CITY OF JUNCTION CITY
Wastewater System Facilities Plan Junction City, Oregon

Section 6

Collection System Evaluation and Recommendations

SECTION 6
COLLECTION SYSTEM EVALUATION AND RECOMMENDATIONS

6.1. General

This section includes an analysis of the collection system. The first subsection focuses on operation, maintenance, and rehabilitation of the collection system. This is followed by the development of alternatives for potential improvements to the wastewater collection system, including gravity mains and pump stations. The evaluation of the forcemains is not included in this section. The evaluation and recommendations for the forcemains are included in **Section 7**. **Section 7** includes an evaluation of the existing treatment system and recommended improvements. Two of the treatment alternatives include relocating the treatment plant to a new site east of the City. The location of the treatment plant has a significant impact on the configuration and alignment of the various forcemains. As such, the evaluation of the existing forcemains and the forcemain alternatives are included as part of the treatment system evaluation. In this way, the division between the collection system and the treatment system is made at the pump stations rather than at the forcemain discharge points.

This section addresses the following key questions:

- What are the current collection system operation and maintenance practices and how can they be improved?
- What are the existing collection system deficiencies?
- What collection system components are likely to become deficient during the planning period or prior to complete buildout of the system?
- What are the alternatives for correcting existing and projected deficiencies?

The existing and projected collection system deficiencies are presented along with a set of alternatives for addressing each of the deficiencies. The alternatives are evaluated against each of the collection system deficiencies to generate complete collection system recommendation. In **Section 7**, the treatment system is evaluated and alternatives for correcting treatment system deficiencies are identified and evaluated.

6.2. Collection System Operation, Maintenance & Rehabilitation

This section discusses the need for sanitary sewer system maintenance and provides recommendations for the basic elements necessary for a maintenance program. The need for system-wide preventive maintenance is addressed first, then the general recommended approaches to collection system maintenance are outlined.

6.2.1 Need for System-Wide Preventive Maintenance

Maintenance of sewerage systems is necessary to insure the proper operation of the facilities and to obtain the full useful life of those facilities. Sanitary sewer systems represent significant investment of public capital. If a sewer system is allowed to fall into disrepair because of the lack of maintenance, it will not operate efficiently or as designed. Health problems and property damage may result from sanitary sewer backups, surcharging and/or overflows. Without proper maintenance, a system's capacity can be reduced by debris clogging, root intrusion growth, structural damage, infiltration and inflow (I/I), and other factors that eventually lead to failures throughout the system. Repair of failed sections of a sanitary sewer system are costly, quite often exceeding the original cost of construction. In spite of this, many jurisdictions do not adequately fund the level of maintenance necessary to protect their investment in the sewerage system. Collection system maintenance can be separated into two types: preventive and corrective.

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

Corrective maintenance, often referred to as emergency maintenance, is typically performed when the sewer system fails to convey sewage. Causes for initiating corrective maintenance may include blockages, solids buildup, excessive I/I, flooding and sewer breaks. Corrective maintenance requires immediate action, and the jurisdiction will typically pay a premium to have this work performed.

6.2.2 Present Maintenance Practices

The City has a relatively active collection system maintenance program. The City currently cleans every line in the 14th & Elm and 9th & Ivy collection systems on an annual basis. Sewers in the remaining basins are cleaned every other year. The City owns a vactor truck and cleaning equipment. Television inspection work is typically performed to troubleshoot problems and not at regular intervals. Where possible, minor emergency repairs are performed by City crews with City owned equipment. However, the City does not typically to perform major repairs on most sewer mainlines. These services are typically contracted out.

6.2.3 Preventative Maintenance Program Recommendations

The following paragraphs outline some recommendations for implementing preventive and corrective maintenance throughout the City's sanitary sewer collection system. These include the following:

- Continue the systematic sewer cleaning and inspection program.
- Establish a sewer rehabilitation and replacement program for removal of excessive I/I and replacement or repair of aging sewers.

6.2.3.1 Sewer Cleaning Program

It is important that the systematic program for the cleaning of gravity sewers be continued. Regular cleaning is necessary to prevent blockages, grease accumulation and sediment buildup in sewer lines. Normally, sanitary sewers laid at steep grades require less frequent cleaning than those laid at flat grades. Sewers at flat grades can experience sedimentation and grease buildup problems and will require more frequent cleaning and maintenance. Since nearly all of the sewers in Junction City are laid at flat grades, routine cleaning is especially important.

As part of the cleaning program, it is important that the City continue to keep records, including conditions encountered such as pipe failures, grease and solids buildup, and other problems. These records are useful in scheduling corrective work and to establish a long term cleaning frequency schedule for different sewers. As the database is established, a schedule for subsequent cleaning can be tailored to the physical character of each line, the area served, and its performance history. Specific problem areas requiring more frequent cleaning can be incorporated into this program.

6.2.3.2 Sewer Inspection Program

As the City's system continues to age and deteriorate, it is recommended that the City begin a regular inspection program. The inspection program should include both above ground and internal inspection of the sewer system.

Above ground inspection is performed by inspecting right-of-ways and easements and noting evidence of structural failure, flooding, manholes covers above or below the present level of streets, or other problems.

The two common methods of internal inspection are TV inspection performed in conjunction with the cleaning activities, and smoke testing. TV inspection of a sewer system utilizes a specially designed television camera and equipment to view the interior of the piping system. A videotape and written record of the inspection is generated and retained by the City. Leaking sewer service connections, debris or root buildup, structural failures, leaking joints and other problems can be easily identified and documented. TV inspection of sewers requires that the sewers be cleaned immediately prior to the inspection.

Due to the high cost of purchasing TV inspection equipment, as well as operator training requirements, it can be more economical to contract out to private firms for TV inspection services rather than owning and operating the equipment. These private firms provide all personnel and equipment necessary to clean the sewer and perform the inspections. TV inspection of sewers is typically performed during the winter months so that sources of I/I can more easily be noted and identified. As the City continues to grow, it may become more economical for the City to own and operate TV inspection equipment. Regardless if the work is done "in house" or contracted out, the City should implement TV inspection program targeted at inspecting every line in the system at 2 to 5 year intervals.

Smoke testing is conducted by blowing harmless nontoxic smoke into the sewer system and observing the points at which it escapes. Smoke testing is typically performed during the summer months so that groundwater does not interfere with the smoke. Smoke testing can be used to identify potential leaks into the system caused by broken pipes, bad joints, manhole failures, and similar deficiencies. Smoke testing is also very effective for locating storm sewer cross connections and illegal connections, such as roof and foundation drains. The equipment necessary to perform smoke testing is relatively inexpensive and can be purchased by the City.

6.2.3.3 Sewer Rehabilitation & Replacement Program

A sewer rehabilitation and replacement program should include mainline, manhole and service lateral rehabilitation or replacement. This type of sewer rehabilitation program is typically referred to as an I/I reduction program. The details of this program are discussed below (see **Section 6.5.1**).

6.3. Identification of Collection System Deficiencies

The purpose of this section is to determine the components of the existing collection system that are or will become deficient. This includes components that lack capacity to convey existing peak flows or will lack capacity as flows increase due to growth. A number of existing collection system deficiencies were identified in **Section 4**. This section is intended to supplement those discussions. Together with the deficiencies listed in **Section 4**, the intent of this section is to present an overall list of deficiencies that must be addressed by the City.

The existing sewage collection system was analyzed under projected peak flow conditions at the end of the planning period. In addition to the capacity of the gravity mains, the existing pump stations and force mains were analyzed for projected 20-year peak flows. Discussions relating to each of these system components follow.

6.3.1 Non-Permitted Users and Illicit Connections

As part of the facilities planning effort, the City reviewed the system with respect to non-permitted users and illicit connections. Only a single suspect user was identified. This is the high-strength industrial user discussed at length in **Section 5.3.1** of this document. As described in that section, this user is discharging a non-permitted high strength waste stream and is in the process of installing a pretreatment system to reduce the waste strength to values equivalent with residential wastewater. No other non-permitted users or illicit connections were identified.

6.3.2 Gravity Main Capacity Analysis

The peak design flows developed in **Section 5** were used as the basis for a basin-by-basin evaluation of the existing sanitary sewer trunk lines. Pipe sizes, lengths, slopes, and locations were determined from City records. The evaluation was limited to the main trunk lines conveying sewage through the basins. This approach was taken since most of the pipes within a basin will actually encounter only a fraction of the total basin flow.

The capacity of the gravity mains were calculated assuming non-pressure flow (i.e., no surcharging) and utilized Manning's equation. The pipe roughness coefficient used in the Manning's equation varies according to the material used and the age of the pipe material. For this planning effort, an "n" value of 0.013 was be used in Manning's formula regardless of pipe material. In theory, new PVC sewers have manufacturer's "n" value of as low as 0.009. However, sand, grit, and slime buildup on the pipe walls over time tend to render true "n" value of 0.013.

Each of the major trunk sewers within each basin were analyzed with respect to three classes of deficiencies. These are; 1) sewers that lack capacity to convey existing peak flows, 2) sewers that are likely to lack the capacity to convey peak flows associated with growth during the planning period, and 3) sewers that are likely to lack the capacity to convey peak flows at buildout conditions. The City's gravity collection system includes sewers that fall into all three categories. These are discussed in greater detail later in this section. At a minimum the City will have to address sewers that fall into categories one and two during the planning period. Should any of the existing sewer lines that fall into the third category need to be replaced as part of I/I reduction efforts or other maintenance reasons, they should be sized to accommodate flows at buildout.

6.3.3 Infiltration and Inflow Analysis

As discussed in **Sections 4** and **5**, the City's collection system collects excessive amounts of I/I. Therefore, I/I is a significant problem that must be addressed by the City during and beyond the next planning period. The recommendations included herein include implementing a large-scale I/I reduction program. The purpose of this subsection is to evaluate the existing collection system to determine where I/I reduction efforts should be focused.

