CHAPTER 4

EVALUATION OF EXISTING WASTEWATER FACILITIES

During the previous facility planning effort in 1995 the existing wastewater treatment facilities were evaluated for performance, capability for serving current and projected development, and ability to meet effluent quality discharge requirements. That analysis of the existing wastewater facilities has been updated to reflect new conditions or requirements and is presented in this chapter.

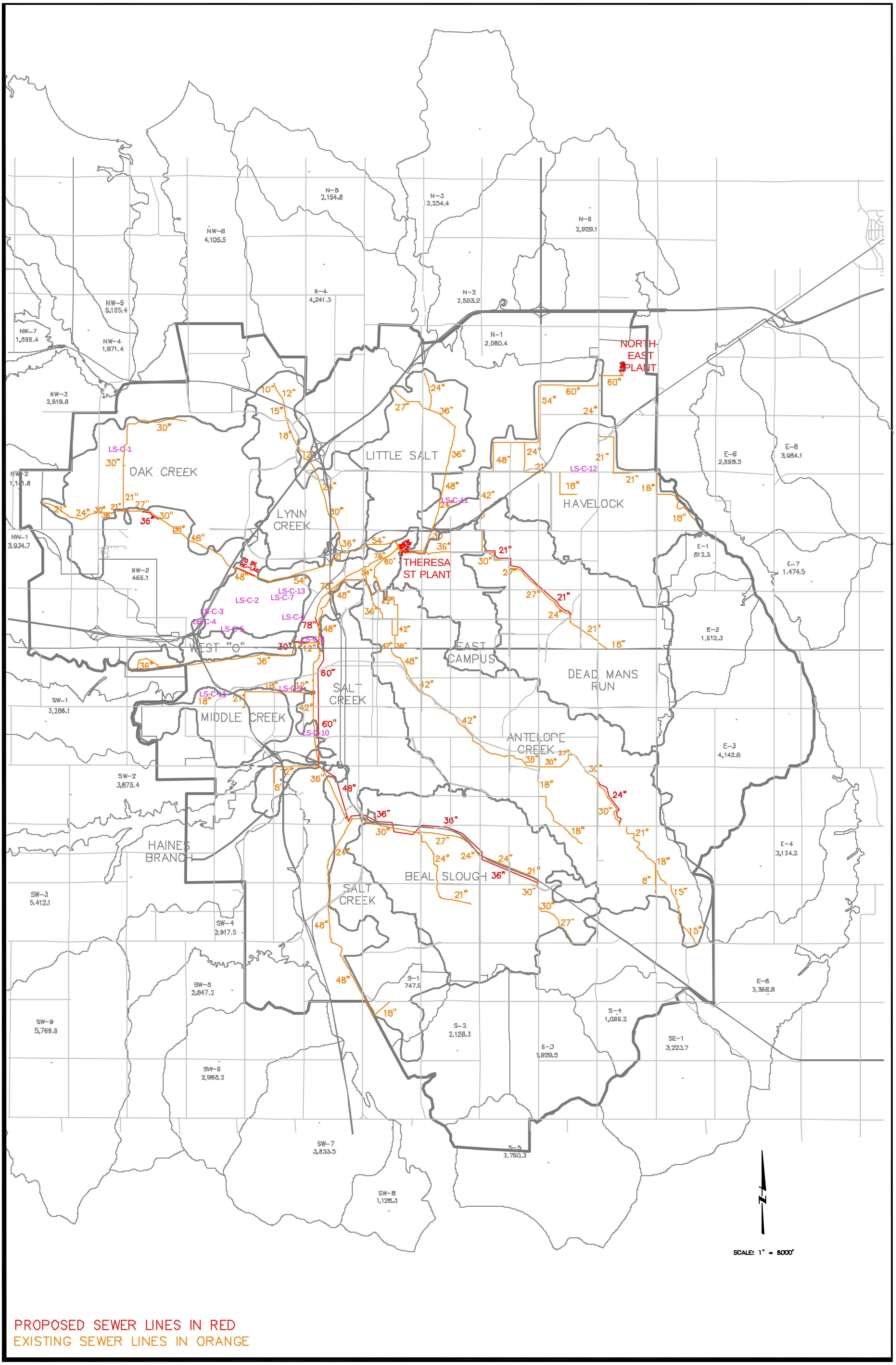
Description of Existing Collection System

The existing Lincoln wastewater collection is shown in Figure 4-1. As described in Chapter 3, the City of Lincoln wastewater collection system currently serves all or part of 13 drainage basins. Ten of these drainage basins are served by the Theresa Street WWTF. The drainage areas served by the Theresa Street facility include:

1. Salt Creek
2. West "O" Street
3. Beals Slough
4. Haines Branch
5. Middle Creek
6. Antelope Creek
7. East Campus
8. Oak Creek
9. Little Salt Creek
10. Lynn Creek

Salt Creek. The existing Salt Valley Trunk (SVT) Relief Sewer line, which represents the backbone of the sanitary sewer system, extends from the Theresa Street WWTF located near the intersection of Theresa Street and 27th Street, 8.6 miles to approximately the intersection of Yankee Hill Road and 14th Street. A six-phase plan for a relief sewer has been established, of which two phases have been completed. Phase I is designed for 17,000 acres of development and Phase IIA for 22,000 acres. Phase IIB is currently in the design phase. This relief sewer construction provides much needed capacity to the system.

West "O" Street. The existing sanitary sewer mains that flow west to east in West "O" Street were built in two segments. The first segment, which connects to the Salt Creek Trunk, consists of a 12-inch vitrified clay pipe (VCP) line that discharges to the "P" Street Lift Station (C-8). This lift station includes two suction lift pumps rated at 900 gallons per minutes (gpm) capacity each, which results in a total capacity of 4.0 cubic feet per second (cfs). To the west of the first segment is the second segment of the West "O" main, a newer 36-inch line that was constructed with the need for future capacity in mind. As the system currently exists, the 36-inch main discharges into the downstream 12-inch main.



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SANITARY SEWER BASINS

Figure 4-1

EXISTING LINCOLN WASTEWATER COLLECTION SYSTEM

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Beals Slough. The center of the Beals Slough Basin is at Old Cheney Road and 40th Street. The Beals Slough Basin is south of the Antelope Creek Basin and discharges flow to the Salt Creek Trunk sewer. The City map shows 5,370 acres of service area within the basin, which will generate an estimated 32.7 cfs of wastewater. This flow will overload selected sections of the Beals Slough trunk line. One location is at the intersection of 56th Street and Highway 2. A 24-inch line is planned to parallel the existing trunk at this location to mitigate this flow problem. Nevertheless, downstream capacity constraints will cause surcharging to extend upstream along almost the entire length of the Beals Slough Systems.

Haines Branch. (Included in the Salt Creek discussion.)

Middle Creek. The majority of existing 12-inch to 21-inch interceptor sewer serving the Middle Creek Basin is currently overloaded. The average overloading is about 2 cfs for the upstream segments of the line and more than 5 cfs for the last 1,739 linear feet (LF) of 18-inch pipe. Lift Station C-9 is located 2,823 LF upstream of the termination of the trunk line into the Salt Valley Trunk. The condition of the piping system has been described as fair.

