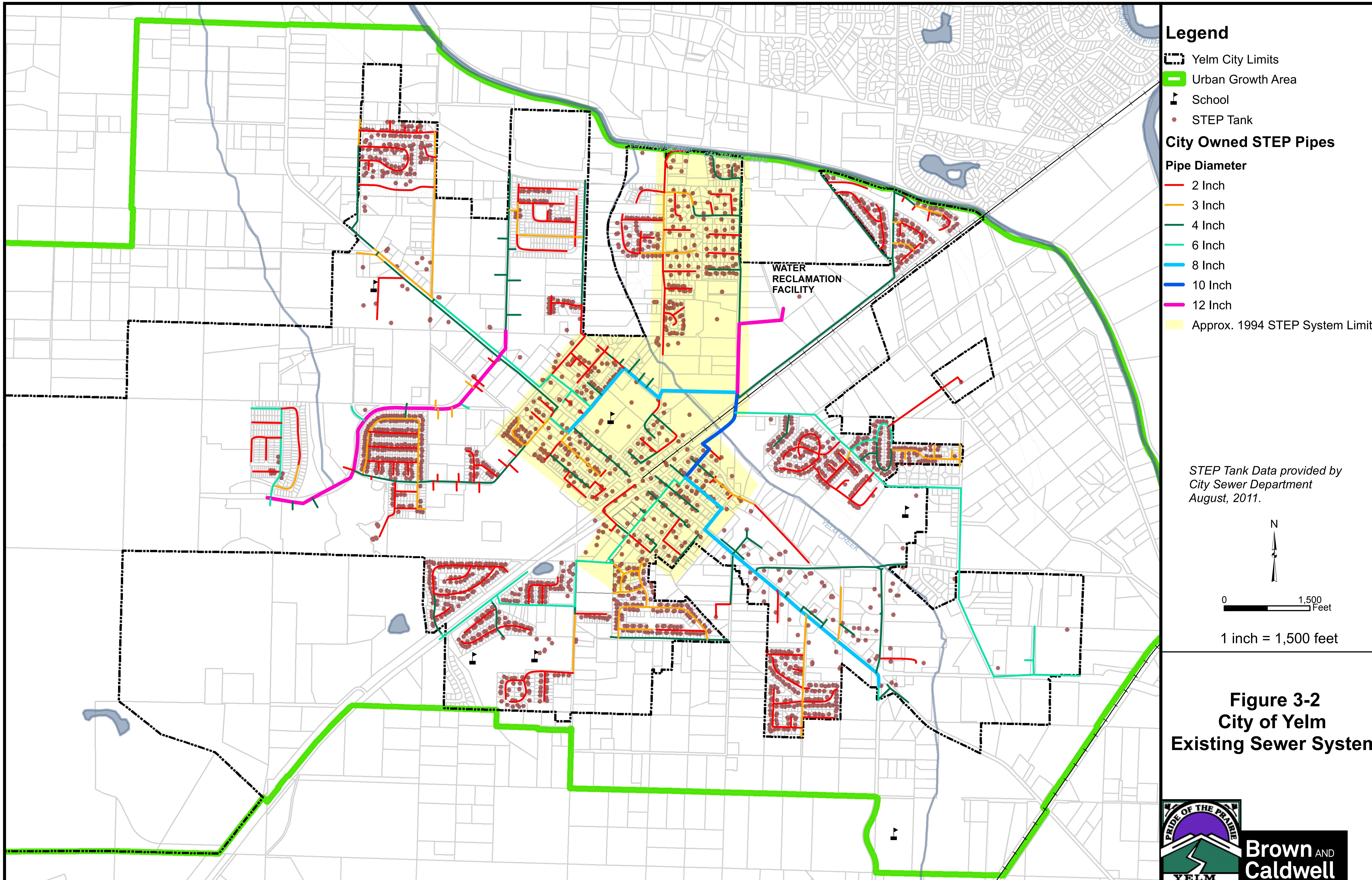

Figure 3-2
City of Yelm
Existing Sewer System

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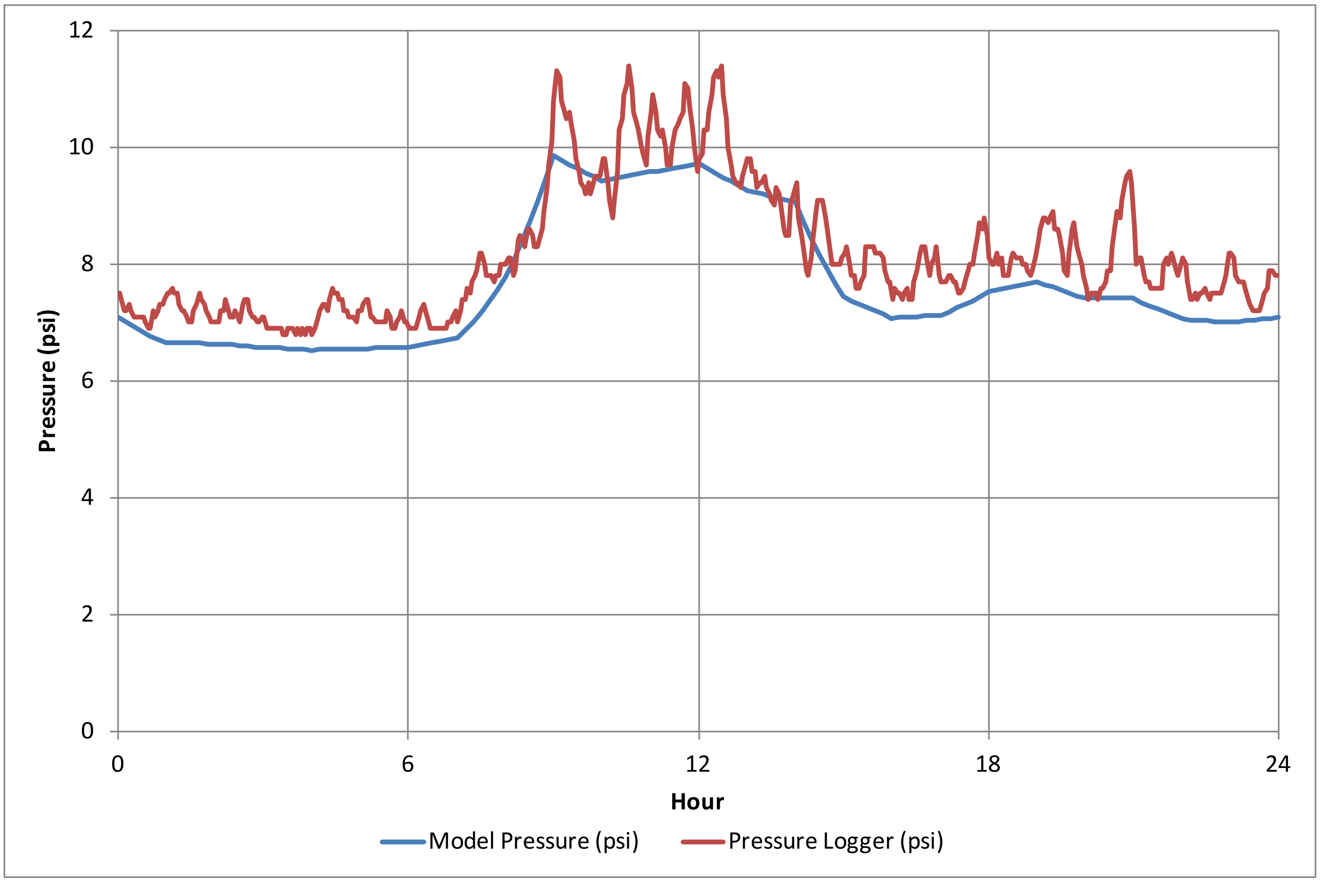

Figure 3-3. Model calibration results