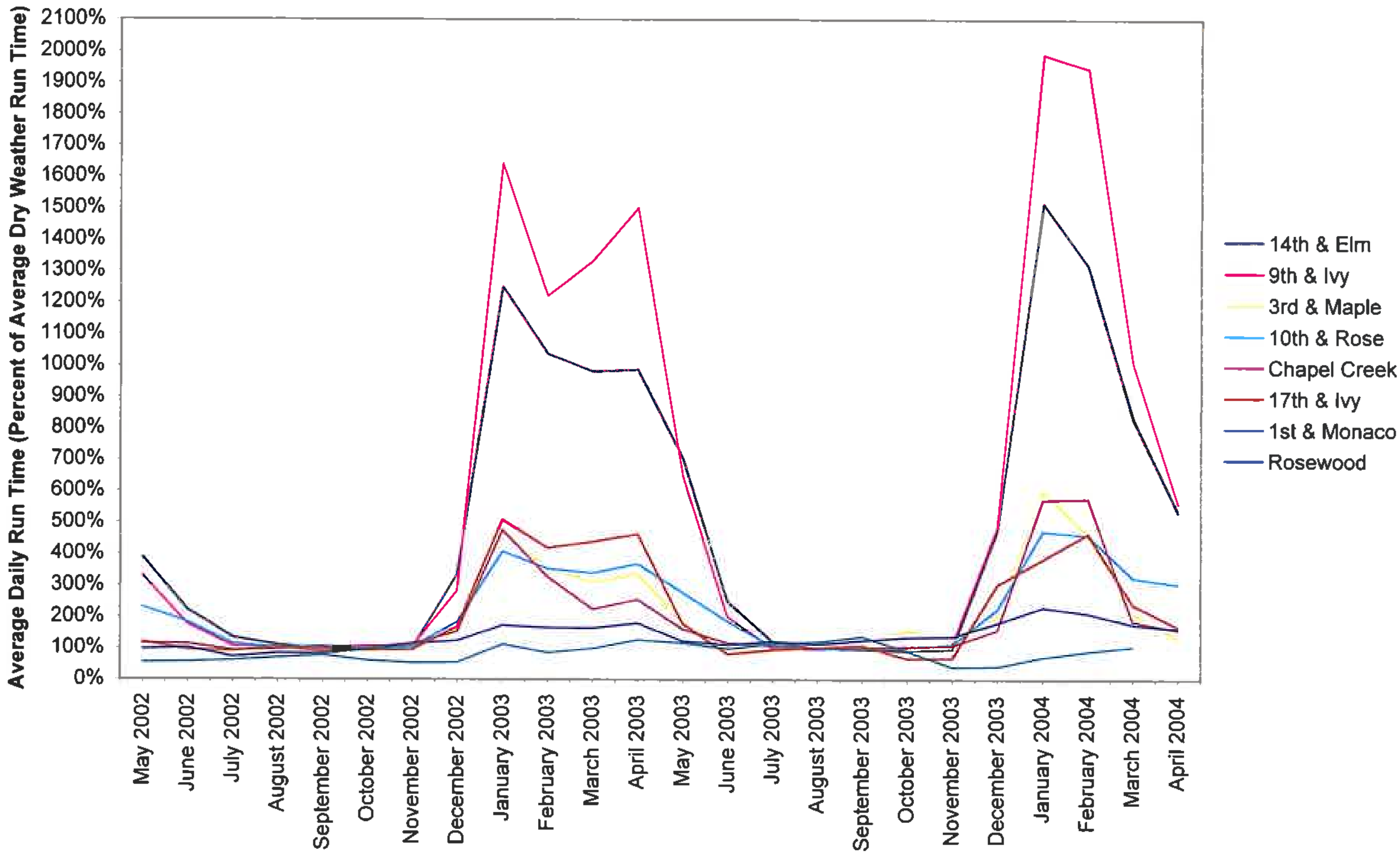
The City's existing I/I problem has been well documented. In 1986, Westech Engineering prepared an I/I control plan for the City. Much of the work presented in that document is still relevant today. In 1986, Westech personnel collected flow measurements in the collection system and identified areas where the I/I problem is most severe. This work showed that the 14th & Elm and 9th & Ivy collection systems gather the most I/I. This is not surprising since these are the older areas of the City where mortar jointed concrete piping was used to construct the majority of the collection system.

An analysis of the pump run times also demonstrates that the14th & Elm and 9th & Ivy basins have the most significant I/I problem. The normalized monthly average pump run times for each station are plotted in **Figure 6-1** for the months of May 2002 through April 2004. The run times for each station were normalized by dividing the monthly average for the station by the average pump run time for the months of August and September. Therefore, the vertical axis in **Figure 6-1** represents the percentage of the base run time. During the dry summer months, the stations operate for 100% of the average dry weather run times. During the wet winter months the run times increase. The run times for the 14th & Elm stations and the 9th & Ivy stations increase to over 10 times the summer run times. As shown in **Figure 6-1**, the increase in wet weather run times for the remaining stations is less dramatic.

The 17th & Ivy collection system includes a fair amount of mortar joint concrete pipe. Therefore, pump run times for this station were examined back to the year 1998. This analysis showed that during prolonged wet periods two pumps routinely run at the 17th & Ivy pump station. This occurred in January 2002, January 2000, January 1999, and February 1999. Based on these observations, it is clear that, though less severe than the 14th & Elm and 9th & Ivy basins, the collection piping in the 17th & Ivy basin collects excessive amounts of I/I.

In short, the City's initial efforts should be focused in the 14th & Elm and 9th and Ivy Street basins. After the I/I problem is corrected in these basins, the City should then move on to the 17th & Ivy basin. These are the areas with the most significant I/I problems and are the areas where the most significant I/I reductions for the least cost may be realized.

Figure 6-1: Normalized Monthly Average Pump Station Run Times



6.3.4 Pump Station Capacity Analysis

The eight major pump stations within the City were analyzed for the anticipated flows at buildout for each basin as developed in **Section 5**. Existing pump capacities, as well as other pump station information (i.e., force main dimensions, pump data and capacities), was previously summarized in **Section 4**.

The existing pump station capacities were compared to the existing and projected peak hour flows at buildout conditions. Buildout conditions were considered for pump station sizing. New wetwells and forcemains should be sized for buildout conditions since these facilities are not suited for incremental expansion. However, during the design of the pump stations, it may be cost effective to initially size the pumps and other such mechanical equipment for some reasonable intermediate design year rather than the buildout condition.

All pumps were analyzed for pump capacity with the single largest pump out of service. Since all the pump stations are duplex stations, the capacity of each station is the capacity with a single pump in operation (i.e., 100% redundancy) per DEQ guidelines. The results of this analysis confirmed that the City should expect to perform significant upgrades at all of the existing pump stations at some point during the planning period. Several stations lack the capacity convey existing peak flows (i.e., 14^{th} & Elm, 9^{th} & Ivy, 3^{rd} & Maple, and Rosewood) and will require upgrades early in the planning period. The other stations (i.e., 17^{th} & Ivy, 10^{th} & Rose, 1^{st} & Monaco, and Chapel Creek) are expected to either reach capacity as the City continues to grow and/or reach the end of their useful life due to age during the planning period. The recommended improvements at each station are discussed in detail later in this section.

TABLE 6-1 Summary of Pump Station Pumping Capacity Analysis				
Pump Station	Existing Firm Capacity (gpm)	Existing Peak Flows (gpm)	Required Buildout Capacity (gpm)	Recommended Upgrades (see discussions later in this section)
14th & Elm	± 1400	± 1970(1)	± 1800(3)	-Replace station
9th & Ivy	± 250	± 690	± 690	-Replace station -Upsize forcemain
17th & Ivy	± 300	± 135	± 380	-Replace station -New forcemain with new connection to primary forcemain
3rd & Maple	± 240	± 250	± 2740(4)	-Replace station -New forcemain to WWTP
10th & Rose	± 350	± 220	± 590	-Replace station -Upsize forcemain
1st & Monaco	± 80	± 80	± 880	-Replace station -New primary forcemain to WWTP
Chapel Creek	± 440	± 410(2)	± 704	-Upsize Pumps
Rosewood	± 80	± 125	± 205	-Convert to submersible station -New forcemain to primary forcemain

(1) Includes discharge from 17th & Ivy and 1st & Monaco pump stations.
(2) Includes discharge from Rosewood pump station.
(3) Projected capacity based on assumption that the discharge from the 17th & Ivy and 1st & Monaco Pump Stations is rerouted to the existing primary forcemain or to the new forcemain.
(4) Flow projection includes discharge from Prairie Road and South Industrial Basins.

6.3.5 Collection System Improvements to Serve Currently Undeveloped Areas

There are a number of areas within the City that are currently undeveloped and lack gravity sewer service. New gravity mainlines and pump stations will need to be installed to serve these areas as they develop. Current City ordinances require that mainlines and pump stations required to serve these areas be installed at the expense of the developer. These lines should be sized as required to serve all upstream areas.

6.3.6 Summary of Collection System Deficiencies

The known deficiencies described in **Section 4** have been combined with the deficiencies described above to develop a complete list of collection system deficiencies. These deficiencies are listed in **Table 6-2**.