Antelope Creek. Antelope Creek Basin includes 7,199 acres and generates approximately 42.6 cfs of wastewater that travels in a 42-inch pipe through the majority of the basin. Near the downstream end of the pipeline is a recently extended 15-inch line that reaches just south of Pine Lake Road. It was extended to serve a 403-acre development bound by 84th & 98th Street, and Pine Lake & Yankee Hill Road. Wastewater from the Antelope Creek basin are discharged into the Salt Creek trunk sewer.

Further downstream a set of parallel pipes carry the flow of the trunk line. At 21st and “R” Streets a 36-inch line (Campus Line) splits off and runs up 20th Street while the main 42-inch trunk runs up 22nd Street. The Campus Line terminates at the Salt Valley Trunk Sewer while the Antelope Creek Trunk line continues all the way to the Theresa Street WWTF.

East Campus. (Included in the Little Salt Creek discussion.)

Oak Creek. The Oak Creek Trunk Line ranges in size from 8-inch to 54-inch and stretches northwest from the City through the Lincoln Municipal Airport. In its present state, there is overloading in the 27-inch and 30-inch portions of the line.

Little Salt Creek. Located immediately north of the Theresa Street WWTF, the Little Salt Creek Basin includes 2,251 acres of developed land, with more developable land to the north. The Little Salt Creek Interceptor ranges in size from 24- to 48-inches and was built in the 1970’s.

Lynn Creek. The main line that serves Lynn Creek ranges in diameter from 18-inches to 36-inches. The line currently handles all of the present flows easily except in the 24-inch segment (where it currently has under 2 cfs of excess capacity for 503 LF) and in the 21-inch segment (where it currently has under 3 cfs of excess capacity for 1,330 LF and under 1 cfs of excess capacity for 7,809 LF). The total flow that the Lynn Creek sub-basins contribute to the trunk sewer line is about 10.0 cfs. This flow enters the Oak Creek Trunk line at MH#B6-265.

The remaining three drainage areas are served at least partially by the Northeast WWTF. These drainage areas include:

1. Deadmans Run
2. Havelock
3. Regent Heights (portion of West Stevens Creek drainage basin)

Deadmans Run. Wastewater flows from the Deadmans Run area initially were treated at the Theresa Street WWTF but now generally flow to the Northeast WWTF (see discussion in Chapter 3 about potentially diverting some of its flow to the Theresa Street WWTF). The Deadmans Run trunk line consists of pipe diameter ranging from 18-inch to 60-inch. Most of the segments with capacity problems are located at the west end of the run. (The 24-inch diameter and 30-inch diameter segments of the line are buried at an average depth of 15.7 feet.)

Havelock. The Havelock Basin is the second existing area that contributes wastewater flow to the Northeast WWTF. The components of the main Havelock line are VCP and PVC pipeline ranging in diameter from 18 to 24 inches. Two of its sub-basins (HV1 and HV10) contribute to the trunk line. Because of low existing flows and the high capacity of the line, there are no existing capacity problems.

Regent Heights. A ridge east of the Havelock, Deadmans Run, and Antelope Basins separates these basins from the West Stevens Creek Basin. There is currently no sanitary sewer infrastructure in the Stevens Creek Basin. The Regent Heights area, which is within the West Stevens Creek Basin, is currently served through the Havelock wastewater collection system.

Collection System Needs

The existing Lincoln wastewater collection system is generally adequate to serve current needs. Some areas of hydraulic overload such as the Salt Valley and Beals Slough areas or deteriorated facilities have been identified for correction. It is recommended that funding be provided to correct these conditions over the next 12 years. As population growth occurs within the service area, the system will have to be upgraded and expanded to continue to meet service needs. Specific upgrade and expansion recommendations are presented in Chapter 8.

Description of Existing Wastewater Treatment Facilities

This section describes the major components of the wastewater treatment facilities serving the City of Lincoln, including the Theresa Street WWTF and the Northeast WWTF. Figure 4-2 shows the locations of these facilities.

Theresa Street Wastewater Treatment Facility. The Theresa Street WWTF is the larger of the two facilities and is located at 2400 Theresa Street. The NDEQ presently considers the design capacity of the Theresa Street WWTF to provide standard secondary treatment to be 30 mgd as indicated in the existing discharge permit (a copy of the existing Theresa Street WWTF NPDES discharge permit is provided in Appendix A). Effluent from the Theresa Street facility is discharged to Salt Creek.

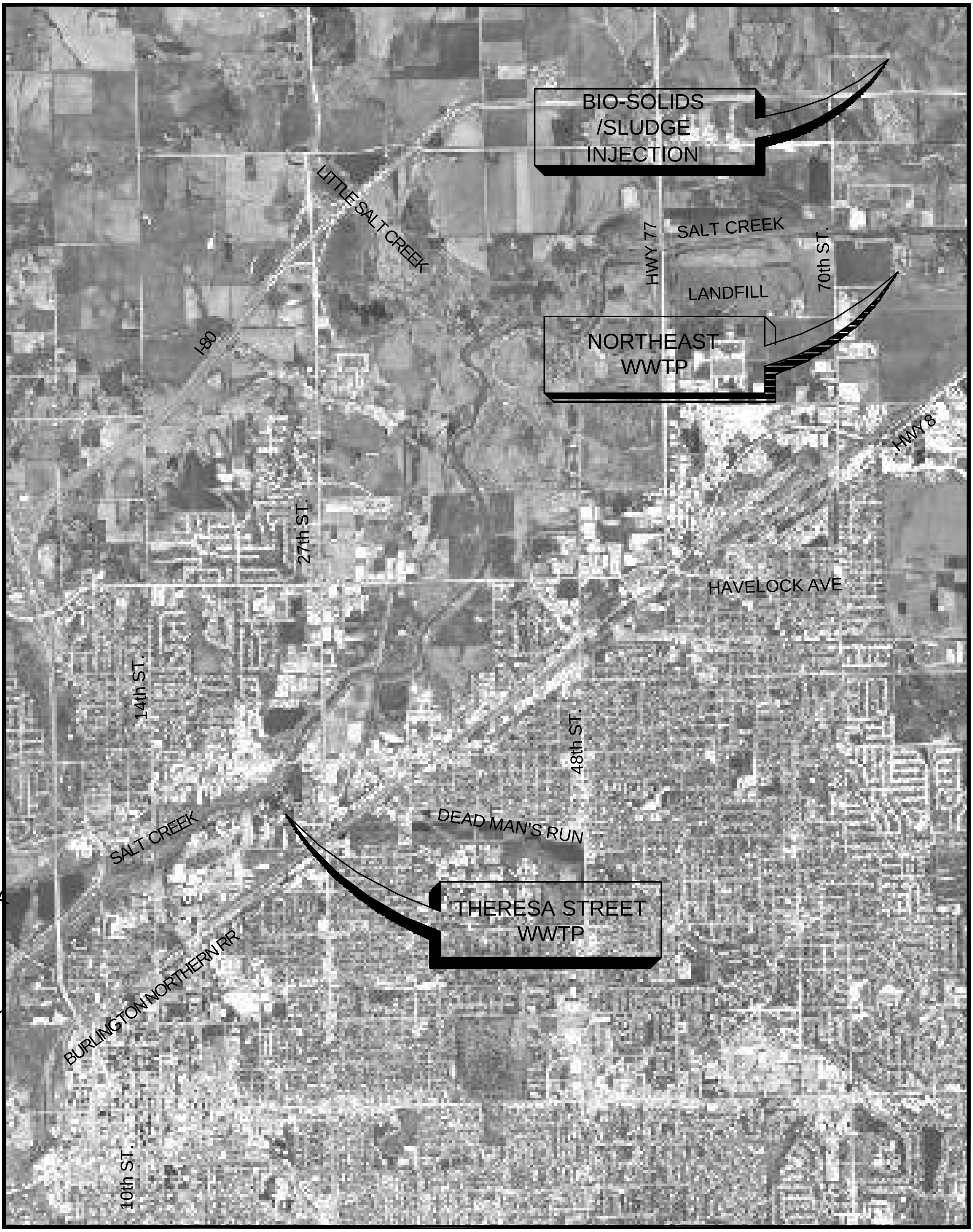

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Figure 4-2
Facility Location Map