Note: Calibration graph for logger P100-7 Thanksgiving, November 24, 2011. Logger located on the south side of Willow Glen at Middle Road.

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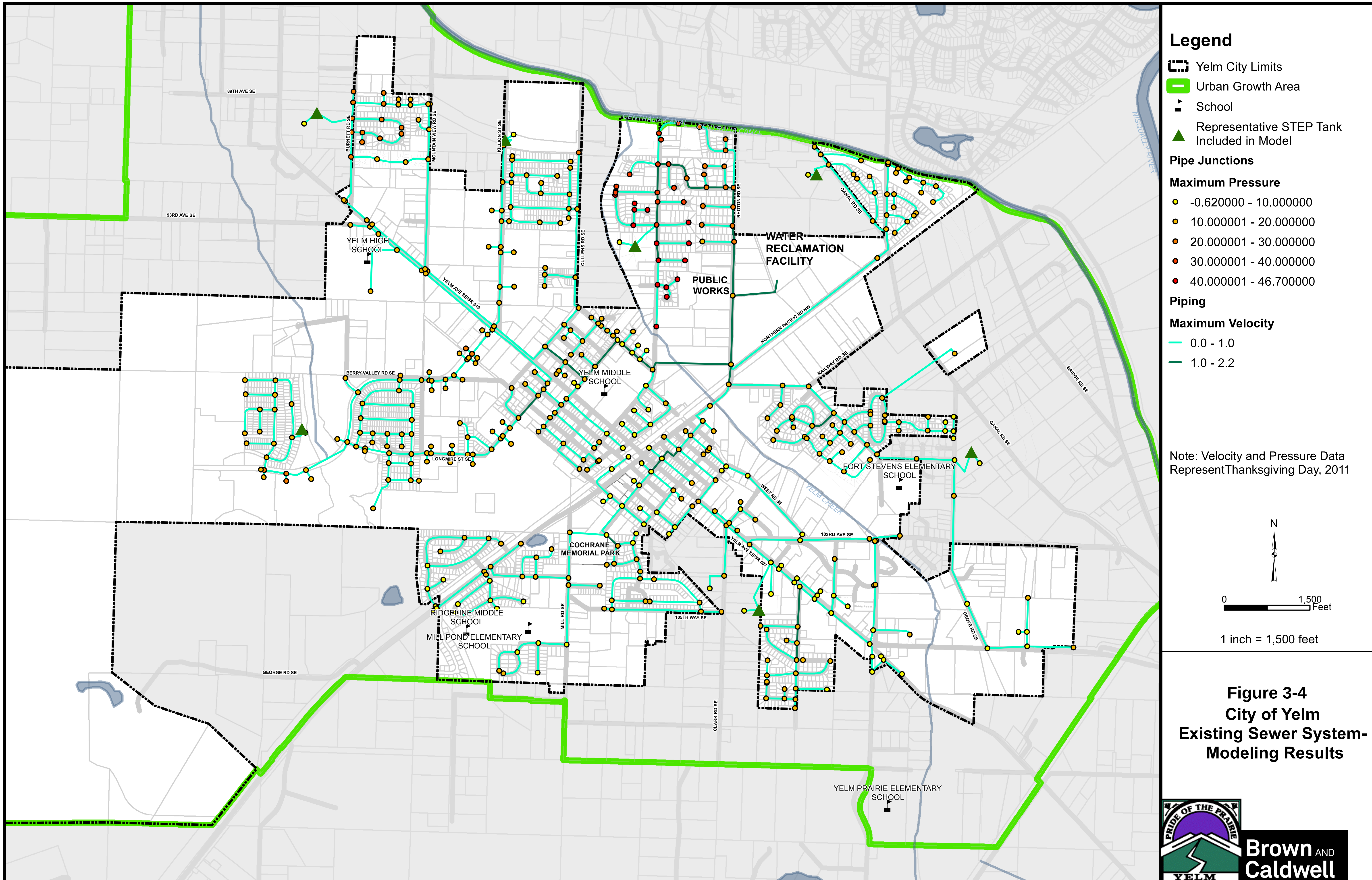

