
ADDITIONAL RECOMMENDATIONS**25.1 GENERAL**

The recommendations in this Chapter are not associated with the capital improvement projects, and therefore have not been included in the cost summaries in Chapter 26. It is recommended that these recommendations be reviewed, refined and incorporated or continued by the City.

25.2 COLLECTION SYSTEM OPERATION AND MAINTENANCE

As discussed in Chapter 4, the City collection system has grown from 650 miles of pipe in 1980 to 970 miles of pipe in 2005. With this amount of piping in the ground, and 650 miles of it over 25 years old, a vigorous and proactive collection system operation and maintenance program is required. It is recommended that the City implement a 10-year cleaning and videoing cycle (entire collection system) rather than the current 12-year cycle to increase response to pipe problems as discussed in Section 4. Implementing a 10-year cleaning and videoing cycle will increase the annual miles of pipe completed and therefore requires additional staff. Table 24.1 and Figure 24.1 shows the projected crew needs for cleaning and for videoing the planning period based on a 10-year cleaning and videoing cycle.

The data from Table 25.1 and Figure 25.1 indicate one additional cleaning crew and one additional video crew will need to be added to the existing staff in the years 2006, 2012, 2031, 2046, and 2058 for a total of 7 cleaning crews and 7 video crews at the end of the planning period.

It is recommended that a 10-year cleaning and videoing cycle be implemented. A 10 year cycle is typical for most large collection systems and is based on experience of achieving improved system performance from clean pipes, identifying repair needs earlier, and reducing major problems such as backups. Based on an average system pipe length from 1993 to 2005 (12 year cycle), the 2 cleaning crews and 2 video crews averaged 71 miles of pipe completion per year or 35.5 miles per crew per year. In order to achieve a 10-year cycle for the current 978 miles of pipe in the system, assuming 35.5 miles per year per crew is kept the same, the current staffing need is 3 crews each for cleaning and videoing.

Table 25.1 Collection System Projected Cleaning and Videoing Crew Needs Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska		
Year	Avg. Miles of Pipe Videotaped Per Year ^(1, 2)	Projected Number of Crews Required for Sewer Cleaning and Videoing ⁽³⁾
2005	71	2
2006	99	2.8
2010	105	3.0
2015	113	3.2
2020	122	3.4
2025	132	3.7
2030	142	4.0
2035	153	4.3
2040	165	4.6
2045	177	5.0
2050	191	5.4
2055	206	5.8
2060	222	6.2

Notes:

1. Based on a 10-year cycle to for entire collection system.
2. Number of crews assumes 35.5 miles per year per crew based on current staffing levels.
3. City currently uses two crews.