The original wastewater treatment facilities at Theresa Street were constructed in 1923 and consisted of influent pumps and Imhoff tanks. In the 1930s, the system was upgraded and expanded to include fixed nozzle trickling filters, secondary clarifiers, and sludge drying beds. A 1940's upgrade included the addition of primary clarifiers and additional trickling filters. Major improvements were made with the construction of a 10-mgd activated sludge train in 1966, and a 15-mgd activated sludge train in 1973. As it currently exists, the Theresa Street WWTF consists of three distinct treatment trains:

1. The Trickling Filter Train,
2. The West Side Activated Sludge Train, and
3. The East Side Activated Sludge Train.

Since completion of the 1995 Wastewater Facilities Plan Update, the following improvements to the Theresa Street WWTF have been completed or are underway:

1. Screening of Raw Primary Sludge Added with Parkson Sieve Press (1997) – These improvements were made to remove plastics and other contaminants from the primary sludge prior to pumping it to the anaerobic digesters.

2. SCADA System Upgrade (1999) – The SCADA System Upgrade increased the capability and reliability of the process monitoring and control system.

3. Primary Clarifier Improvements (2000) – Intended to improve performance of these units, this project replaced the existing primary clarifier sludge collection mechanisms; primary clarifiers 3, 4, 5, and 6 were renovated with new mechanisms and weirs.

4. Headworks Improvements (2001) – Additional influent pumping capacity was installed along with new bar screen equipment. Influent Bar Screens 3 and 4 were replaced. The addition of new screenings conveyance and compaction equipment for headworks, and an additional raw sewage pump were also installed.

5. West Side Aeration Basin Improvements (2000) – This project reconfigured the aeration basins to improve the settling characteristics of the mixed liquor, increase the aeration efficiency and prepare for operating in a nitrification/denitrification configuration.

6. East Side Aeration Basin Improvements (2002)* – This project reconfigures the East Side aeration basins in a way similar to that of the West Side system.

7. ADA Improvements to Building A-16 (2002) – This project brings Building A-16 into compliance with requirements of the Americans with Disabilities Act (ADA).

8. Ultraviolet Disinfection (2002)* – This project replaces chlorine with UV light as the primary wastewater disinfectant.

9. Grit Removal (2002)* – This project replaces the existing aerated grit basins with new vortex type grit basins.

10. Odor Control Project (2002)* – Improvements include odor containment and scrubbing for the East Side System.

11. Secondary Electrical Feed (new transformer) (2002)* – Driven by the need for redundant power for the new East Side aeration blowers, the purpose of this project is to provide electrical back-up to the facility.

12. FEMA Flood Mitigation Project (2002)* – This project includes flood proofing of the electrical substation, area transformers, and key building locations.

13. West Side Blower Replacement (2003)* - Replace existing West Side blowers with new blowers to provide adequate oxygen for waste activated sludge systems.

14. Upgrade return activated sludge (RAS) pumping station for East Side activated sludge systems (2002)*.

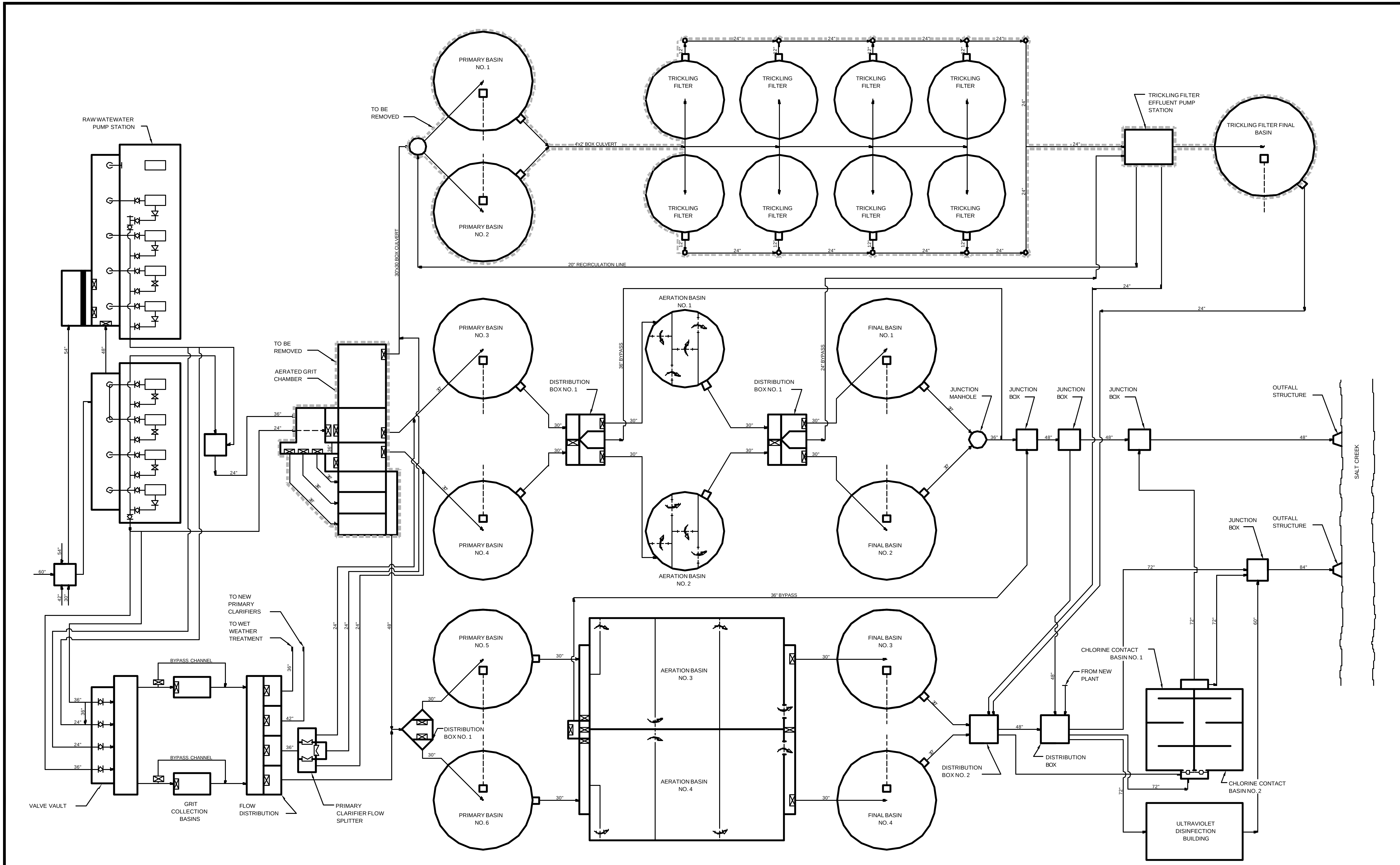
*currently underway.