Figure 3-4
City of Yelm
Existing Sewer System-Modeling Results

Future Growth by Basin

Basin	percent of growth-2020 residential	percent of growth-2020 commercial	percent of growth-2020 schools	percent of growth-2030 residential	percent of growth-2030 commercial	percent of growth-2030 schools
Basin 2	0%	0%	0%	0%	0%	0%
Basin 3	30%	30%	20%	15%	20%	10%
Basin 4	0%	0%	0%	10%	0%	0%
Basin 5	17%	5%	0%	10%	20%	0%
Basin 6	17%	5%	0%	15%	15%	0%
Basin 7	5%	5%	20%	5%	15%	5%
Basin 8	0%	0%	0%	5%	0%	0%
Basin 9	2%	0%	0%	0%	0%	0%
Basin 10	7%	0%	20%	5%	5%	5%
Basin 11	15%	35%	0%	10%	15%	0%
Basin 12	0%	0%	0%	5%	0%	0%
Basin 13	0%	0%	0%	5%	0%	70%
Basin 14	0%	0%	0%	5%	0%	0%
Basin 15	7%	20%	40%	10%	10%	10%

Note: Basin 1 (MPC) not inlcuded. See Chapter 6.

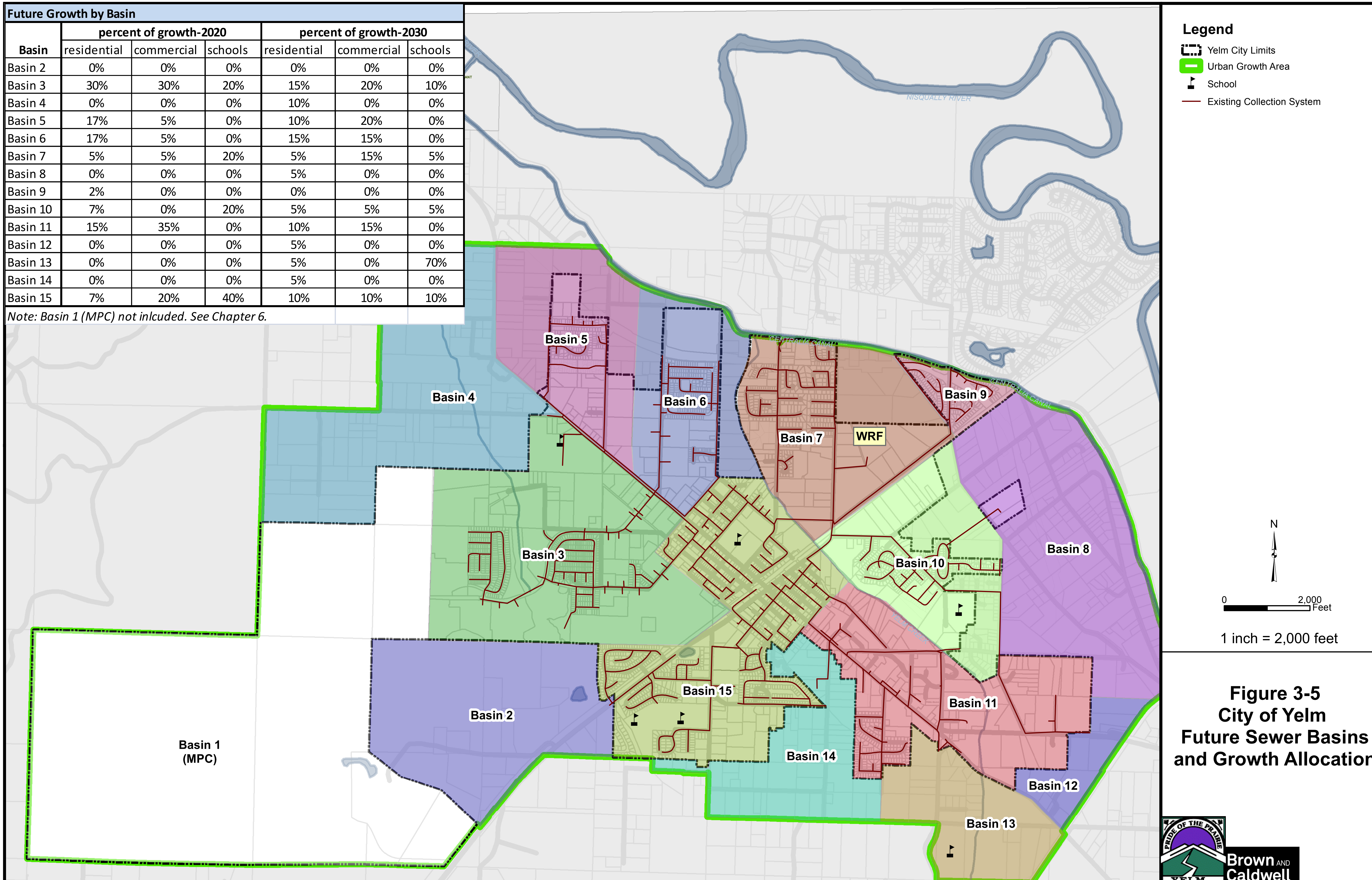

Figure 3-5
City of Yelm
Future Sewer Basins and Growth Allocation

Brown AND Caldwell

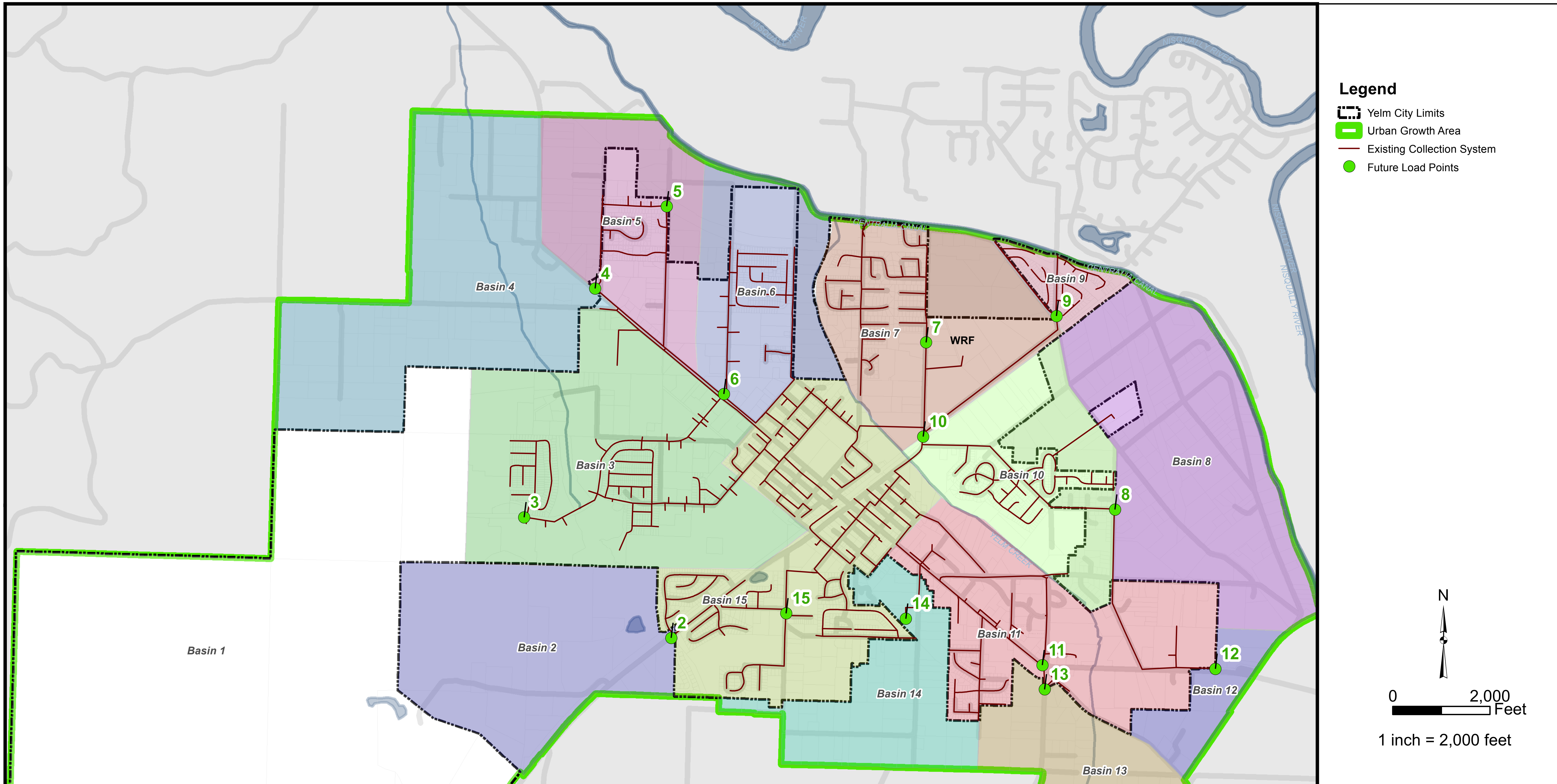

Figure 3-6
City of Yelm
Future Load Point Allocation by Basin

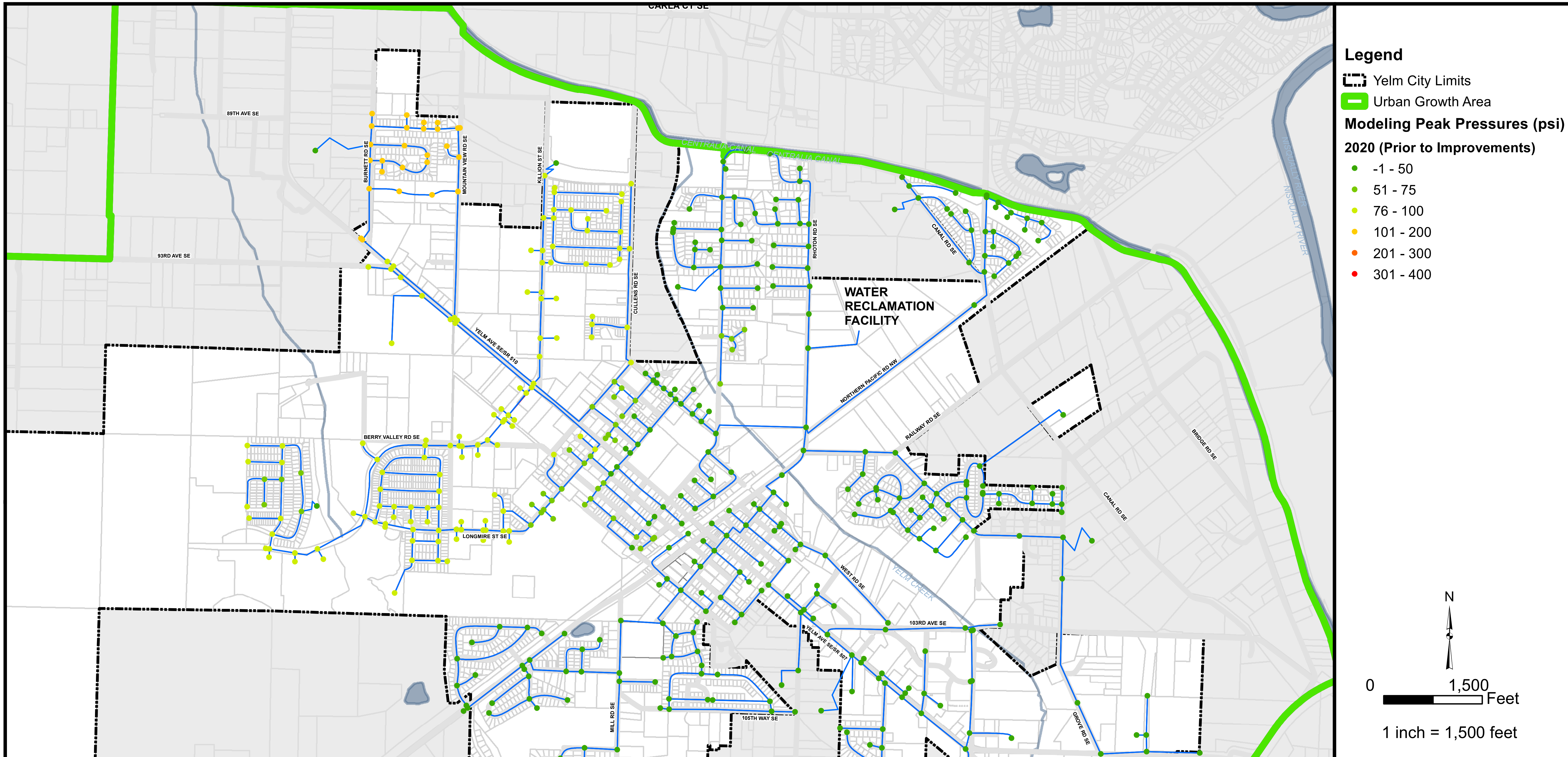

Figure 3-7
City of Yelm
Future Collection System
2020 Modeling Results
Before Improvements