TABLE 6-2 Summary of Collection System Deficiencies	
Location	Description of Deficiency
14th & Elm Basin	
14th & Elm Pump Station	Lacks capacity to convey existing peak flows.
14th Avenue (14th & Elm P.S. to MH A1)	Lacks capacity to convey existing peak flows.
East Front Street (MH A1 to MH A3)	Lacks capacity to convey existing peak flows.
East Front Street (MH A3 to MH A12)	Lacks capacity to convey existing peak flows.
East 10th and 9th Avenue (MH A12 to MH A18)	Lacks capacity to convey existing peak flows.
14th Elm concrete mortar joint pipe	Excessive I/I, end of useful life
14th Elm collection piping	Excessive I/I
9th & Ivy Basin	
9th & Elm Pump Station	Lacks capacity to convey existing peak flows.
9th & Ivy concrete mortar joint pipe	Excessive I/I, end of useful life
9th & Ivy collection piping	Excessive I/I
17th & Ivy Basin	
17th & Ivy Pump Station	Lacks capacity to convey peak flows at buildout.
17th & Ivy concrete mortar joint pipe	Excessive I/I, end of useful life
17th & Ivy collection piping	Excessive I/I
Undeveloped Areas	No sewer service
3rd & Maple Basin	
3rd & Maple Pump Station	Lacks capacity to convey existing peak flows.
Undeveloped Areas	No sewer service
10th & Rose Basin	
10th & Rose Pump Station	Lacks capacity to convey peak flows at buildout.
Undeveloped Areas	No sewer service
Chapel Creek Basin	
Chapel Creek Pump Station	Lacks capacity to convey peak flows at buildout
Undeveloped Areas	No sewer service
Rosewood Basin	
Rosewood Pump Station	Lacks capacity to convey existing peak flows.
Undeveloped Areas	No sewer service
1st & Monaco Basin	
1st & Monaco Pump Station	Lacks capacity to convey peak flows at buildout.
Undeveloped Areas	No sewer service
West 10th Basin	No sewer service
Prairie Road Basin	No sewer service
South Industrial Basin	No sewer service

6.4. Identification of Collection System Alternatives

Facilities planning requires the examination of a broad range of alternatives for each portion of the wastewater system. This section examines the alternatives for collecting wastewater within the study area and conveying it to the point of treatment. This section develops and screens wastewater collection alternatives using criteria such as land requirements, topographic constraints, reliability, operational flexibility, construction and long-term O&M costs, and regulatory restrictions. The alternatives listed in this section represent the tools used in the facilities planning effort to address the previously listed deficiencies in order to provide a comprehensive long-term solution for the City's collection system.

6.4.1 No Action

The no action approach implies that no improvements will be made to the existing collection system (excluding maintenance or repairs). Obviously, this approach is recommended for those areas of the system which have sufficient capacity to convey the design flows and are in acceptable condition. Although this approach may be justified in isolated areas within the system on a case-by-case basis where there is insufficient capacity to convey peak design flows (i.e., minor surcharging for short periods of time), this approach is effectively eliminated by DEQ guidelines and regulations.

Although it is always an option to not improve the system, the result will be health risks, damages, and inconveniences where sewage collection and pumping facilities are inadequate. Furthermore, delaying required improvements almost inevitably leads to a greater future problem. However, to ensure that system improvements are justified, it is necessary to consider the costs and advantages of proposed improvements against the risks entailed by the no action alternative. It should be noted that since resources are limited and the sewer system cannot be upgraded all at one time, the phasing plan adopted by the City for the improvements will in effect require that the no action alternative be adopted <u>on a temporary basis</u> for all but the first phase improvements.

6.4.2 Reroute Sewage (Basin Transfer)

Under this scenario, sewage would be diverted or rerouted from one sewer basin or system to another. This approach is practical in cases where an existing sewer and pump station has capacity in excess of that needed to convey design flows from that basin, and where flow diversion is practical from a construction and topographic standpoint.

6.4.3 Upgrade Existing Collection System, Pump Stations, & Force Mains

This approach involves constructing replacement pipes and/or upgrading pump stations and force mains to provide adequate capacity for the design flows. This is the most obvious alternative since it provides assurance that the sewage collection system can convey the design flows through town and that overflows will be kept to a minimum, which in turn limits the City's liability.

6.4.4 Infiltration/Inflow Reduction

As stated previously, the collection system collects large amounts of I/I during the winter months. While reduction of the existing I/I flows and minimization of future I/I flows is important, experience in western Oregon has shown that the goal of <u>complete</u> elimination of I/I is unreasonable and largely unattainable. An understanding of I/I hydraulics is necessary to understand why this is so, and to illustrate the place that I/I reduction has in the overall management and improvement program.

Infiltration is groundwater that enters the collection system through faults in manhole barrels or bases, mainline pipes or service laterals. Inflow, on the other hand, is surface water or storm runoff that enters the collection system directly from sources such as manhole lids, open cleanout covers, roof drain connections or sump pump connections. Such inflow connections are illegal under the City's current ordinances. Unless there are illegal drainage connections, typically very little water entering the sewer system is direct inflow.

Many of the trenches dug when the sanitary sewers were installed are backfilled with granular materials. As the sewer trenches are generally deeper than any other utilities, stormwater tends to collect in the old trenches as soon as there is enough precipitation to cause surface runoff. In the older portions of the sewer system, there are generally more than enough breaks, leaks and faults in the sewer system to allow virtually all water collecting in the sewer trenches to enter the sewer piping. Inadequate downstream capacities (pipe capacities and/or pump station capacities) cause surcharges that inhibit the rate at which water enters the sewer system.

As the sewers are repaired, the number of system faults in each area are reduced until the size and number of faults start to inhibit the flow of I/I into the sewers. When that happens, groundwater levels in the sewer trenches rises. Peak I/I flows are smaller, but as long as some faults remain at elevations generally below trench-water levels, the I/I flows several days after a precipitation period remain high. The relationship between ground water levels, precipitation and I/I is complex and transient.

Several options are available for reducing infiltration and inflow into the collection system. These include complete replacement of mainlines manholes and services, in place rehabilitation (i.e., pipe bursting, cured in place pipe, slip lining, grouting, etc.), and spot repairs. Selection of the proper technology must be done on a project by project basis to determine the most cost-effective approach. Examples of factors that must be considered include pipe size, depth, level of deterioration, backfill, soil condition, alignment, surface restoration and number of services.

Experience has shown that successful I/I correction requires a carefully planned iterative approach. The first step involves fieldwork and data collection within the proposed work area. Each line should be cleaned and inspected with television monitoring equipment. With the exception of smoke testing, all fieldwork should be done during wet periods when reliable I/I flows are high. The data must be carefully analyzed to refine the locations of the problem areas and to determine if the line should be replaced entirely or if an in-place repair technology is more appropriate. After the improvements are constructed, more fieldwork and inspections should be performed to determine the success of the I/I correction. For example, if high I/I flows are observed from a particular section of sewer main that has been replaced including the manholes and the public portion of the services, a logical source would be the private portion of the services. This would indicate that to be successful, the entire system must be replaced/rehabilitated from the mainline to each structure.

Replacing the private portions of the services can be politically challenging. Many Cites require users to repair the private portions of the services upon notice from the City that the service is causing excessive infiltration. At $1,500 to $2,500 per service, this can be a difficult cost for homeowners to bear. The political ramifications of implementing such a policy must be carefully considered. In some successful I/I control programs grant funding to correct service laterals for low income users has been available and makes the I/I correction work less of a financial burden.

Most I/I correction programs have not been as successful as intended because the nature of sewer system I/I was not fully understood. In the past, many I/I reduction programs were based on the theory that to significantly reduce I/I, only the major leaks need to be identified and repaired. There are many reasons why this approach has failed. Two significant reasons are summarized as follows.

- The effects of "hydraulic transfer" have not been well understood. Water in the sewer trenches easily runs along the outside of the sewer pipes. After the mainline pipes that collect I/I are grouted or otherwise repaired, nearby pipes and adjacent service laterals begin collecting large I/I quantities and total system flows remain substantially unchanged. This is hydraulic transfer. Plugging some leaks causes the trench groundwater level to rise slightly. The trench backfill material is relatively permeable, allowing water to run along the pipeline and enter other faults at slightly higher elevations, or through smaller leaks that now have more pressure on them (greater hydraulic head).

- Service laterals have not been effectively addressed. In most systems, service lateral piping represents half of the total system. In many systems, very little is done to locate and stop service lateral leakage. Some have concluded that because service laterals are relatively shallow, they will not contribute much I/I. Frequently, however, service laterals contribute a major part of total I/I and significant I/I reductions cannot be achieved without repairing faulty service laterals. The connection of service laterals to the sewer main is particularly critical. Typically, a significant percentage of these connections in older systems are faulty and leaking profusely.

Some of the lessons from successful I/I correction programs of the past are as follows.

- Do I/I correction on a basin-by-basin basis. Significant I/I reductions are only reliably achieved by eliminating all or nearly all I/I contributing faults in a sewer basin. To repair much less, tends to shift the entry of I/I from one fault to the next.

- Measure wet weather I/I flows from the selected basins before repair work starts.

- Initially determine what, in general, must be done to repair the faults contributing significant I/I. Locate as many such faults as reasonable, but realize that it is impossible to find them all. Some will not be discovered until some repairs are made.

- Establish a repair plan and budget for all known repairs. Make allowances for repair of faults not initially discovered. The repair plan must include repairs to mains, manholes and service laterals if each contributes significant I/I.

- Make the initial repairs and then re-measure wet weather I/I. Unless the I/I reductions are acceptable, find the remaining I/I sources and repair them. Repeat this process until acceptable I/I reductions are achieved. Experience has demonstrated that the ratio of I/I reduction per dollar spent will be much higher for the last repairs than the first.

  I/I correction is a complex process. A process that is part art and part science, since there are often multiple methods for correcting the system faults. In general, the repairs must be long lasting, and the least expensive method of achieving a long-term repair should be utilized.

Several methods are available for rehabilitating pipelines to eliminate I/I. These methods include the following:

- Sewer replacement
- Chemical grouting of joints and lateral connections
- Slip lining (HDPE)
- Cured-in-place Pipe (Insituform or equivalent inversion lining)
- Folded & formed pipe (Nupipe, U-liner or equivalent)
- Pipe Bursting

Factors such as cost, structural conditions, safety, and potential for I/I migration will influence the selection of the proper technique and must be considered when selecting a rehabilitation method on any specific pipeline section.