Figure 4-3 presents a schematic diagram of the liquid stream treatment process at the Theresa Street WWTF. Flow entering the Theresa Street WWTF receives preliminary treatment (screening and grit removal) prior to being split among the three separate treatment trains. Each train employs primary sedimentation followed by secondary treatment via trickling filters or activated sludge. From April 1st through September, following secondary treatment, all wastewater is disinfected with chlorine prior to being discharged to Salt Creek. From October 1st through May, the secondary effluent is discharged directly to Salt Creek without disinfection. The ultraviolet disinfection project currently underway will replace the chlorine disinfection with UV disinfection. Appendix B contains a summary of key process data for the Theresa Street WWTF.

Figure 4-4 presents a schematic of the residuals handling facilities at the Theresa Street WWTF. The facilities treat five types of solids:

1. Screenings and grit,
2. Primary sludges,
3. Waste activated sludge and trickling filter sludge (humus),
4. Primary and secondary scum, and
5. Septage waste.

Egg-shaped anaerobic digesters were constructed in 1992 to treat the sludge, scum, and septage waste. Screenings and grit are disposed directly in the Lancaster County landfill. Methane gas produced by the anaerobic digestion process is used to heat the digesters and power two 450-kW engine driven generators which produce electric power. The electric power produced is introduced into the Lincoln area power grid and serves to offset electric power used at the WWTF to operate plant equipment.



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THERESA STREET WASTEWATER TREATMENT PLANT

Figure 4-3
Theresa Street WWTF Process Schematic

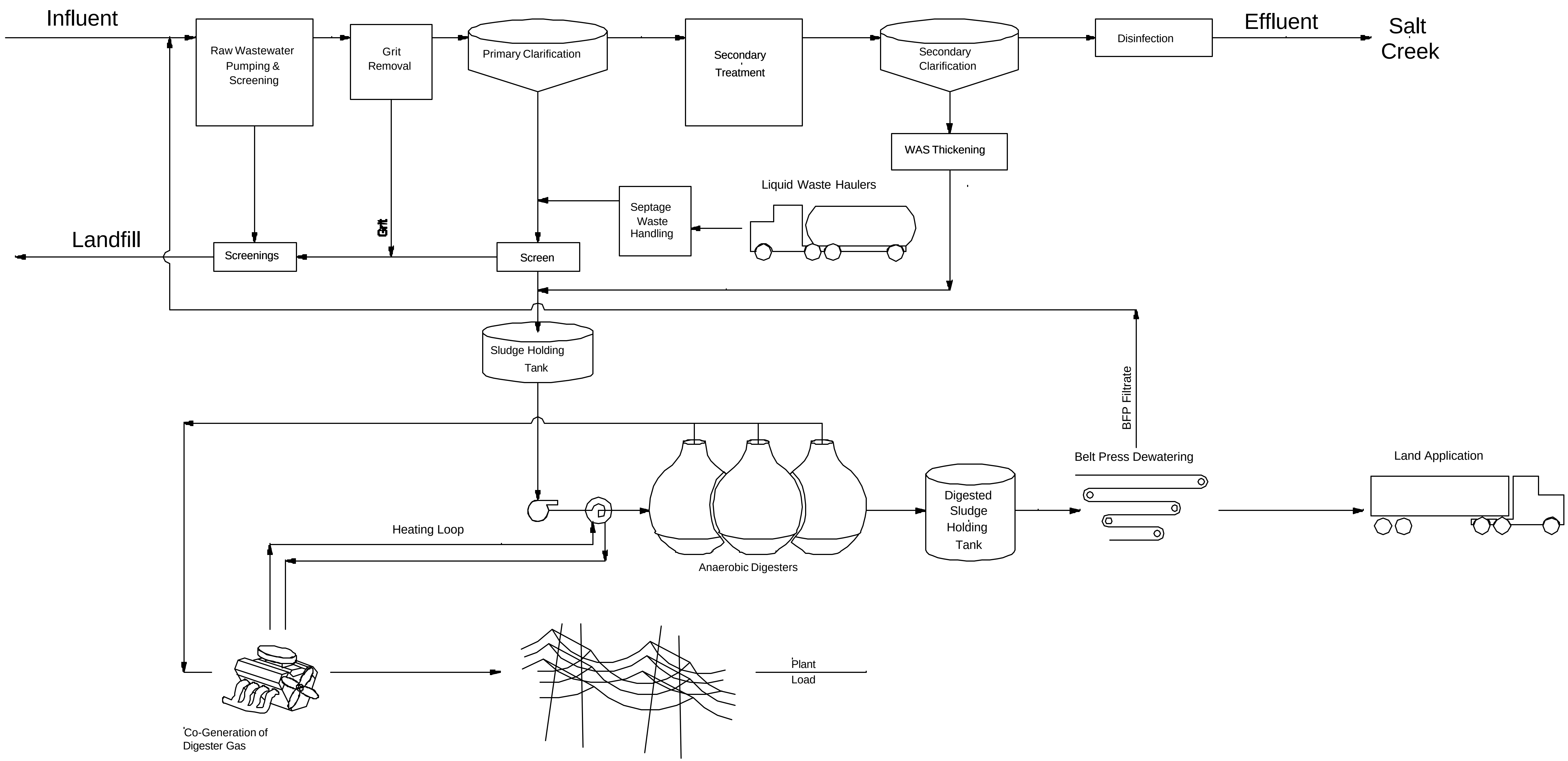


Figure 4-4
Theresa Street WWTF Solids Handling Schematic

Northeast Wastewater Treatment Facility. Construction of the Northeast WWTF was completed in November 1980. Preliminary treatment (screening and grit removal) is provided prior to primary and secondary treatment. The NDEQ currently considers the capacity of the Northeast WWTF to provide standard secondary treatment to be 8 mgd as indicated in the existing discharge permit (a copy of the Northeast WWTF NPDES discharge permit is provided in Appendix C). Secondary treatment at the Northeast WWTF is provided by an activated-biotower process which consists of biotowers, aeration basins, and secondary clarifiers. From May through September the final effluent is chlorinated prior to discharge to Salt Creek. From October through April the secondary effluent is discharged directly to Salt Creek without disinfection. Figure 4-5 presents a schematic diagram of the Northeast WWTF liquid stream treatment processes, and Figure 4-6 is a schematic diagram of the Northeast solids treatment system. Appendix D contains specific design data for the Northeast WWTF.

Primary sludge, secondary sludge, and scum generated at the Northeast WWTF are stabilized by anaerobic digestion prior to thickening and disposal at a dedicated land application site. All digested sludges are pumped about 2 miles offsite to a storage lagoon located at the land application site. Sludge from the storage lagoon is injected into City owned cropland adjacent to the lagoon. Supernatent from the sludge storage lagoon is returned to the Northeast WWTF for treatment.

Since completion of the 1995 Wastewater Facilities Plan Update, the following projects have been completed or are under construction at the Northeast Wastewater Treatment Facility:

1. Chemical Feed Facilities for Odor/Corrosion Control (1997) – This project included the construction of iron feed facilities to allow ferric chloride to be injected into the plant influent.

2. Headworks Rehabilitation (1997) – This project included the installation of new flow measurement equipment and repaired concrete grit handling structures which had deteriorated due to hydrogen sulfide attack.