Brown AND Caldwell

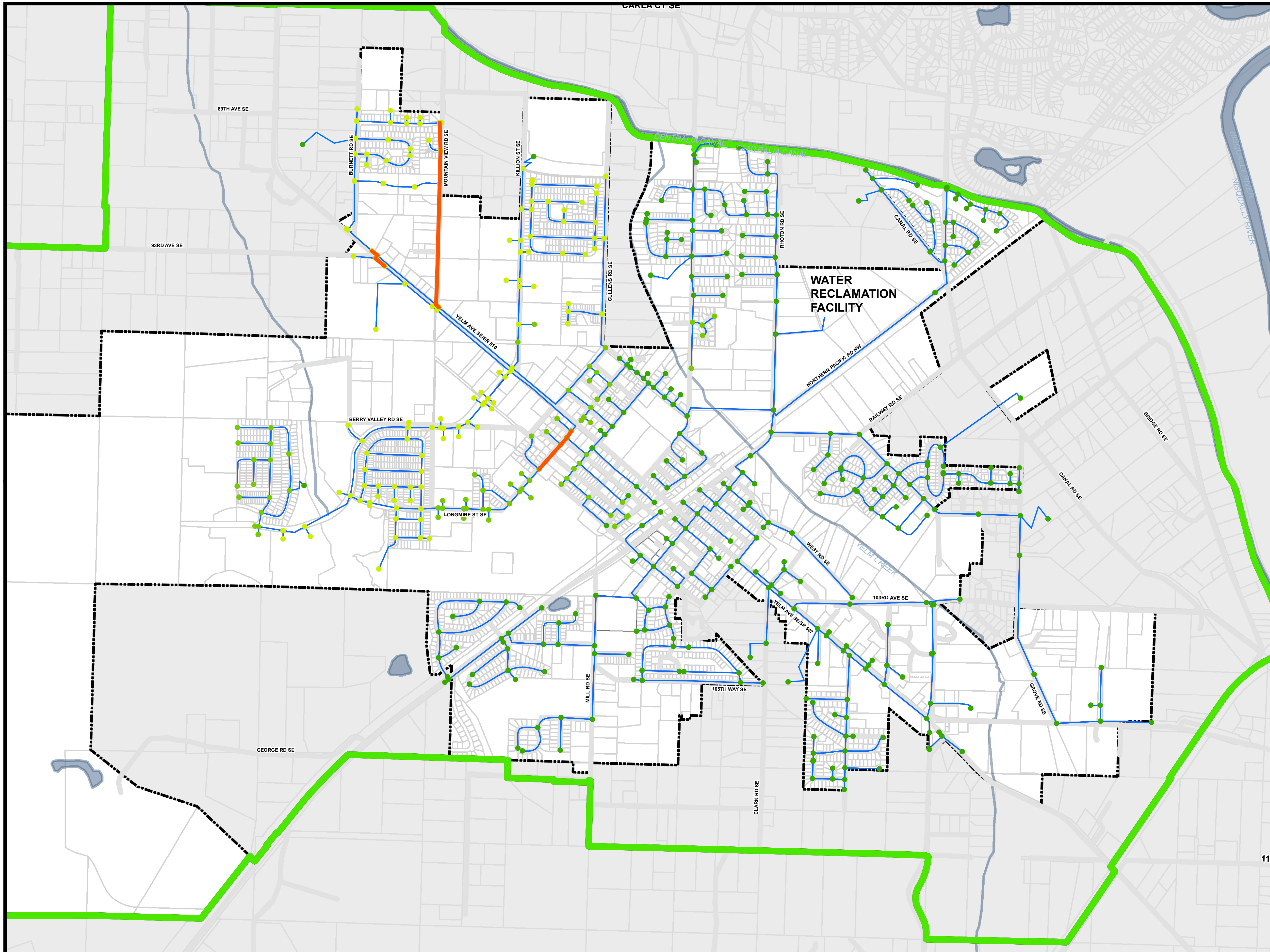

Figure 3-8
City of Yelm
Future Collection System
2020 Modeling Results
After Improvements

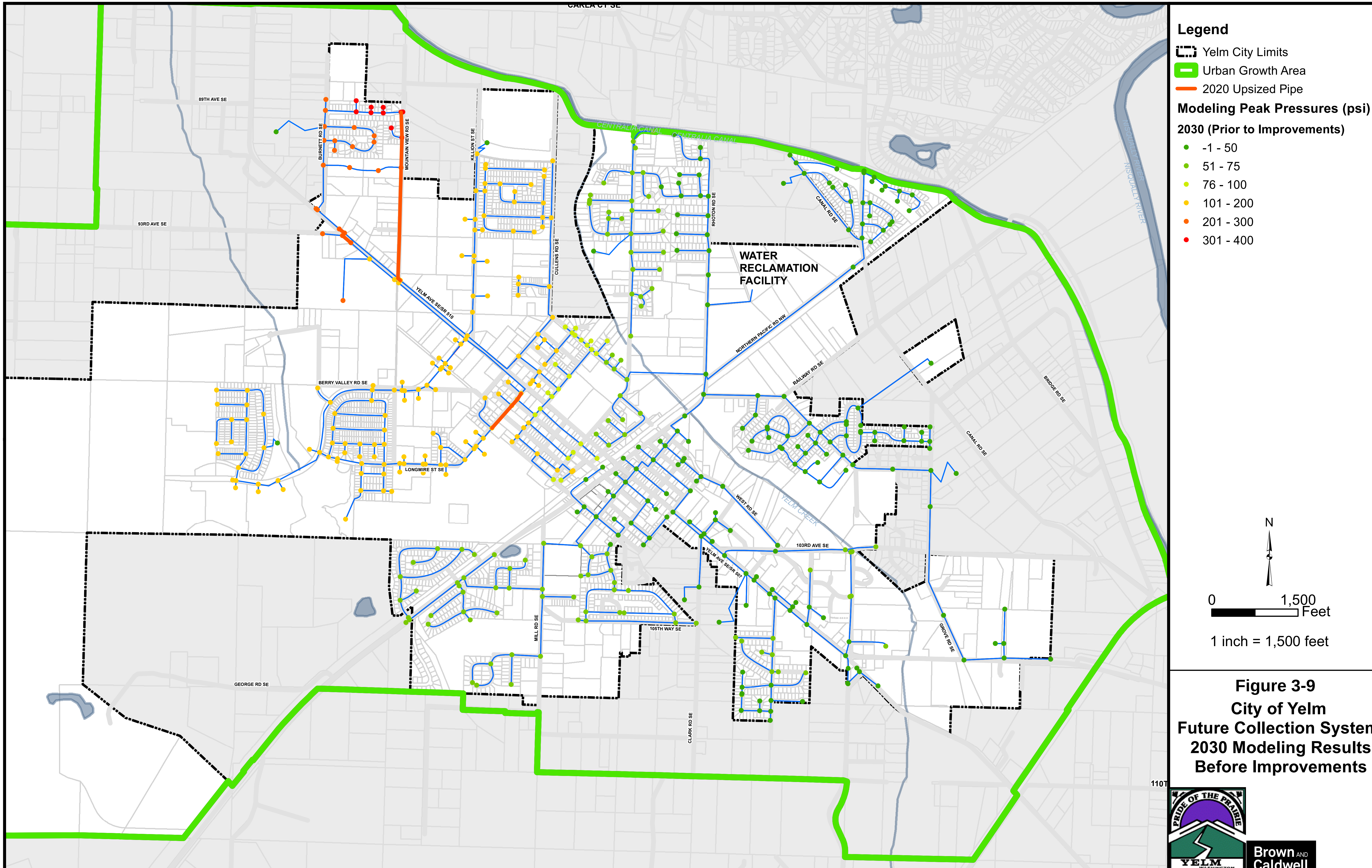

Figure 3-9
City of Yelm
Future Collection System
2030 Modeling Results
Before Improvements