Manholes are usually rehabilitated to correct structural deficiencies and to eliminate the entrance of ground and surface water. Each manhole should be evaluated to determine the type of problems occurring and the optimum method of rehabilitation and repairs including frame, cover, side wall, and base rehabilitation. Chemical grouting is usually very effective for correcting sources of infiltration in manholes.

Based on the above discussion, it is recommended that, at a minimum, the entire remaining 1948 concrete mortar jointed pipe be replaced or rehabilitated during the planning period. This work should include replacing or rehabilitating the services and manholes as well as the mainlines. The remaining 1948 collection piping is believed to be the most significant collector of infiltration. However, other significant sources may exist. During the late 1960's and early 1970's, the City replaced large sections of the 1948 system with rubber gasketed AC pipe. It appears the original manholes and service laterals were salvaged. The existing service laterals in these areas are a significant concern. These services may be a significant contributor to the City's I/I problem.

Replacing all of the faulty mainlines, service, and manholes in the City during the planning period is not feasible from cost point of view. As such, initial efforts should be concentrated in the areas known to have the most significant problems. For purposes of this Facilities Plan, it is recommended that the City focus only on those areas served entirely by the original 1948 system. As the City begins to implement I/I reduction efforts, a key first step will be flow monitoring to locate problem areas. The City should carefully select segments for flow measurement to determine if the areas in which the 1948 concrete mainlines were replaced by AC pipe still collect excessive amounts of I/I. If measurements show these areas are also large contributors to the I/I problem, the City should consider expanding the scope of the work effort accordingly. Clearly it is safe to assume that the areas served entirely by the 1948 collection system should be replaced or rehabilitated during the planning period. This represents the minimum goal. Work in these areas should include the replacement or rehabilitation of the service laterals and manholes. If subsequent field observations show severe I/I problems in other areas of town, the work effort will simply have to be expanded. The City may find that most sensible approach is to view I/I correction as an ongoing effort and include the costs in the annual maintenance budget for the sewer utility. Another approach would be to view I/I correction as a capital improvement in which the work is completed over a shorter duration. These two approaches are discussed in greater detail in the following sections.

6.4.4.1 I/I Correction Alternative A: I/I Correction as a Maintenance Item

Under this alternative, I/I correction is included as an item in the City's annual sanitary sewer maintenance budget. This alternative is founded on the principle that the management of I/I is an ongoing work effort that will continue indefinitely. Since I/I results from faults in the collection piping, to some degree, I/I is directly related to the age of the system. Over the course of the planning period, other portions of the collection system will continue to age and new I/I problem areas are likely to emerge. As such, this approach is more in-line with the nature of I/I problems than the capital improvement approach.

When considering an ongoing I/I reduction program, the key question that needs to be answered is how much of the collection system should be addressed on an annual basis. As described above, the initial efforts should be focused on the areas served by the original 1948 system. The recommended plan includes budgeting enough resources to replace or rehabilitate all of the remaining 1948 collection system including service laterals and manholes by the end of the planning period. Assuming the City will not fully implement the I/I reduction plan for a few years, it is envisioned that the 1948 system should be upgraded over a 20-year period.

Based on the collection system maps, the remaining 1948 collection system includes approximately 20,500 feet of gravity piping, 100 manholes, and 400 services (see **Appendix E**). Therefore, over a 20-year period, the annual improvement goal is 1,025 feet of gravity piping, 5 manholes, 20 services. The annual cost of this work is based on the assumption that all mainline manholes and all public and private portions of the service laterals are replaced. This assumption is conservative. It may be more cost effective to repair the existing mainline using in-situ methods for certain portions of the collection system. In addition, experience may show that replacing the service laterals is not necessary. Due to the relatively high permeability of the underlying soils, pipe faults above groundwater levels may contribute relatively little to the I/I problem. If this is the case, these pipes may not need to be replaced. It is likely that many of the service laterals are above the high groundwater elevation. If this is the case, these service laterals may be allowed to remain in service. The associated cost savings can simply be used to replace a longer section of the system. It is also likely that unforeseeable (at the facilities planning stage) difficulties will result in certain projects costing more than estimated herein. As such, it is likely that individual cost savings and overruns will balance out over the 20-year term of the effort.

As shown in **Table 6-3**, the annual project cost for the proposed I/I reduction plan is approximately $275,000.

The drawback with this alternative is that the benefits of I/I reduction are not achieved until the latter half of the planning period. This alternative is also more susceptible to increasing construction cost. A benefit of this alternative is that it permits greater flexibility in the focus of future I/I correction work. The improvements can be made slowly over many years. The effects of the various improvements can be carefully studied and adjustments in future work can be made. In recent years, significant advancements in sewer rehabilitation methods have occurred. I/I correction is not a problem unique to Junction City. Problems associated with I/I, are experienced in many systems throughout the world. As such, a fairly significant construction industry has developed to serve the sewer rehabilitation market. Therefore, it is fair to assume future technological advancements will occur. The long-term approach to I/I correction has the potential advantage of capitalizing on future technological advancements in sewer rehabilitation methods.

TABLE 6-3 I/I Correction Alternative A: Recommended Annual Budget				
Item	Unit	Quantity	Unit Cost(3)	Total Cost(3)
TV Inspection	L.F.	1,025	$2.00 (2)	$2,050
10" Mainline (1)	L.F.	1,025	$120.00	$121,770
Manholes	Each	5 (3)	$3,800	$19,000
Services	Each	20 (4)	$2,700	$54,000
Subtotal Construction Cost				$197,000
Construction Contingency @ 10%				$19,700
Engineering Costs @ 20%				$39,400
Administrative Costs @ 10%				$19,700
Total Project Costs				$275,000

(1) 10" mainline assumed to be average size over entire project area.
(2) Assumed unit price based on TV work done at ± 5,000 foot increments.
(3) Costs are in 2006 dollars and assume dry weather construction, publicly bid project, ENR 20 Cities index = 7883.

6.4.4.2 I/I Correction Alternative B: I/I Correction as a Capital Improvement

As an alternative to addressing the I/I correction problem incrementally over a long duration (i.e., I/I Correction Alternative A), the City could choose to implement the I/I correction measures more rapidly. Under this alternative, the recommended I/I correction goals would be completed early in the planning period as opposed to extended over the entire planning period. This would require a significant financial expenditure early in the planning period and would likely require to the City to procure financial assistance in the form of a loan. The loan would most likely be repaid through the collection of user fees. The scope of work under this alternative would remain the same as the scope of I/I Correction Alternative A, and would include replacing all of the remaining 1948 collection system including mainlines, manholes, and services. Completing the work in a single construction season would be extremely disruptive to the community. As such, it is recommended that, the improvements be implemented in at least four phases.

It is recommended that the first phase include a significant amount of analysis work to verify that the improvements will have the desired affect. The first phase should essentially be a study phase with a demonstration project and further study upon the completion of the demonstration project. The demonstration project would include relatively small-scale improvements with a detailed comparison of flow measurements before and after construction. Due to the expense of the final three stages, it is recommended that a significant amount of analysis work be completed to ensure that the money is wisely spent. Since I/I is a wintertime phenomenon, all flow measurements must be completed during the winter months. As such, work will be required throughout the year rather than only over the construction season. In addition, dry years similar to the winters of 2001 and 2005 may not permit the collection of useful flow measurements. If such a winter occurs during the implementation of the I/I correction work, it may be wise to delay the project accordingly. The general steps for the execution of the four phases is as follows.

- Phase 1 Winter: Collect and analyze flow data, define limits of demonstration project
- Phase 1 Summer: Construct demonstration project
- Phase 2 Winter: Collect and analyze flow data, assess success of demonstration project, revise future work efforts or move forward with scheduled work.
- Phase 2 Summer: Construct I/I improvements in 9th & Ivy Basin.
- Phase 3 Winter: Collect and analyze flow data, assess success of improvements in 9th & Ivy basin, revise future work efforts accordingly.
- Phase 3 Summer: Construct I/I improvements in 17th & Ivy Basin.
- Phase 4 Winter: Collect and analyze flow data, assess success of previous work, revise future work efforts accordingly.
- Phase 4 Summer: Construct I/I improvements in 14th & Elm Basin.

Since the improvements in the 14th & Elm basin are the most extensive in scope, it is recommended that they be implemented as the last step. In this way, the lessons learned from the previous work efforts can be put to the greatest use. The total costs for the improvements in each basin may be determined by estimating the total amount of 1948 collection system in each basin. A listing of all the sewer segments that should be included in the overall project is included in **Table E-3** of **Appendix E**. It is envisioned that the demonstration project would include one or few of the segments listed in **Table E-3**. As such, the costs for the demonstration project are included in the total cost of the project. The engineering and administration costs include the costs of the wintertime flow measurement and analysis work. The total estimated project costs for each basin are included in the following table.

TABLE 6-4
I/I Correction Alternative B: Estimated Construction Costs

Basin	Mainline Length (ft)	Manholes #	Services #	Construction Cost(1)	Engineering, Admin and Contingency(2)	Total Project Cost(3)
14th & Elm	10,580	52	180	$1,967,400	$786,800	$2,754,200
9th & Ivy	7,800	37	187	$1,589,500	$635,700	$2,225,200
17th & Ivy	2,150	11	29	$380,300	$152,200	$532,500
Totals	20,530	100	396	$3,937,200	$1,574,700	$5,511,900

(1) Construction costs based on unit prices of $119 per foot of mainline, $3,800 per manhole, and $2,700 per service.
(2) Engineering , administration and contingency at 40% of construction cost (20% Engineering, 10% administration, 10% contingency).
(3) Costs are in 2006 dollars and assume dry weather construction, publicly bid project, ENR 20 Cities index = 7883.