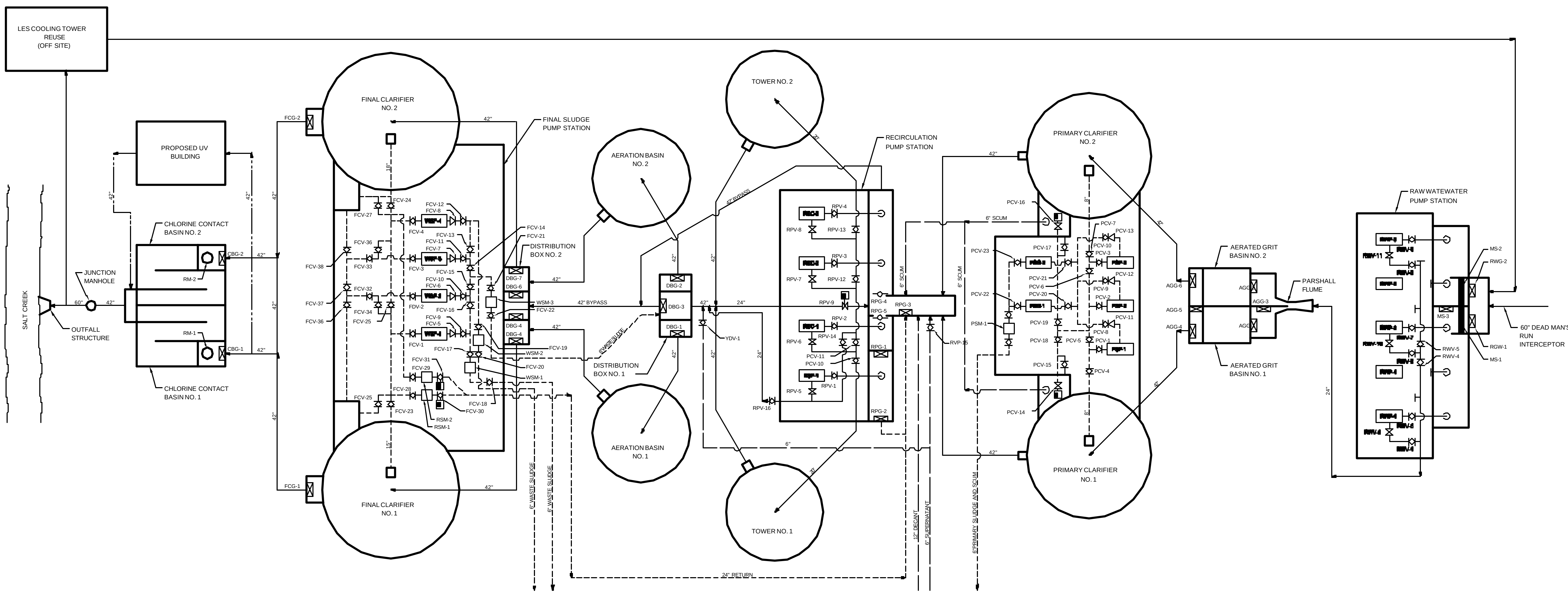
3. Aeration Basin Modifications (1998) – This project included the installation of fine-bubble diffusers in the existing aeration basins and converted the basins to a plug flow regime.

4. Flow Meter Replacement (1998) – An influent mag meter has been installed to replace an old Parshall flume.

5. Maintenance Shop Improvements (1998) – The project involved upgrading the maintenance shop with addition of a paint booth and added storage space.

6. Heating Water Loop Improvements (2002) – This project involved replacing corroded heating water piping with new fiberglass piping. The heating water system serves the recirculation pump station and the digester building.

7. Digester Upgrade (2002)* – This project will convert aerobic digesters to waste activated sludge (WAS) or thickened WAS storage tanks, add rotary drum thickeners, convert a secondary digester to a primary digester, and provide screening of primary sludge with a Parkson Sieve Press.



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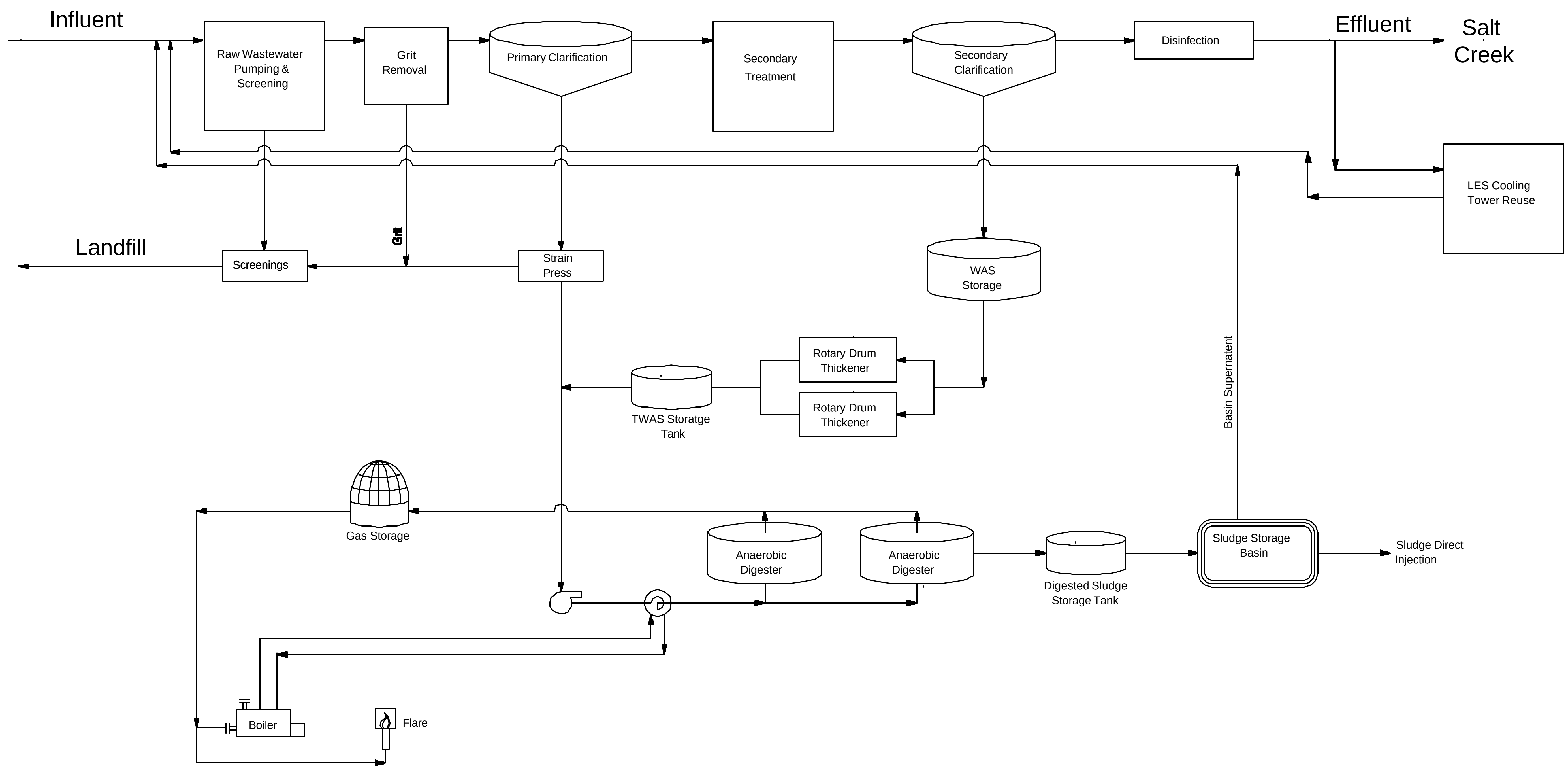
NORTHEAST WASTEWATER TREATMENT PLANT

Figure 4-5
Northeast WWTF Process Schematic



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NORTHEAST WASTEWATER TREATMENT PLANT

Figure 4-6
Northeast WWTF Solids Handling Schematic

8. Ultraviolet Disinfection (2002)* – This project will add ultraviolet disinfection facilities to the plant. UV disinfection will replace the chlorine disinfection as the primary method of disinfection at the Northeast WWTF.