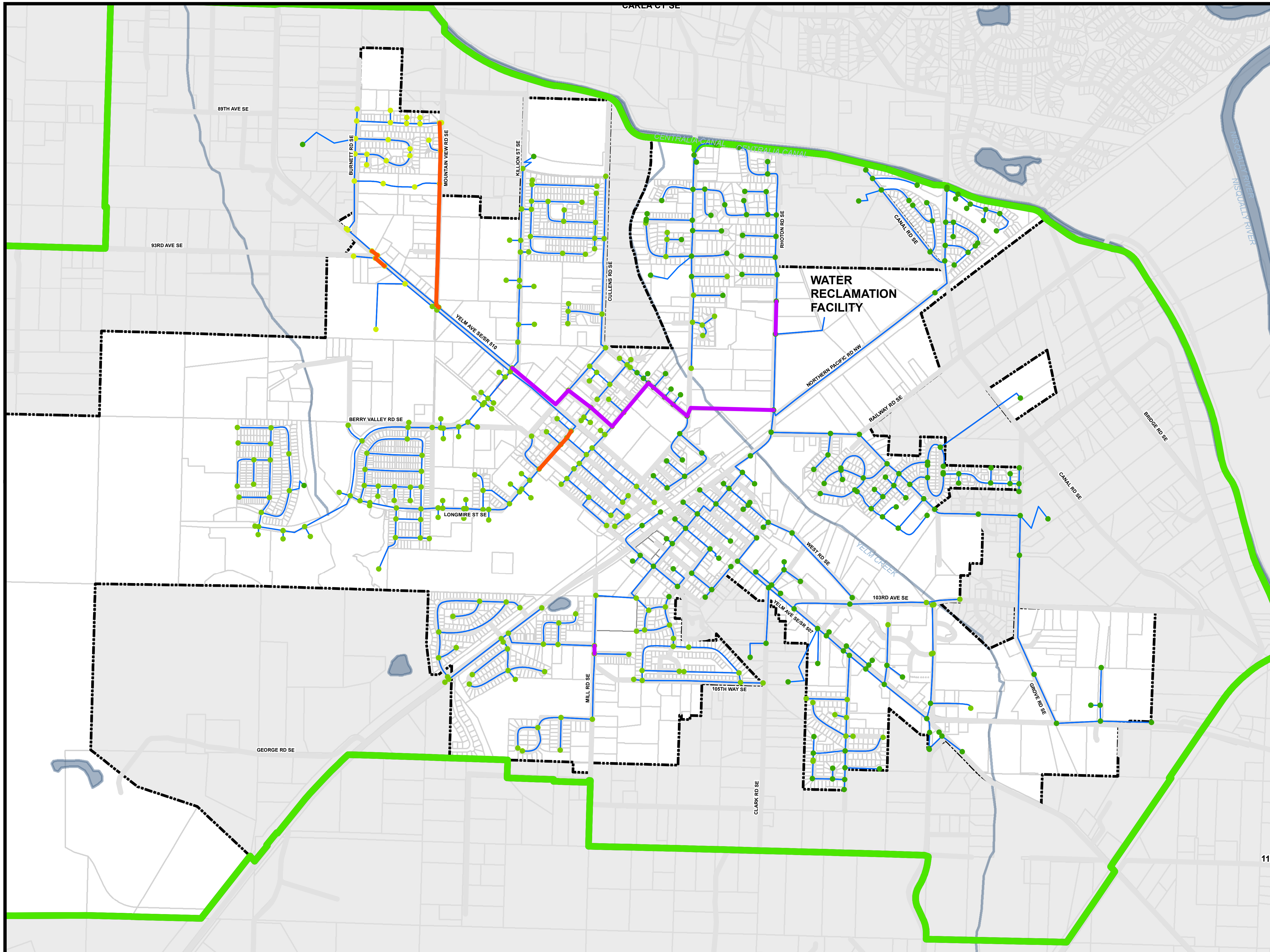

Figure 3-10
City of Yelm
Future Collection System
2030 Modeling Results
After Improvements