The major potential drawback of this alternative involves the relatively fast pace with which it is implemented. As described at great length above, I/I correction is a complex process that is part art and part science. A slower implementation schedule better facilitates the data collection, analysis, and thought processes necessary for a successful I/I correction program. The major risk associated with the capital improvement option is that the resources will be expended over a short duration without as much detailed data collection and analysis. This may result in relatively less "bang for the buck" than I/I correction as maintenance alternative.

6.4.5 New Trunk Sewers, Pump Stations, & Force Mains

The construction of new collection system components including trunk sewers, lift stations, and force mains is the only method considered herein for providing service to undeveloped areas. This method basically involves extending the conventional gravity collection system into the undeveloped areas and installing new pump station where topographical limitations require. Septic tank effluent pumping (STEP) or Septic tank effluent gravity (STEG) collection systems were not considered practical given the City's reliance on a conventional gravity system and the potential deterioration of concrete components in the existing system from hydrogen sulfide present in STEP and STEG effluents.

6.5. Evaluation of Alternatives

Each of the alternatives listed previously were evaluated against each of the collection system deficiencies to determine the most cost-effective, long-term solution for the City's collection system. This section presents the results of this evaluation and summarizes the collection system recommendations. The City's goal is to develop a sewage collection system that not only meets existing needs, but also accommodates future development.

Shortcomings with the City's collection system include excessive I/I, lack of trunk sewer capacity and lack of pump station capacity. The recommended improvements include the implementation of a full-scale I/I reduction program, trunk sewer upsizing, and pump station upgrades. The following discussions include discussions on the various recommendations.

A conceptual design was developed for each major improvement project to determine the approximate size and features needed to convey the design flows. As part of this process, alternatives such as alignment, feasibility of reusing existing portions of the system were identified and evaluated. This involved evaluation of topographic opportunities, available vacant lands, and natural resource constraints with field reconnaissance to confirm the conceptual level feasibility of each alternative.

6.6. Gravity Sewer Collection System Recommendations

6.6.1 Recommended I/I Reduction Program

I/I is a significant problem that the City will need to begin addressing during the planning period. As an alternative to addressing I/I, the City could chose to collect, treat, and dispose of all existing and anticipated I/I. This would amount to the "do nothing" option with respect to the I/I problem. Without continued I/I reduction efforts, the amount of I/I in the existing system will continue to increase as the collection system continues to age. This increase in flow will exceed the capacity of sections of piping in addition to those currently at capacity. As a result, additional sections of collection piping would have to be upsized and pump stations and force mains would have to be oversized to handle the anticipated increase in I/I. Once collected and conveyed to the treatment plant, the I/I must be treated and disposed of. In order to treat the anticipated increase in I/I, the hydraulic capacity of the treatment plant would have to be oversized. All of these improvements would be in addition to the improvements listed in the recommended plan. As such, the "do nothing" alternative with respect to the I/I problem is not the least cost alternative. Even if this fact is ignored, the real problem with the "do nothing" approach is in relation to disposal at the WWTP. As the City continues to grow during and beyond the planning period, wintertime disposal will become a controlling factor with regard to the treatment facilities. This is due to the fact that the receiving waters have a limited capacity to accept treated wastewater. As such, the City will likely be limited on the amount of pollutants it will be allowed to contribute to the receiving stream. Since wastewater flows will grow as the City grows, the only way to maintain the pollutant loads to the river is to provide a higher level of treatment. As wastewater flows increase, eventually the City will be forced to produce a higher quality effluent than it currently does. If the I/I problem is not addressed, the City may be forced to make the modifications required to produce a higher quality effluent sooner than necessary. Given this fact, and the fact that the "do nothing" alternative with respect to the I/I problem is not the most cost effective solution, it will be dropped from further consideration.

The majority of the problems associated with the existing gravity collection system are the result of the age of the original 1948 gravity piping and the materials and construction methods used to install the system. The system is now more than 55 years old and is showing significant signs of deterioration. Through previous work, the City has determined that many of the joint mortar packing was either poorly installed, or has severely deteriorated. This deterioration results in a significant amount of infiltration into the collection piping and appurtenances. This infiltration is the major reason for many of the capacity issues in the existing gravity collection piping. If all of the infiltration and inflow sources could be removed, the existing gravity piping would most likely have the required capacity to convey existing and projected peak flows. Though, complete elimination of infiltration and inflow is not possible, it can be significantly reduced. Reducing the amount of I/I into the collection system has a number of benefits. Some of these are listed as follows.

- **Reduction in wintertime disposal requirements.** All of the infiltration and inflow that enters the collection system must be transported, treated, and disposed of as if it were wastewater. During the winter, the only disposal method available to the City is surface water discharge of the treated effluent. As described above, the DEQ limits the amount of treated wastewater that can be discharged by setting mass load limits. Efforts to reduce I/I will result in a decrease in the amount of treated wastewater that must be disposed of and will ultimately ensure that the City is in compliance with the mass load limitations set forth by the DEQ.

- **Reduces pumping costs.** In Junction City all wastewater that is collected from the users is pumped to the treatment plant. As such, reducing the amount of I/I will decrease pumping costs.

- **Extends the life of the pumping and treatment facilities.** I/I utilizes capacity that could be used for wastewater. If the amount of I/I can be reduced, the time until the pumping and treatment facilities reach capacity can be extended.

Two alternative approaches to I/I correction are described above. Of these alternatives, I/I Correction Alternative A is the recommended approach. This approach permits the more flexible of the two alternatives, it is also more in-line with the nature of the I/I problem, and has the potential to take advantage of future advancements in sewer rehabilitation technologies.

6.6.2 Replace Under-Capacity Trunk Sewers

This approach involves replacing existing sewers with new pipes sized to provide the required capacity. This approach is the most obvious alternative since it provides assurance that the sewage collection system can convey the design flows through town and that overflows will be kept to a minimum which in turn limits the City's liability.

6.6.3 Collection System Improvements to Serve Undeveloped Areas

The only way to serve undeveloped areas is to construct new facilities. The collection system improvements to serve currently undeveloped areas have been partitioned into the individual projects listed in the recommended improvements to allow for inclusion in the CIP at the discretion of the City Council. It is assumed that developers will construct the trunk sewers and pump stations required to provide service to undeveloped areas. The final locations of the new pump stations and detailed alignment of the trunk sewers and force mains have not yet been determined, and will be based on the proposed development pattern of the land being served by the facility. The locations shown later in this section represent the general location required for the facilities in order to serve the tributary drainage basins. Alternate locations proposed by developers should be considered only if they are capable of providing service to the entire basin.

6.6.4 Recommended Gravity Sewer Improvements

Brief descriptions of the recommended trunk sewer improvements for each basin are included in the following subsections. The recommended pump station and trunk sewer improvements are shown in **Figures 6-2** through **6-7**. The recommended improvements and project costs are listed in **Table 6-5**. A detailed breakdown of the construction costs, contingency, design and administration/financing costs are included in **Table E-1** of **Appendix E**.

Only the trunk sewer improvements in the 14^{th} & Elm and the 9^{th} & Ivy basins are required to meet existing peak flows. The remaining trunk sewer improvements are all required to address future growth. Therefore, the costs of these projects should be partially eligible for funding by the collection of SDC's. The oversize component of the overall project budget is included in **Table 6-5.**

As the I/I correction program is implemented, the flows should be evaluated to quantify any reductions in the amount of I/I. If during the implementation the I/I reduction program, significant reduction in the amount of I/I into the collection system is observed, the City may wish to reevaluate the pipe diameter recommendations listed in **Table 6-5**.

6.6.4.1 14^{th} & Elm Basin

There are a few isolated parcels of undeveloped land in the 14^{th} & Elm Basin. Gravity sewer piping surrounds these parcels. Therefore these areas can be served by relatively short 8-inch diameter sewer extensions. No large diameter trunk sewers will be required to serve these areas. The recommended trunk sewer improvements are shown in **Figures 6-3** and **6-5**. These trunk sewer upgrades are largely required to relieve existing bottlenecks. Therefore, it is anticipated that the costs of the recommended 14^{th} & Elm trunk sewer improvements will mostly be borne by the existing ratepayers.

Large sections of the 14^{th} & Elm Basin operate in a surcharged condition when groundwater levels are high. A long-term objective of the recommended improvements is to eliminate most of the surcharging that now occurs. However, the recommended trunk sewer upsizing alone will not eliminate the surcharging. In addition to upsizing selected trunk sewers, the faulty collection piping must be replaced as part of the I/I reduction program discussed above. Therefore, I/I reduction efforts are a major element of the recommended gravity sewer improvements for the 14^{th} & Elm Basin.

6.6.4.2 9th & Ivy Basin

The 9th & Ivy Basin is essentially built out. As such, no trunk sewers are required to serve undeveloped areas. The existing trunk sewers are adequately sized to accommodate the peak flows to the station. As discussed below, the recommended improvements include relocating the 9th & Ivy Pump Station to a new site at the northeast corner of 9th & Juniper Streets. This will require the reconstruction of a short segment of gravity sewer from the existing 9th & Ivy Pump Station site to the new site. This trunk sewer improvement is shown in **Figure 6-5**. The costs for this trunk sewer are included in the costs for the 9th & Ivy Pump Station work.

Large sections of the 9th & Ivy Basin operate in a surcharged condition when groundwater levels are high. A long-term objective of the recommended improvements is to eliminate most of the surcharging that now occurs. However, the recommended pump station improvements alone will not eliminate the surcharging. In addition to the pump station improvements, the faulty collection piping must be replaced as part of the I/I reduction program discussed above. Therefore, I/I reduction efforts are a major element of the recommended gravity sewer improvements for the 9th & Ivy Basin.