9. Mechanical Screens (2002)* – This project will replace the existing mechanical screens with new units.

*currently underway

Existing Treatment Process Capacity Analysis

Techniques used to assess the process capacity of wastewater treatment facilities have improved significantly since the 1995 Wastewater Facilities Plan Update. These improvements have allowed a more accurate analysis of treatment system capacities to be performed as part of this facilities plan update. These techniques include:

1. Derivatives of the International Water Association Activated Sludge Model Number 1 incorporated into the BioWin™ simulator for the aeration basin system.

2. State Point Analysis (SPA) techniques for the secondary clarifier evaluation.

Anticipated changes in the discharge limits for ammonia at both the Theresa Street and Northeast facilities will have significant impacts on treatment system capacity.

A detailed facility rating of the Northeast WWTF was completed in November 1999. Similar modeling techniques were utilized as part of this facilities plan update to determine the capacities of the Theresa Street WWTF, and the 1999 evaluation of the Northeast WWTF was updated to reflect current conditions.

Factors Affecting Treatment Capacity. This section discusses the environmental and operational factors that affect the treatment capacity of an activated sludge system. This discussion is intended to promote a better understanding of the capacity analysis methodology used to evaluate treatment capacities and provide a basis for development of treatment alternatives.

Table 4-1 summarizes the primary factors that affect the capacity of an activated sludge facility.

Table 4-1. Primary Factors Affecting Treatment Capacity of an Activated Sludge System

Factor	Capacity Impact
Effluent Requirements	More stringent effluent requirements typically decrease facility capacity.
Temperature	Lower wastewater temperature typically decreases facility capacity.
Wastewater Characterization	Highly variable and strong influent wastewater typically decrease facility capacity.
Mixed Liquor Settling Characteristics	Poor mixed liquor settling characteristics typically decrease facility capacity.
Flow Peaking Factor	Large peaking factors typically decrease facility capacity.
Operator Expertise	Knowledgeable operators significantly increase wastewater facility capacity.

More information about each of these factors is presented in the following paragraphs:

Effluent Requirements. Effluent requirements establish the performance constraints within which an activated sludge facility must function. Generally, biochemical oxygen demand (BOD), ammonia, total nitrogen, and total phosphorus are the parameters that most significantly affect treatment capacity. Although specific ammonia limits are currently being negotiated between the City and the NDEQ, ammonia removal will require that the activated sludge system be operated at a solids retention time (SRT) sufficiently high to ensure the presence of nitrifying organisms. Effluent ammonia affects treatment capacity by dictating the minimum SRT required to ensure the presence of nitrifying organisms. Consequently, higher SRT requirements translate into a need for larger aeration basin sizes to treat a given quantity of wastewater and larger clarifiers to handle the resulting solids loads.

For the past 10 years the City of Lincoln, the NDEQ, the Water Environment Research Foundation, and several other interested parties participated in an extensive study to determine site-specific ammonia effluent criteria for Salt Creek. This process is ongoing and Lincoln expects a new NPDES permit in the near future (i.e., before the end of 2003). Table 4-2 presents the effluent ammonia requirements for the Theresa Street and Northeast WWTF that this facility plan update assumes will be implemented. Table 4-2 also presents anticipated future limits calculated with future flows and existing ammonia waste load allocations. For this facility plan analysis the treatment capacities are based on the projected 2025 ammonia limits.

Table 4-2. Anticipated Effluent Ammonia Limits*
(Calculated With 30-Day Averaging Period For
Waste Load Allocation Long-Term Average Multiplier)

Treatment Facility	Spring		Summer		Winter	
	Monthly Avg mg/L – N	Daily Max mg/L – N	Monthly Avg mg/L – N	Daily Max mg/L – N	Monthly Avg mg/L – N	Daily Max mg/L -N
Theresa Street						
2008	8.29	21.71	2.88	7.55	8.34	21.84
2013	8.20	21.46	2.75	7.21	8.27	21.64
2025	8.05	21.07	2.55	6.68	8.15	21.31
2050	6.93	18.14	2.23	5.84	7.96	20.85
Northeast						
2008	13.99	36.62	5.68	14.86	14.87	38.93
2013	13.50	35.53	4.98	13.03	14.35	37.56
2025	12.45	32.58	4.18	10.94	13.81	36.16
2050	7.45	19.51	2.48	6.49	8.21	21.50

* The effluent ammonia limits shown are not final and are based on the best information available at the time this report was prepared (March 2003).

Effluent ammonia requirements, as prescribed by the expected permit limits, affect treatment capacity by dictating the minimum SRT required to ensure the presence of nitrifying organisms. The transition from the presence to the absence of nitrifying organisms occurs rapidly at an SRT value known as the washout SRT. Figure 4-7 presents the results of BioWin™ model simulations from the City of Lincoln East Side activated sludge system. The figure demonstrates how the effluent ammonia concentration decreases rapidly from approximately 30 mg/L to less than 2 mg/L with a one to two day change in SRT, dependent on the temperature. Figure 4-7 shows the aerobic SRTs required to reliably meet permit ammonia limits at each temperature.

Temperature. Figure 4-8 presents monthly average influent wastewater temperatures at the Theresa Street WWTF based on hourly average temperature measurements taken from 1987 through 1993. From this data, and the fact that lower temperatures tend to decrease facility capacity, the critical month in terms of nitrification capacity rating is determined to be March. Anticipated spring ammonia limits are relatively low, as shown in Table 4-2, and the monthly average temperature in March has been recorded as low as 13°C.