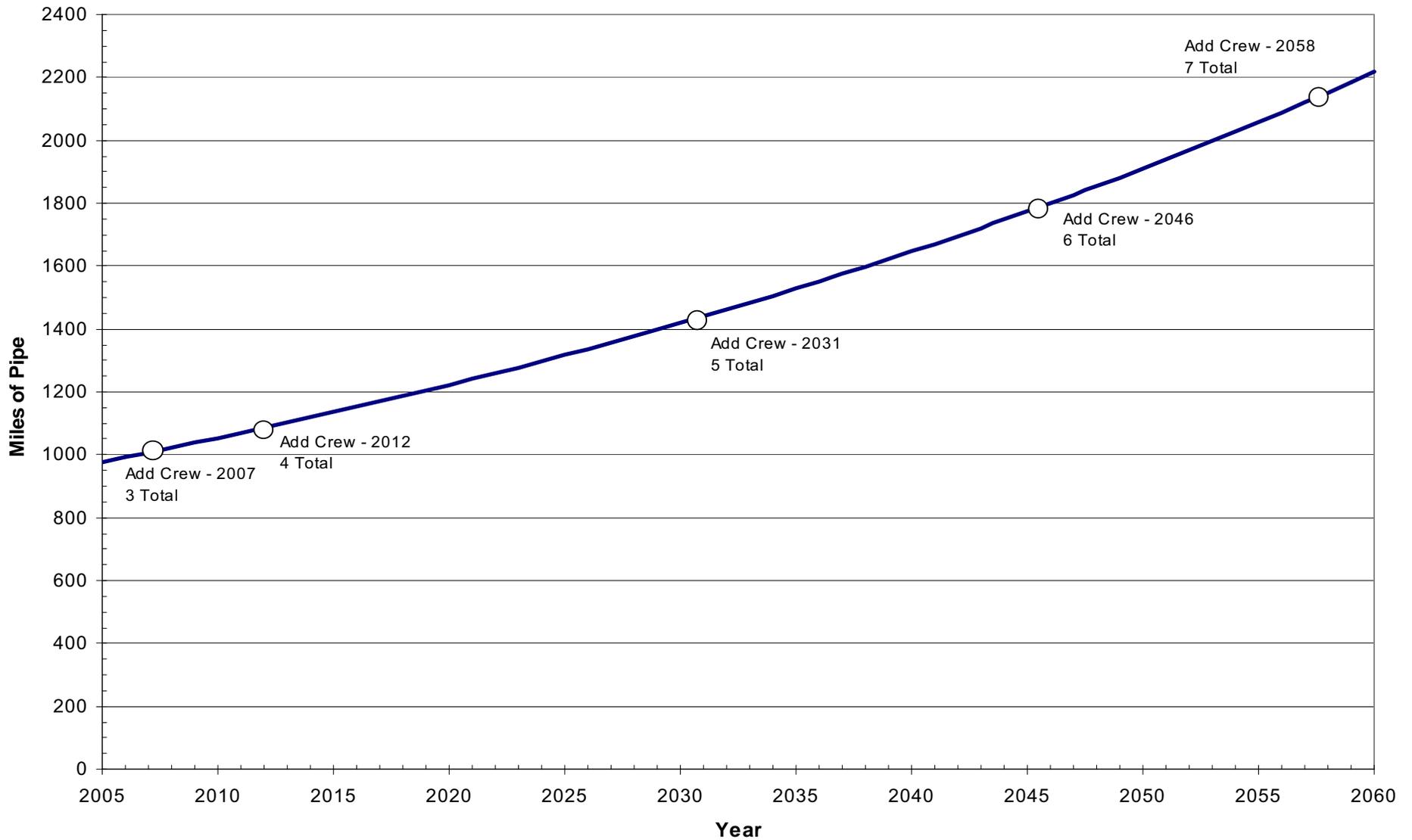


Figure 25.1

Collection System Projected Maintenance Crew Requirements
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska



25.3 PEAK FLOW REDUCTION

Reducing the peak flow will provide the City with the ability to serve the existing and future customers more efficiently. The reduction of peak flows not only extends the service area of the existing trunk sewers, but reduces impacts to the WWTF's as well. It is recommended that the City's current peak flow reduction programs be continued, and new opportunities be explored as they become available.

25.3.1 I/I Flow Reduction

The physical characteristics (size, slope, pipe material, etc.) of the collection system piping is directly related to the peak flows that are required to be conveyed by the system to the WWTF's. Therefore, a reduction in the non-sanitary, or I/I component of the flow will provide several benefits to the City

The first benefit is to the collection system. Lowering the I/I component will result in a reduced peak flow that the piping systems need to convey. This results in the existing collection system being capable of conveying the sanitary wastewater from a larger service area. Additionally, new collection piping being installed in the upper reaches of the drainage basins may be smaller than presently required.

The second benefit is realized at the WWTF's. Lowering of the peak flows that enter the WWTF's results in a reduction of energy to pump the water into and through the treatment processes. Additionally, the more constant the flow rate the more efficient the treatment processes function. Lowering hydraulic surges through the WWTF's reduces carry over from the treatment basins and results in smaller sized facilities.