6.6.4.3 17th & Ivy Basin

The 17th & Ivy Basin is shown in **Figure 6-3**. The basin includes a few large parcels of undeveloped industrial ground at the north end of the basin. 8-inch diameter gravity sewers at minimum grade can serve all of this area. As such, no large diameter trunk sewers are envisioned for the 17th & Ivy Basin. Some of the existing sewers in the basin are near capacity. For example, the 8-inch diameter sewer that crosses Ivy Street in the 7th Street right of way, has very little reserve capacity. As such, the City Engineer should review any new development plans that will increase flows in this particular sewer segment. It is envisioned that new 8-inch diameter mainlines will extend from the site of the 17th & Ivy pump station to the north to serve the undeveloped areas. In this way, very little additional flow resulting from growth in the basin is expected in the existing sewer pipes.

6.6.4.4 3rd & Maple Basin

The 3rd and Maple Basin includes large parcels of undeveloped land. The basin also includes large portions of developed land that is outside the City Limits and is not served by the City's sewer system. Homes in these areas are served by septic systems with drainfields. As discussed below, the recommended collection system improvements include converting the 3rd & Maple Pump Station to a regional station that will convey wastewater from the 3rd & Maple, Prairie Road, and South Industrial basins to the WWTP. Wastewater from these sources will flow by gravity through a large-diameter trunk sewer to the 3rd & Maple Pump Station. The new large-diameter trunk sewer will bisect the 3rd and Maple basin. Wastewater from the 3rd & Maple Basin will be routed to the trunk sewer by smaller diameter laterals. The recommended trunk sewer improvements are shown in **Figures 6-5** and **6-6**.

6.6.4.5 10th & Rose Basin

There are significant parcels of residential land in the 10th & Rose Basin that are undeveloped. There are also large parcels of land that are developed, but are outside the City Limits and are not served by the City's sewer system. Homes in these areas are served by septic systems with drainfields. As discussed below, the long-term plan includes replacing the 10th & Rose Pump Station with a new station near the intersection of 10th Avenue and Tamarack Street. To convey wastewater to this point, new 10-inch diameter trunk sewers must be constructed to the east and west along 10th Avenue. The recommended trunk sewer improvements are shown in **Figures 6-4** and **6-5**.

6.6.4.6 Chapel Creek Basin

The Chapel Creek Basin is shown in **Figures 6-2** and **6-3**. There is a significant amount of residential land in the Chapel Creek Basin that is undeveloped. However, as long as development densities do not exceed the design criteria set forth in **Section 5**, the existing network of gravity sewer piping should have the capacity to convey the flows from all newly developed areas. It is envisioned that 8-inch gravity sewers at minimum grades will have the capacity to convey flows from all undeveloped areas. The facilities plan includes no large diameter trunk sewers in the Chapel Creek Basin.

6.6.4.7 Rosewood Basin

The Rosewood Basin straddles **Figures 6-2, 6-3, 6-4,** and **6-5**. Though mostly developed, there still remains a fair amount of residential land in the Rosewood Basin that is undeveloped. However, as long as development densities do not exceed the design criteria set forth in **Section 5**, the existing network of gravity sewer piping should have the capacity to convey the flows from all newly developed areas. It is envisioned that 8-inch gravity sewers at minimum grades will have the capacity to convey flows from all undeveloped areas. The facilities plan includes no large diameter trunk sewers in the Rosewood Basin.

6.6.4.8 1st & Monaco Basin

There is a fair amount of industrial land in the 1st & Monaco Basin that is undeveloped. The existing 8-inch trunk sewer does not have the capacity nor is it deep enough to serve the entire basin. As such, new primary trunk sewers are envisioned. The final size of these sewers will depend on the final location of the pump station and the development patterns in the basin. The recommended trunk sewer improvements include the construction of a new

10-inch diameter trunk sewer in 1st Avenue. It is envisioned that this trunk sewer will be constructed deep enough to serve the entire basin to it's southern boundary. The recommended trunk sewer improvements are shown in **Figures 6-5** and **6-6**. The costs for the trunk sewer are included in **Table 6-5**. The trunk sewer section in 1st Avenue west of the existing pump station site includes a railroad crossing. The cost estimate for this segment includes additional budget for boring under the railroad at this location.

6.6.4.9 West 10th Basin

The West 10th Basin is shown in **Figures 6-2** and **6-4**. The entire West 10th Basin is undeveloped at the present time. The City has been involved in preliminary discussions with a developer who controls most of the land in the basin. Based on these discussions, development in this basin is expected to begin early in the planning period. Any development in this area must be accompanied by large-scale infrastructure improvements. Under buildout conditions, it is envisioned that trunk sewers will carry wastewater from the edges of the basin to a new pump station. The sizes and configuration of the gravity trunk sewer system will depend on the layout of the proposed development. As such, the facilities plan does not include any trunk sewers in this area. The design of these sewers will be left to the developer. However, the City Engineer should review the development plans to ensure that the new facilities are constructed in accordance with this document and the public works design standards.

6.6.4.10 Prairie Road Basin

There is currently no sewer service in the Prairie Road Basin. There is a fair amount of developed area in the basin that is outside the current City Limits. Septic systems and drainfields serve these homes and businesses. It is envisioned that the entire basin will ultimately be served by public sewer. Under buildout conditions, it is envisioned that a large diameter trunk sewer will run from the south end of the basin to the north end of the basin and will ultimately convey wastewater to the 3rd & Maple Pump Station. The trunk sewer will also convey wastewater from the South Industrial Basin and must be sized accordingly. The recommended trunk sewer improvements are shown in **Figure 6-6**.

6.6.4.11 South Industrial Basin

The majority of the South Industrial Basin is undeveloped at the present time. The entire basin is currently outside the City Limits and inside the UGB. Any development in this area must be accompanied by large-scale infrastructure improvements. Under buildout conditions, it is envisioned that a large diameter trunk sewer will carry wastewater from the south end of the basin to the north end of the basin. A new lift station at the north end of the basin will lift wastewater into the Prairie Road Basin gravity sewer system where it will ultimately flow by gravity to the 3rd & Maple pump station. The recommended trunk sewer improvements are shown in **Figures 6-6** and **6-7**.

6.6.5 Pump Station Recommendations

In most cases, the proposed pump station improvements are limited to a single feasible alternative (i.e., replacement or reconstruction). The following is an evaluation of each pump station based on the general design evaluation criteria discussed in the previous sections. The recommended pump station improvements are shown in **Figures 6-2** through **6-7**. The total project estimates for each of the pump station improvement projects are listed in **Table 6-5**. A detailed breakdown of the construction costs, contingency, design and administration/financing costs are included in **Table E-1** of **Appendix E**.

6.6.5.1 14th & Elm Pump Station

The 14th & Elm Pump Station lacks the capacity to convey existing peak flows. The structural elements of the system are over 55 years old. Most of the mechanical components are over 35 years old. Due to the age of the station, it will reach the end of its useful life during the planning period. For these reasons, upgrades are recommended early in the planning period. With the possible exception of the auxiliary power unit, none of the existing pumping facilities will be salvaged. The existing facilities are now near the end of their useful life and cannot be relied upon to provide reliable service through the next planning period. As such, the only real alternative for upgrading the station is to construct a new station.

The 14th & Elm Pump Station is located at the site of the original treatment plant. Immediately west of the existing pump station is a large storage yard that is on property owned by the City. The proposed improvements include constructing a new station in this area. This will allow the existing station to remain in service until the new station is ready to go online. The recommended improvements consist of a new wet well with submersible pumps. A triplex or quadraplex station with three or four equally sized pumps is recommended. This arrangement allows for a wide range of pump station discharge rates to match the large flow variations between the dry and wet seasons. All other design criteria shall be in accordance with **Table 3-2**. The total project cost for the new station including construction, engineering, legal, and administration costs is estimated to be approximately $1,663,000. This figure does not include costs for forcemain improvements. The recommended forcemain improvements are discussed in **Section 7**.

6.6.5.2 9th & Ivy Pump Station

The 9th & Ivy Pump Station lacks the capacity to convey existing peak flows. Most of the structural and mechanical components of the station are over 55 years old. Due to the age of the station, it will reach the end of its useful life during the planning period. For these reasons, upgrades are recommended early in the planning period. With the possible exception of the auxiliary power unit, none of the existing pumping facilities will be salvaged. The existing facilities are now near the end of their useful life and cannot be relied upon to provide reliable service through the next planning period. As such, the only real alternative for upgrading the station is to construct a new station.

The existing location of the 9th & Ivy Pump Station is not large enough to accommodate the new station. As such, the recommended improvements include obtaining a new pump station site. Due to the layout of the gravity collection system, the new pump station site must be located in the same general area as the existing pump station. The four lots on the corner of Juniper and 9th Street were considered feasible locations for the new pump station. The lot on the southwest corner of Juniper and 9th is vacant. The other three lots are occupied by homes. Of these three lots, the lot at the northeast corner of 9th & Juniper has the lowest assessed value. The home appears to be a rental. The lots at the southeast and northeast corners of 9th & Juniper were eliminated from consideration due to their higher assessed values. The lot at the southwest corner of 9th & Juniper is owned by Christ's Center Church and appears to be used as a playground area. This lot represents the best alternative for a new pump station site. The pump station would require only a small portion of this site. During the predesign phase, negotiations with the landowner should begin. If these negotiations do not prove useful, the City may begin negotiations with the owner of the lot at the northeast corner of 9th and Juniper. Locating the pump station at this site will require the demolition of the existing home. The land costs are also likely to be higher than those associated with the site at the southwest corner of 9th and Juniper. As such, the lot at the northeast corner is a less desirable location than the lot at the southwest corner. An additional $150,000 for land acquisition is included as a "place holder" in the total project cost for the 9th & Ivy Pump Station improvements.

The recommended improvements consist of a new wet well with submersible pumps. A duplex or triplex station with equally sized pumps is recommended. With the possible exception of the auxiliary power unit, none of the existing pumping facilities will be salvaged. As described in previous sections, the existing facilities are near the end of their useful life and cannot be relied upon to provide reliable service through the next planning period. All other design criteria shall be in accordance with **Table 3-2**. The total project cost for the new station including land acquisition construction, engineering, legal, and administration costs is estimated to be approximately $1,101,000. This figure does not include costs for the design or construction of the new forcemain. The recommended forcemain improvements are discussed in **Section 7**.