Wastewater Characteristics. Wastewater chemical oxygen demand (COD) impacts the capacity of the overall system, particularly through the required minimum SRT and oxygen supply requirements. Other wastewater characteristics also affect the biodegradation of compounds within the wastewater. During August and September of 2000, the City of Lincoln conducted a special sampling campaign designed to determine wastewater characteristics and factors required to calibrate the BioWin™ model. The sampling data were used to calibrate the BioWin™ simulation models of the Lincoln WWTFs, which were subsequently used to evaluate WWTF capacities and treatment alternatives for this facilities plan update. Various comparisons between model results and actual operating conditions

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Figure 4-7
Effect of Aerobic SRT on Effluent Ammonia

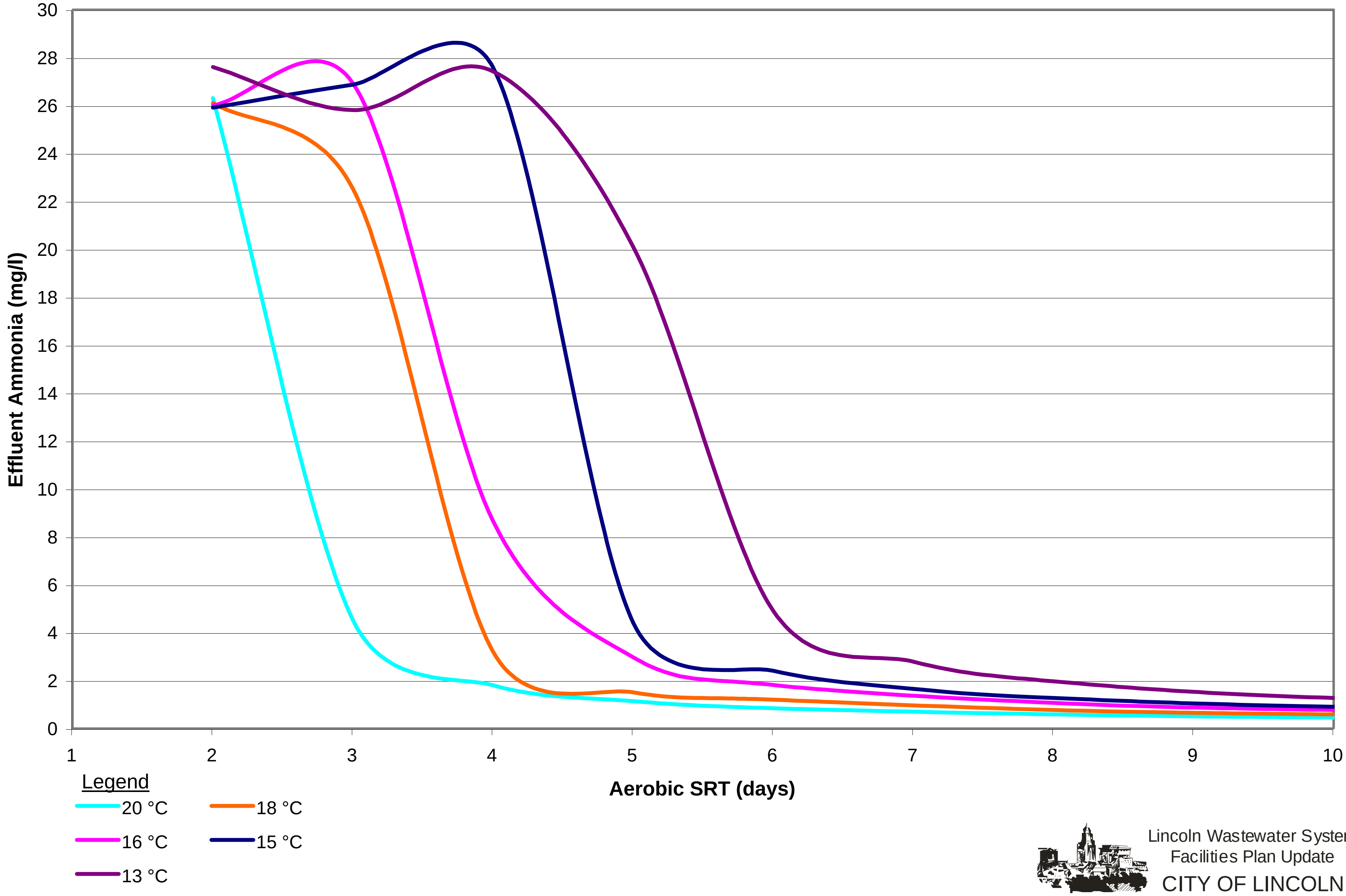

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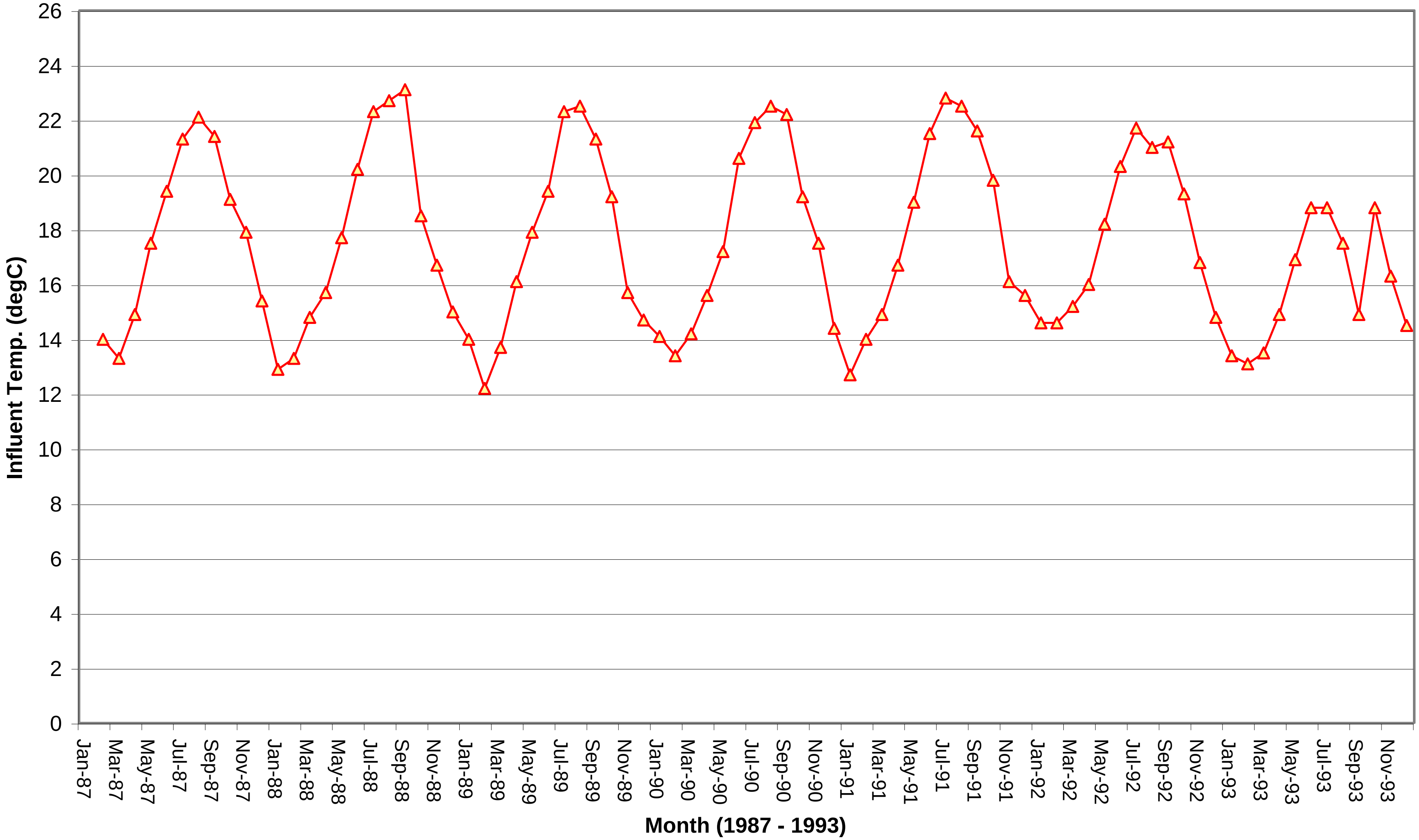
Figure 4-8
Monthly Average Influent Wastewater Temperatures
Theresa Street WWTF



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observed during the West Side stress testing period showed good correlation between model predictions and actual system performance. However, it is recommended that the City continue to improve the model calibration and wastewater characterization via additional sampling and field testing.