The City currently televises the collection system on a regular basis. During this process, leaking manholes and infiltrating pipes are identified and placed on a repair list. On a yearly basis the City prioritizes the areas needing the most attention and lines or rehabilitates the worst leaking sewers and manholes. It is recommended that this televising and inspection program be kept in service and repairs be made to infiltrating pipes and manholes in an effort to reduce the infiltration to the system.

Inflow reduction is primarily related to surface water entering the collection system. In Lincoln, inflow generally enters the collection system through manhole lids. As these areas are identified they should be remedied to eliminate the inflow of surface water. Where flow monitoring data suggests higher than anticipated flow per area of service, specific basin I/I flow studies should be conducted and are recommended. These studies should be customized for each basin.

The City currently has a program in place that includes the following items. It is recommended that this program be continued.

1. Define basin, sub-basins, and their respective boundaries from the Foreman's maps.
2. Identify manholes using the City's current manhole identification system outlined in the Foreman's maps.
3. Review locations of existing flow and rainfall monitoring gauges.
4. Select locations to install additional flow and rainfall monitoring gauges with input from the City.
5. Review existing complaints and investigate reports provided by the City. A minimum of three significant rainfalls should be measured as well as dry weather flow. From the data, establish a peak flow to rainfall intensity relationship. Also evaluate existing sewer system capacity during wet and dry weather for any recommendations on new lines or relief sewers. Develop flow hydrographs to present fluctuations between wet and dry weather.
6. Send letters to the residents to inform them of upcoming work to be performed on the sewer system, the purpose of the work, and any public meetings scheduled.
7. Conduct comprehensive manhole and pipeline inspections to identify possible I/I sources in manholes and pipes connected to the manholes. In addition, take measurements from the manhole inverts to the manhole rim to be used for establishing the system network.
8. Conduct smoke testing in the sub-basins where appropriate. The smoke testing will identify private sector sources such as defective services lines, downspouts, and driveway drains as well as public sector sources such as storm catch basins that are connected to the sanitary sewer system. Smoke testing can also identify main sewer defects.
9. Conduct building inspections in the sub-basins where high levels of I/I flow were identified. The inspection will identify sources such as sump pumps connected to the sanitary sewer and holes in floor drain pipes. The inspectors will also collect information from the resident regarding basement backups and flooding.
10. Conduct dye-water testing to determine if the suspect sources identified from smoke testing and building inspections are actually connected to the sewer system. Suspect downspouts, driveway drains, area drains, and stairwell drains that did not smoke will also be dye-water tested. Selected building foundations may be dye-water tested using injection to estimate the magnitude of connections.
11. Based on the findings from flow monitoring, inspections, smoke testing, and dyed-water testing, identify areas of defects and infiltration sources.

12. Prepare and submit a study that documents the findings of the RDI/I flow study. Included will be a cost effective analysis, recommended actions, and a prioritization schedule.

25.3.2 Foundation Drains - Sump Pumps

It is our understanding that the majority of the basements in the City have sump pumps installed. These sumps collect ground water from foundation drains and pump the collected water to the sanitary sewer system. This practice is suspected to be a major contributor of extraneous flows that enter the sanitary collection system.

Title 17, paragraph 17.58.030 Discharges into Wastewater Collectors; Types Not Permitted, reads as follows:

“No person shall discharge or cause to be discharged any stormwater, surface water, groundwater, roof runoff, or subsurface drainage, including interior and exterior foundation drains, to any wastewater collector. Uncontaminated cooling water and unpolluted process waters, less than ten gallons per minute, may be discharged to a wastewater collector only if expressly authorized by the Director. (Ord. 12784 §4; December 17, 1979; prior Ord. 9965 §3; April 27, 1970).”