6.6.5.3 17th & Ivy Pump Station

The 17th & Ivy Pump Station lacks the capacity to convey existing peak flows. Most of the structural and mechanical components of the station are over 55 years old. Due to the age of the station, it will reach the end of its useful life during the planning period. For these reasons, upgrades are recommended early in the planning period.

The existing station is located in the 17th Avenue right of way east of Ivy Street. The area around the pump station site is used as parking for the adjacent commercial establishments. The recommended location for the new station is immediately east of the existing station within the 17th Avenue right of way. The recommended improvements also include the demolition of the existing pump station and the conversion of the old site into a parking area for the adjacent commercial businesses. Since the new improvements will be located in the existing 17th Street right of way, no land acquisition is anticipated.

The recommended improvements consist of a new wet well with submersible pumps. A duplex station with two equally sized pumps is recommended. With the possible exception of the auxiliary power unit, none of the existing pumping facilities will be salvaged. As described in previous sections, the existing facilities are near the end of their useful life and cannot be relied upon to provide reliable service through the next planning period. All other design criteria shall be in accordance with **Table 3-2**. The total project cost for the new station including construction, engineering, legal, and administration costs is estimated to be approximately $756,000. This figure does not include costs for the design or construction of the new forcemain. The recommended forcemain improvements are discussed in **Section 7**.

6.6.5.4 3rd & Maple Pump Station

The 3rd & Maple Station lacks the capacity to convey existing peak flows. As a result, the City should plan to upgrade the station early in the planning period. If no other growth in the basin were to occur, it is likely that the pumps could be modified or replaced for a modest cost to provide the required capacity. The costs for this type of work are likely to be within the City's existing maintenance budget. At the time this document was written, the City was involved in negotiations with a developer that controls most of the undeveloped land in the basin. The existing wetwell and pumps are not sufficient to facilitate capacity increases necessary to serve the proposed development. Therefore, the planned development will require significant pump station upgrades beyond those required to address the existing capacity shortfall. If the development project continues to move forward, the City should not undertake any improvements geared at addressing the existing capacity shortfall since the station will need to be replaced to accommodate the new development. If the development project stalls, the City may wish to implement the minor upgrades required to increase the capacity of the station as required to convey existing peak flow.

The long-term collection system improvements include constructing a new 3rd & Maple Station to replace the existing station. The new station will act as a regional pump station and will convey discharge from the 3rd & Maple, Prairie Road, and South Industrial sewer basins to the WWTP. The existing station is not sufficient for this purpose and must be replaced. The recommended improvements include a two-phase approach. The first phase will consist of a new wetwell and a new duplex or triplex pump station. It is envisioned that the first phase of the pump station improvements will be sized to convey the peak flow from the 3rd & Maple basin at buildout (i.e., 770 gpm). As development in the Prairie Road and South Industrial Basins occurs, it is envisioned that the pump station will be expanded in a second phase. The second phase will include the construction of a second wetwell adjacent to the first with parallel set of pumps that will operate in a duplex or triplex configuration. The second phase should be designed to increase the capacity of the station to 2,740 gpm. The layout of the wetwell, valve vault, and control building for the first phase should allow for the construction of a second wetwell and valve vault with the second phase.

The new station will be constructed immediately east of the existing station on land owned by the City. The site is sufficiently sized to accommodate both phases. It is envisioned that both the phase I and phase II improvements will be designed in accordance with the design criteria listed in **Table 3-2**. The recommended project budgets for the phase I and phase II improvements are $726,000 and $1,512,000 respectively. These figures do not include costs for the design or construction of the new forcemain. The recommended forcemain improvements are discussed in **Section 7**.

6.6.5.5 10th & Rose Pump Station

The 10th & Rose Pump Station has the capacity to convey existing flows. However, most of the mechanical components of the station are now 30 years old. The pump station is a packaged pump station. The typical design life for packed pump station is approximately 25-30 years. As such, the equipment is essentially at the end of its design life. Based on discussions with the pump manufacturer, the existing pumps will no longer be supported by the manufacturer. Therefore, replacement parts will be increasingly difficult to find. Eventually, the existing pumps will wear to the point that they are no longer useful. When this happens, the City may be forced to upgrade the system. It is likely that this will occur during the planning period. Therefore, the City should plan accordingly. As development in the basin continues, the capacity of the station will eventually be exceeded. Based on growth trends, it is likely that growth in the basin will exceed pump station capacity during the planning period. As such, any pump station upgrades should be sized to accommodate the entire basin at buildout. The timing of the upgrade will either be growth driven, or driven by the need to ensure reliable operation by replacing obsolete equipment. As such, the exact timing of the upgrade is unknown.

The existing wet well, pumping equipment, and discharge piping lack the capacity to accommodate the flows and pumping equipment required to meet flow projections at the buildout condition. As such, the only real alternative for upgrading the station is to construct a new station. The existing station is located in an easement inside a trailer park. The easement is not large enough to accommodate a new station. As such, a new pump station site will be required. The recommended location for the new station is west of the existing station on the south side of 10th Avenue near the intersection of Tamarack Street. During the predesign phase, negotiations with the landowner should begin. An additional $50,000 for land acquisition is included as a "place holder" in the total project cost for the 10th & Rose Pump Station improvements.

In order to move the pump station to the proposed location a new trunk sewer must be connected from the existing pump station site to the new site. The costs for the design and construction of this trunk sewer are included in the cost of the pump station project.

The recommended capacity upgrades consist of a new wet well with submersible pumps in accordance with the design criteria listed in **Table 3-2**. The total project cost for the new station and 10th Avenue trunk sewer including land acquisition, construction, engineering, legal, and administration costs is estimated to be approximately $926,000. This figure does not include costs for the design or construction of forcemain improvements. The recommended forcemain improvements are discussed in **Section 7**.

6.6.5.6 1st & Monaco Pump Station

The capacity of the 1st & Monaco Pump Station is essentially equal to the peak flow to the station. As such, any growth in the basin will have to be accompanied by a pump station upgrade. The existing equipment is more than 30-years old. The pump station is a packaged pump station. The typical design life for packed pump station is approximately 25-30 years. As such, the equipment is essentially at the end of its design life. Based on discussions with the pump manufacturer, the existing pumps will no longer be supported by the manufacturer. Therefore, replacement parts will be increasingly difficult to find. Eventually, the existing pumps will wear to the point that they are no longer useful. At that time the City will be forced to upgrade the system. It is likely that this will occur during the planning period. Therefore, the City should plan accordingly.

The 1st & Monaco basin includes a few large parcels of industrial land. It also includes a single large parcel of land zoned for agricultural use that is outside the UGB and inside the City Limits. The projections included herein are based on the assumption that this parcel will be annexed and developed for industrial use. An application is pending for just such a land use action. Since there are relatively few parcels in the 1st & Monaco basin, it is assumed that a single, large industrial or residential development will occur that will eventually create the need for major capacity upgrades.

The existing wet well, pumping equipment, and discharge piping lack the capacity to accommodate the flows and pumping equipment required to meet flow projections at the buildout condition. As such, the only real alternative for upgrading the station is to construct a new station. The existing station is located in a parking area for a recreational vehicle manufacturing facility. With modifications to the parking area, the adjacent area could accommodate a new pump station. The details of where to locate the new station will be left to designer of the new facility. For planning purposes, it is assumed that the new pump station will be located east of the existing station at the Location shown in **Figure 6-4**. In order to relocate the station to this site, new gravity sewer must be constructed in 1st Avenue to convey wastewater from the old pump station site to the new site. The costs for this trunk sewer are included in the costs for the pump station project. No allowance for land acquisition is included in the cost of the proposed improvements. Since the need for the station is entirely growth driven, it is assumed that the developer will provide the site at no cost to the City.

Since the need for the capacity upgrades is growth driven, it is difficult to forecast when the work will occur. If development does not occur during the planning period, the City will have to upgrade the station due to its age. The City will be faced with the decision to construct an entirely new station sized for the entire basin, or rehabilitating the existing station. For facilities planning purposes, it is recommended that the City plan for a two-phase construction project. The first phase will involve converting the station to a submersible station sized to accommodate the existing flows. It is recommended that the City anticipate implementing these improvements early in the planning period. The second phase, will include the construction of an entirely new pump station as described above. If growth occurs early in the planning period, the City may forego the fist phase in lieu of the developer-backed phase two improvements.

The recommended phase one upgrades include converting the station to a submersible station sized to convey existing flows. The second phase includes capacity upgrades consisting of a new wet well with submersible pumps in accordance with the design criteria listed in **Table 3-2**. The total project cost for the recommended phase one and phase two improvements including construction, engineering, legal, and administration costs are estimated to be approximately $237,000 and $979,000 respectively. These figures do not include costs for the design or construction of new forcemains. The recommended forcemain improvements are discussed in **Section 7**.

6.6.5.7 Chapel Creek Pump Station

The Chapel Creek Pump Station has adequate capacity to convey existing peak flows. The station is relatively new and in good condition. During the initial startup, the station was troubled by excessive noise and vibration from the pumping equipment. In an effort to reduce noise and vibration, the belt drive coupling the motor to the pump was reconfigured to reduce the speed of the pump. The pump is powered by a constant speed 1750 RPM motor. The motor is coupled to the pump by a belt drive system. The pump was originally designed to operate at a speed of 1680 RPM to deliver 575 gpm at 83 ft. TDH. To reduce noise and vibration, the sheave/belt configuration was replaced to reduce the pump speed to 1480 RPM. At this speed, the pump delivers 325 gpm at 75 ft TDH. The station O&M manuals includes specifications for the sheave/belt combinations required to operate the pumps at the two speeds.