Brown AND Caldwell

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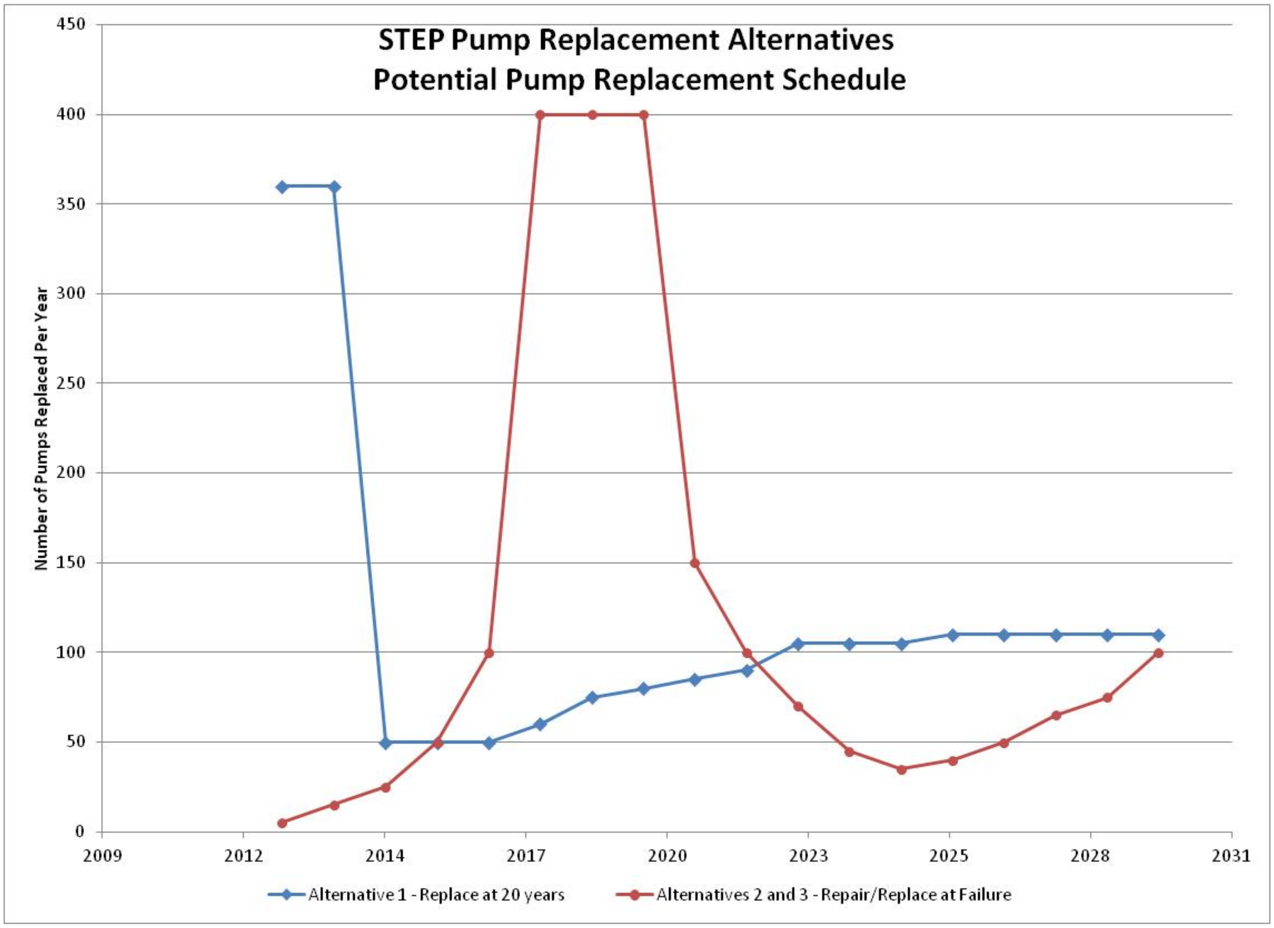