It is recommended that the City minimize and/or eliminate the discharge of foundation drains and sump pumps to the sanitary sewer system. Since the majority of the sump pumps are installed in existing residential dwellings, it may be more practical to ban the sump pump discharge to the sanitary system on new developments. This will likely require developers to install a separate storm sewer system that needs to be convey the drain and sump pump discharge with the storm run off to an acceptable location.

25.3.3 Service Lateral Repairs

As previously mentioned in Section 4.1.2, the City has a program in place where leaking service laterals are repaired. It is recommended that this program be continued.

25.3.4 Low Flow Plumbing Devices

The City currently encourages the installation of low flow plumbing devices. It is recommended that the City continue to encourage, and possibly require the use of these fixtures in all new construction.

25.4 COLLECTION SYSTEM FLOW MONITORING PROGRAM

25.4.1 Components of Wastewater Flows

A wastewater collection system receives two flow components: dry weather flow (DWF) and wet weather flow (WWF) over the course of a year. The dry weather flow component (or baseflow) is generated by routine water usage in the residential, commercial, business, and industrial sectors of the City. The other component of dry weather flow is the contribution of dry weather groundwater infiltration into the collection system. Dry weather groundwater infiltration will enter the collection system when the relative depth of the groundwater table is higher than the elevation of the pipeline and when the propensity of the sanitary sewer pipe allows infiltration through defects such as cracks, misaligned joints, and broken pipelines.

The wet weather flow component includes storm water inflow, trench infiltration, sump pump discharge, and similar sources. The storm water inflow and trench infiltration comprise the wet weather flow component termed inflow.

Groundwater infiltration is not specific to a single rainfall event but rather the effects on the collection system over the entire wet weather season. Groundwater infiltration is infiltration caused by the depth of the groundwater table rising above the pipe invert elevation and entering the piping system. Defective pipes and manholes within close proximity to a body of water can be greatly influenced by groundwater effects. As the groundwater table fluctuates over the wet weather season, this fluctuation is seen as a mounding effect in the flow monitoring data. Thus at different times during the wet weather season, groundwater infiltration can play a more significant role. It is important in the modeling process to calibrate to the highest groundwater mounding effect seen in the flow monitoring data. This ensures that the model is being calibrated to the worst-case scenario and that the potential impact of groundwater infiltration is not underestimated.

25.4.2 Need for Flow Monitoring Program

It is recommended that the collection system flow monitoring program not only continue, but expand. It is especially important that the flow monitoring program be in place when wetter than normal periods are realized. With this data in hand, the sanitary flow components as well as I/I flow components for individual basins and sub-basins can be determined. This information can then be used to model and evaluate the existing as well as proposed collection system components. Understanding the dry weather flows is just as important as understanding the impacts that wet weather flows have on the system. Dry weather flow parameters are important for the following reasons:

1. Analyze average base flows in the wastewater collection system.

2. Compare dry weather flows from one year to another for each basin. Effects of development in the basin or greater unit household wastewater flows can be determined.
3. Characterize the diurnal effects of flow rate through the collection system.
4. Provide valuable information to determine what impacts that the I/I flow reduction programs have on the overall capacity of the systems.
5. Provide valuable data for comparison of seasonal effects of groundwater infiltration on the system.
6. The importance of the wet weather flow data is important for the following reasons:
7. Analyze how the system responds to peak flows.
8. Provides reliable peaking factors that can then be used for basins with similar characteristics.
9. Peak flow design curves can be generated from this data, which will aid in determining the time of travel that it will take peak flows to enter the WWTF's.
10. Provide valuable information to determine what impacts that the I/I flow reduction programs have on the overall capacity of the systems.

The City currently has the first step of the process in place, the basic flow monitoring program. The next step of the process is to expand and modify the program to collect flow data. The flow monitoring program should include flow monitoring sites for each major basin as well as larger sub-basins and sub-basins that have unique characteristic such as industrial facilities, institutional facilities, or are suspected of having unusually high I/I flow components. Temporary flow monitoring, routine data collection, and the collection of data during and after rainfall should also be part of the flow monitoring program. It is recommended that a reasonable and cost-effective compromise involving a temporary and permanent flow monitoring program be implemented. This program needs to be in place both during periods of normal precipitation as well as during rain events.