Based on the flow projections in **Section 5**, the peak flow to the station will be approximately 680 gpm. This assumes that the discharge from the Rosewood Pump Station is removed from the Chapel Creek Basin. If the projections contained herein materialize, the pump station sheave/belt combination will have to be replaced to deliver 680 gpm. Based on the pump curves, the pumps can deliver the required 680 gpm if the pump is rotated at 1750 RPM (i.e., no turn-down). Therefore, the only anticipated improvement to the station is the replacement of the belt/sheave combination. Unfortunately, the noise and vibration problems will likely resurface when the capacity of the station is increased. As such, an allowance of $100,000 is included in the project to replace the sheave/belt combination and install vibration attenuation measures. The total project cost for the recommended improvements including construction, engineering, legal, and administration costs is estimated to be approximately $151,000. As discussed in **Section 7**, the existing forcemain is adequate to convey the projected peak flows and no forcemain improvements are required.

6.6.5.8 Rosewood Pump Station

The Rosewood Pump Station lacks the capacity to convey existing peak flows. The station is relatively new and in good condition but was not designed to convey the peak flows from the basin it now serves. The capacity shortfall is relatively minor at the present time. However, any additional development in the basin must include upgrades to the pump station. The Rosewood Station currently discharges to the gravity collection system that drains to the Chapel Creek Pump Station. As such, all wastewater generated in the Rosewood

Basin is pumped twice (once at the Rosewood Station and again at the Chapel Creek Station). In order to ensure that the Chapel Creek Pump Station has adequate capacity to convey the peak flows from its drainage basin, we recommend that the discharge for the Rosewood Station be rerouted. This will require the construction of a new forcemain that discharges directly into the existing 16" primary forcemain. The recommended forcemain improvements are discussed in **Section 7**.

Based on the flow projections in **Section 5**, the peak flow to the station will be approximately 205 gpm at buildout. In order to deliver this flow rate at the heads required to pump the wastewater to the WWTP via the primary forcemain, the pumps must be replaced with larger pumps. Two alternatives for increasing the pump station capacity were considered. The 3-hp motors that drive the existing Hydromatic model 40MP pumps could be replaced with 10-hp motors. The larger motors would rotate the pumps at a faster speed and sufficiently increase the capacity of the station. The larger motors would require a new 3-phase power service, new motor starters, and new controls. The costs of this work would be approximately $50,000. Based on discussions with the pump manufacturer, this approach is feasible. However, it appears the manufacturer is planning to terminate the 40MP line of pumps. As such, the existing pumps will soon be obsolete, and replacement parts will become more and more difficult to find. Therefore, rather than expending the ±$50,000 on what would amount to a short term solution, we recommend converting the station to a submersible pump station with new pumps, discharge piping, valve vault, and controls. The existing wetwell would be salvaged. This approach is a long-term solution that is believed to be the lowest cost alternative over the life span of the project. The total project cost for the recommended improvements including construction, engineering, legal, and administration costs is estimated to be approximately $227,000. This does not include the cost of the forcemain improvements discussed in **Section 7**.

6.7. Summary of Recommended Collection System Improvements

The improvements outlined in **Table 6-5** of this report are shown in **Figures 6-2** through **6-7.** These improvements will result in a sewage collection system with the capacity needed to convey flows from within the planning area assuming development to zoning densities shown. The proposed improvements are intended to minimize the amount of new piping which must be installed, as well as to minimize the unnecessary replacement of existing sewer mainlines. The proposed trunk sewer system improvements largely follow existing street right-of-ways through the community along existing sewer alignments. As such, the alternative alignments are limited. Construction of the recommended new sewers to address capacity issues will also result in a decrease in the I/I contributions as the existing concrete sewers are replaced with new sewers of PVC pipe material.

The improvements are based on the complete development of the land within the UGB. Therefore, many will not be required during the planning period. The improvements address existing deficiencies, as well as potential deficiencies at the end of the planning period and at buildout. Only the improvements that address the existing deficiencies are required at this time. The remaining deficiencies are growth dependent. Of these, some may be required before the end of the planning period and some may not. Nonetheless, should any of the sewer mainlines be replaced as part of the I/I correction work, they should be sized in accordance with the recommendations listed in **Table 6-5** regardless of whether or not the mainline lacks capacity at the time of construction. The improvements are prioritized in **Section 8** if this report.

The alignment of future lines through the undeveloped portions of town has not yet been determined. The final alignment of sewer lines in these areas should be determined as property develops. Sewer lines should be placed within right-of-ways whenever possible. If the City Limits or UGB are to be expanded in the future, the sewer system should be re-examined to determine where additions are needed and if alternate alignments are justified. The capacity problems in the collection system are well documented. Any additional development upstream of the identified bottlenecks prior to the implementation of the recommended improvements will exacerbate the capacity problem and will result in additional surcharging of sewers and possible overflow or flooding of homes or businesses.

TABLE 6-5
Recommended Collection System Improvements

Project Location(s)	Existing Size/ Capacity	Length (ft)	Recommended Size/Capacity	Total Estimated Project Cost[1]	Oversize Cost Required for Future Growth[1]
I/I Reduction Plan (Original 1948 Collection System)			As listed	$275,000/yr [2]	$0
14^{th} & Elm Basin					
14th & Elm Pump Station	1400 gpm	N/A	1800 gpm	$1,663,000	$0
14th Avenue (14th & Elm P.S. to East Front Street)	12 in.	180	21 in.	$51,000	$0
East Front Street (14th to 12th Streets)	12 in.	640	18 in.	$163,000	$0
East Front Street (12th to 10th Street)	12 in.	720	15 in.	$170,000	$0
9th to 10th Alley (Between East Front and Elm Streets)	10 in.	470	12 in.	$137,000	$0
9^{th} & Ivy Basin					
9^{th} & Ivy Pump Station and Trunk Sewer	250 gpm	N/A	690 gpm/10in.	$1,101,000	$0

(1) Costs are in 2005 dollars and assume dry weather construction, publicly bid project, ENR 20 cities index = 7298. See Section 3.7 for basis of project cost estimates (i.e., 10% construction contingency, 20% engineering, 10% legal, permits, easement, and administration)
(2) Costs will increase over time due to inflation.

TABLE 6-5 (Continued) Recommended Collection System Improvements					
Project Location(s)	Existing Size/ Capacity	Length (ft)	Recommended Size/Capacity	Total Estimated Project Cost	Oversize Cost Required for Future Growth
3rd & Maple Basin					
3rd & Maple Pump Station Phase I	240 gpm	N/A	770 gpm	$726,000	$405,000
3rd & Maple Pump Station Phase II	N/A	N/A	2740 gpm	$1,512,000	$1,512,000
3rd Street and Maple Street Trunk Sewer (3rd & Maple P.S. to 1st Ave.)	N/A	720	24 in.	$184,000	$184,000
Prairie Road Trunk Sewer (1st Ave to Bryant Street)	N/A	965	21 in.	$293,000	$293,000
Prairie Road Trunk Sewer (Bryant Street to Basin Boundary)	N/A	1985	21 in.	$546,000	$546,000
1st Ave. Trunk Sewer (Maple St. west to existing MH)	10 in	180	10 in.	$47,000	$0
17th & Ivy Basin					
17th & Ivy Pump Station	300 gpm	N/A	405 gpm	$756,000	$196,000
10th & Rose Basin					
10th & Rose Pump Station and Trunk Sewer (Rose to Tamarack)	350 gpm	N/A	590 gpm/ 10 in.	$926,000	$377,000
10th Avenue Trunk Sewer (New 10th & Rose Pump Station to Vine St.)	N/A	600	10 in.	$177,000	$177,000
Vine Street Trunk Sewer (10th to 6th Avenues)	N/A	1300	10 in.	$339,000	$339,000
1st & Monaco Basin					
1st & Monaco Pump Station Phase I	80 gpm	N/A	80 gpm	$237,000	$0
1st & Monaco Pump Station and Trunk Sewer Phase II	80 gpm	N/A	880 gpm/10in.	$979,000	$890,000
1st Ave. Trunk Sewer (New 1st & Monaco P.S. East)	N/A	650	10 in.	$119,000	$119,000
1st Ave. Trunk Sewer (Old 1st & Monaco Site West)	N/A	670	10 in.	$152,000	$152,000
Chapel Creek Basin					
Chapel Creek Pump Upgrades	440 gpm	N/A	680 gpm	$151,000	$151,000
Rosewood Basin					
Rosewood Pump Station	80 gpm	N/A	205 gpm	$227,000	$138,000
West 10th Basin					
West 10th Pump Station	N/A	N/A	1170 gpm	$1,134,000	$1,134,000
Prairie Road Basin					
Prairie Road Trunk Sewer (Northern Basin Boundary to Hwy 99)	N/A	3540	21 in.	$898,000	$898,000
Highway 99 Crossing	N/A	300	21 in.	$227,000	$227,000
Prairie Road Trunk Sewer (Hwy 99 to Hwy 36)	N/A	2060	18 in.	$499,000	$499,000
Highway 99 Trunk Sewer (Hwy 36 to South Industrial Lift Station)	N/A	4620	18 in.	$1,111,000	$1,111,000
South Industrial Basin					
South Industrial Lift Station	N/A	N/A	1110 gpm	$1,134,000	$1,134,000
Trunk Sewer (Lift Station to Milliron Rd.)	N/A	3430	15 in.	$748,000	$748,000
Trunk Sewer (Milliron Rd. to South UGB)	N/A	2630	12/10 in.	$475,000	$475,000
Totals				**$16,882,000**	**$11,705,000**

(1) Costs are in 2006 dollars and assume dry weather construction, publicly bid project, ENR 20 cities index = 7883. See Section 3.7 for basis of project cost estimates (i.e., 10% construction contingency, 20% engineering, 10% legal, permits, easement, and administration)
(2) Funds generated as part of the I/I reduction plan may be used to complete the trunk sewer replacement projects listed in this table. Costs will increase over time due to inflation.