Figure 3-11. Assumed STEP pump R/R schedule

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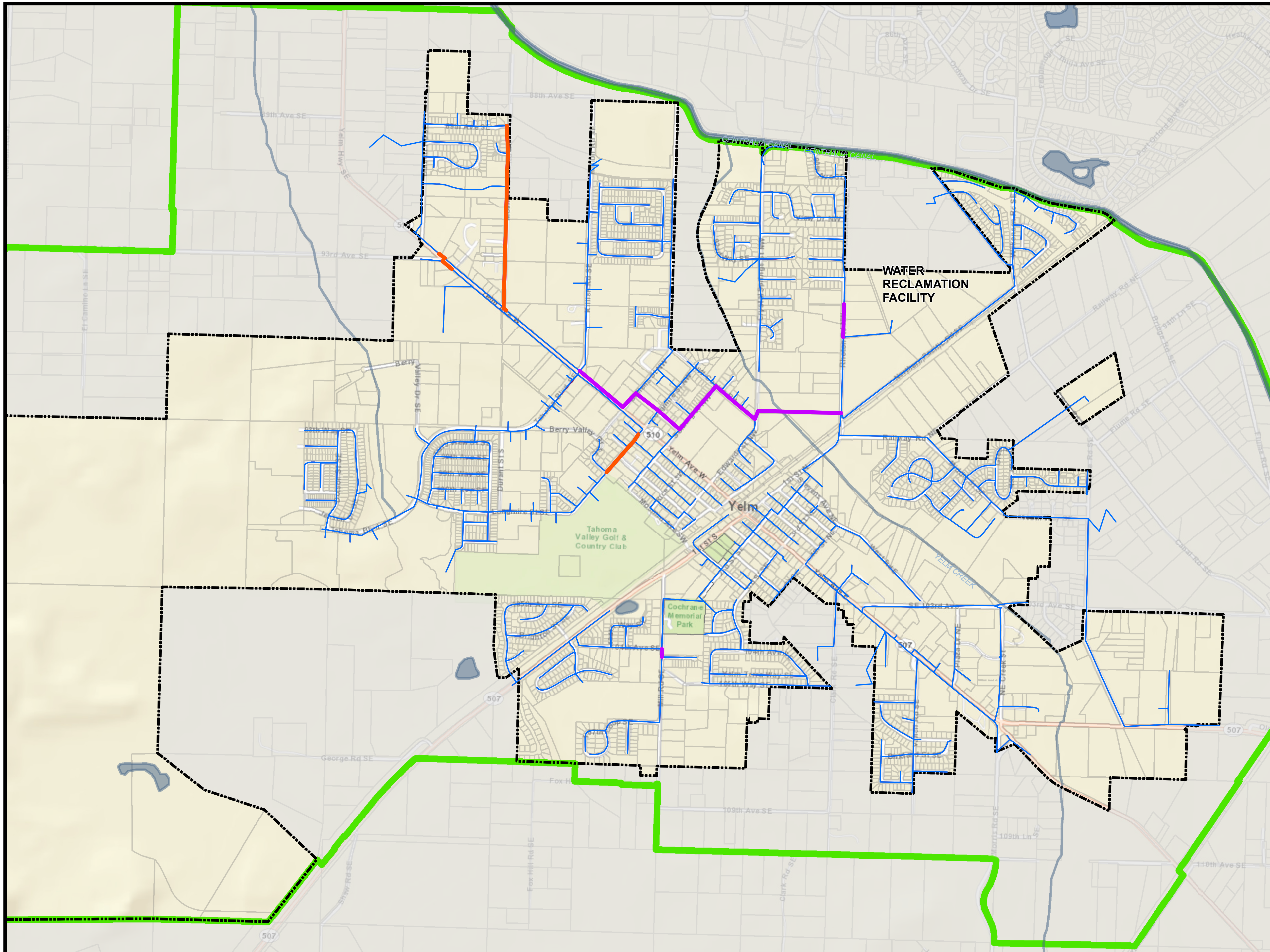

Legend

- Yelm City Limits
- Urban Growth Area
- 2020 Upsized Pipe
- 2030 Upsized Pipe

N

0 1,500 Feet

1 inch = 1,500 feet

Figure 3-12.
City of Yelm
Collection System
Proposed Improvements

Brown AND Caldwell