To minimize inflow and infiltration flow (I/I) in the City's collection system, the I/I sources need to be identified through a comprehensive flow monitoring program. The flow monitoring program will accomplish the following:

1. Determine current flow quantities
2. Determine average dry weather flows
3. Determine flow during rain events
4. Determine fluctuation of flow in the system per intensity of rain
5. Determine flow patterns following the rain events.
6. Identify I/I and extraneous sources and develop removal or control strategies.

25.4.2.1 Flow Metering Locations

Permanent meters should be located where they can monitor all or a majority of flow from a basin. It is recommended that a review of the current metering locations as well as identifying suggested permanent metering locations be performed. Shown schematically in Figure 25.2 is a preliminary flow meter location plan. Additional permanent metering locations are suggested as the newer basins develop. In addition to the permanent meter locations, it is recommended that the City continue to monitor the flows using temporary metering equipment on suspect areas to confirm flows, and I/I flow problems.

25.4.2.2 Hydraulic Modeling

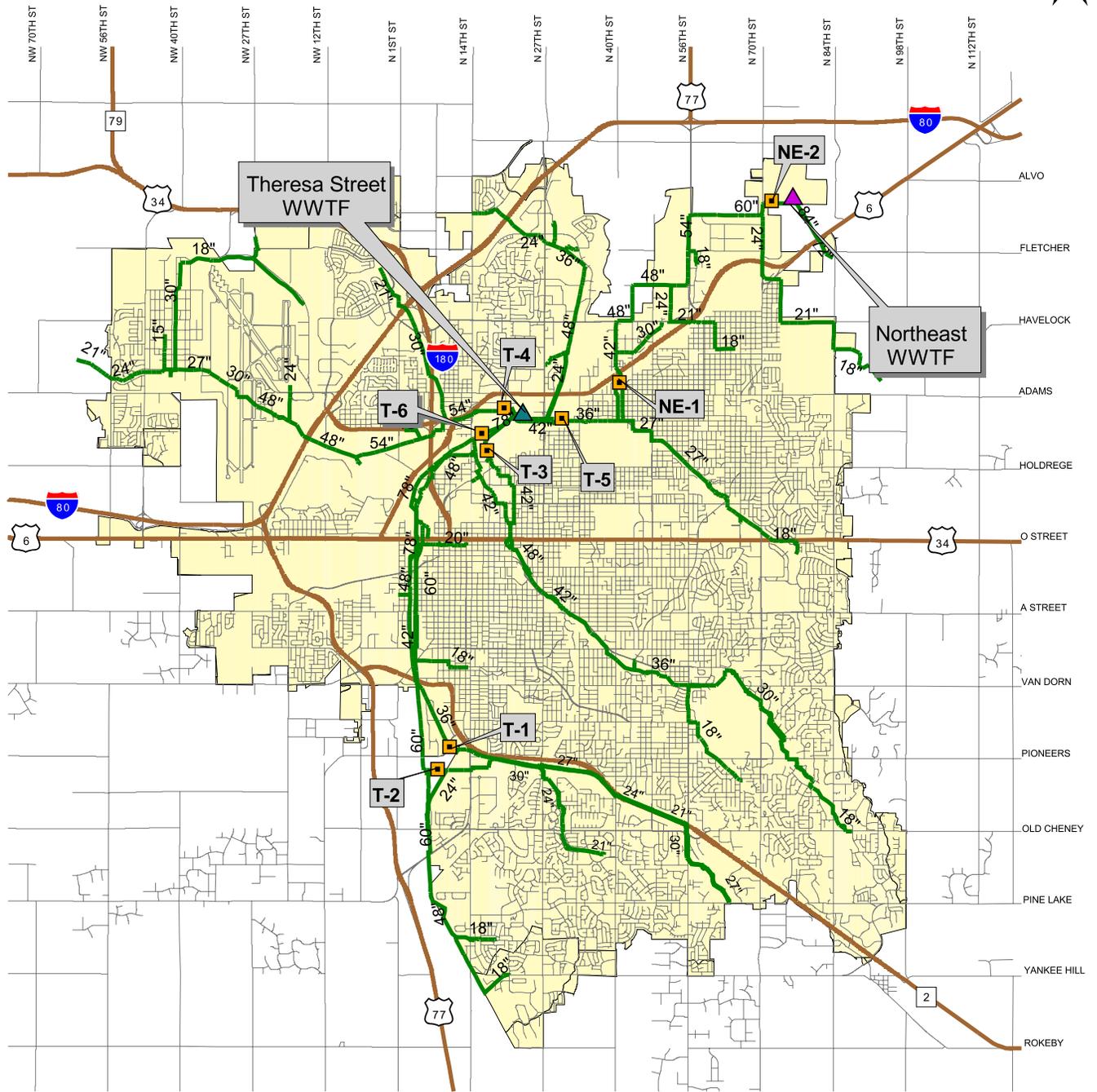
Generally, collection systems are analyzed using peak wet weather flow, which is the sum of average dry weather flow and rainfall dependent inflow and infiltration (RDII). Within a hydraulic model, a design storm produces RDII flows. A combination of RDII and dry weather flows is then routed through the collection system hydraulic model. Land use and population estimates are the basis for determining the quantity of wastewater generated within a City and thus the dry weather flow loading to the hydraulic models.

Results from flow monitoring activities are frequently used to develop a computer-simulated hydraulic model of the collection system. Modeling can provide a user with a variety of information, most importantly, the hydraulic capacity as it compares with peak flows imposed on the system. A model is only as good as the data it contains. Modeling protocol normally requires flow information in various forms including average, minimum, and peak base (dry-weather) flow; minimum, average, and seasonal peak infiltration; and inflow rate as it compares with selected design-level rainfall.

Calibration of the hydraulic model is best when storms of varying characteristics are used. By using a set of storms with varying intensity, volume, and duration, I/I flow will be more accurately predicted. With the storm events captured during the flow monitoring periods, the return periods are fairly short so the hydraulic model can only be calibrated to these events. The characteristics of more severe events have to be extrapolated which can influence the predictive accuracy of the model.

25.4.2.3 Master Planning

Throughout the brief history of municipal planning, master plans have an interesting legacy. They have been labeled anything from a crucial element needed to guide growth and development to a wasteful effort in constructing millions of dollars of unnecessary relief and interceptor sewers. Why do some master plans succeed and others fail? Much depends on whether a city used reliable and adequate flow monitoring information. Bad master plans usually result from "desktop" studies that do not consider the changing wastewater flow characteristics of the existing system. Good flow information is helpful both in examining the existing performance of the sewer system and in projecting the hydraulic impact of future collection system expansion. At a minimum, short-term monitoring helps cities understand



LEGEND

-  Northeast WWTF
-  Theresa Street WWTF
-  Proposed Flow Monitoring Locations
-  Trunk Sewers
-  Highways
-  Streets
-  Existing Service Area

0 1 2 3 Miles



Figure 25.2 Proposed Locations for Flow Monitoring Facilities
Wastewater Facilities Master Plan Update - 2007
City of Lincoln, Nebraska

their respective collection system's reactions to the changing effects of major users, population growth, rainfall, groundwater, and even snow-melt.

25.5 INDUSTRIAL PRE-TREATMENT PROGRAM

The City has an Industrial Pretreatment Program in place. Currently there are 43 Industrial Dischargers that are included in this program. It is encouraged that the City work with the industrial dischargers and look for opportunities to reduce both the flows and loadings from these dischargers. See Appendix G for additional information.