The COD introduced to the activated sludge treatment process is termed primary effluent (PE) COD. PE COD is a function of the plant influent COD and the performance of the primary clarifiers. Due to the presence of food product industries in the service area, the Theresa Street facility experiences a highly variable influent wastewater strength.

Figure 4-9 presents the daily and 30-day average PE COD at the Theresa Street facility from late 1999 through early 2002. In addition to the high daily variability, seasonal variation in influent COD results from variations in food manufacturers discharges.

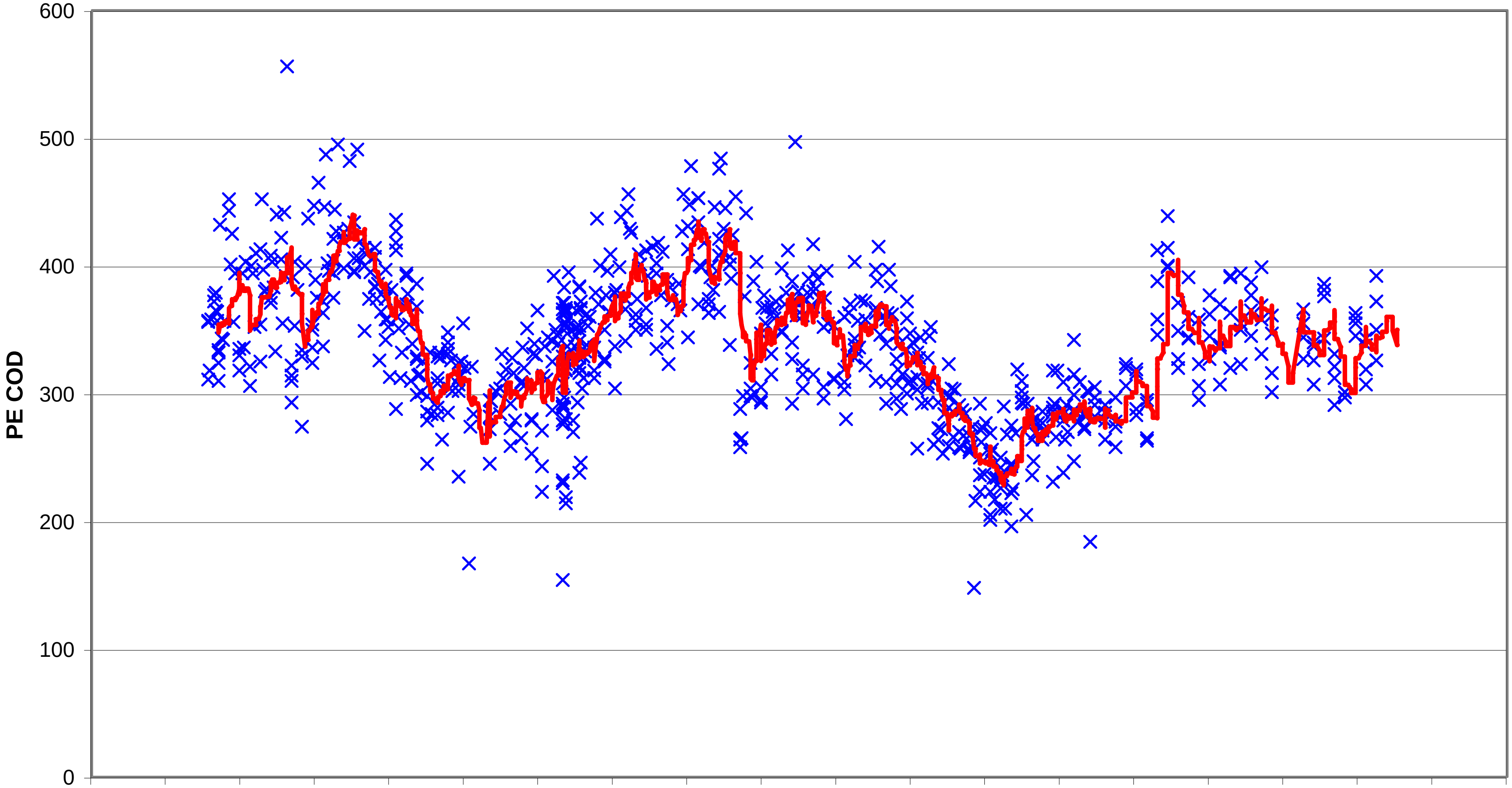
The data indicate that a monthly average PE COD of 450 mg/L is appropriate to use for the capacity analysis during the critical spring design period when the low wastewater temperatures can also occur.

The Northeast WWTF influent lacks the industrial wastewater component and therefore does not experience the same fluctuation in influent COD load as does the Theresa Street facility.

Mixed Liquor Settling Characteristics. Sludge settling characteristics play a significant role in establishing the capacity of an activated sludge system. Wastewater engineers and operators commonly utilize the sludge volume index (SVI) as an indication of the settling characteristics of the activated sludge solids. Settling characteristics affect the capacity by limiting the quantity of solids that can be applied to the secondary clarifiers while maintaining acceptable clarifier performance. WWTFs not specifically designed to control the sludge settling characteristics typically experience wider variations in settling characteristics than those designed to control sludge settleability. Such wide variations in sludge settling characterizations must be considered in evaluating system capacity. Many facilities chlorinate the RAS in an attempt to selectively kill the filamentous organisms believed to be responsible for most poor settling characteristics. Historically, the City of Lincoln has chlorinated the RAS to control settling characteristics.

Recently, the City of Lincoln constructed improvements to aeration basin design at both the Theresa Street and the Northeast WWTFs, incorporating features known to improve mixed liquor settling characteristics. These improvements have increased the capacity of these facilities without construction of new secondary clarifiers. Features such as anoxic selectors, plug flow reactor configurations, and fine-bubble aeration all improve settling characteristics by creating conditions that encourage the predominate growth of microorganisms known to settle well. These aeration system improvements have increased the capacity of the activated sludge systems by controlling the SVI without the use of chlorine.

Figure 4-9
Daily and 30-day Average Primary Effluent COD
Theresa Street WWTF



Legend

- CODT
- 30 per. Mov. Avg. (CODT)

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Tab: Fig 4-9 PE COD

Flow Peaking Factor. The hydraulic peaking factor also affects the capacity of an activated sludge system. During the peak flow periods of the day, solids within the system tend to move from the aeration basin to the secondary clarifier at a higher rate than they can be returned. This condition results in an increase in the quantity of sludge in the clarifier and may negatively affect the facility performance. Excessive solids accumulation in the secondary clarifier may cause the following additional detrimental effects:

1. Enhanced growth of "low dissolved oxygen filaments" unable to be controlled through aeration basin improvements such as anoxic selectors. Lincoln may have experienced some of this during start-up of the West Side activated sludge system.

2. Decreased ammonia removal efficiency. This may occur when mixed liquor suspended solids (MLSS) concentrations decrease as solids migrate from the aeration basin to the clarifier. As the MLSS decreases, the nitrifier population under aeration also decreases. Lincoln operators have been measuring inventory distribution between the aeration basins and clarifiers. These measurements indicate that 15 to 25 percent of the solids inventory can be resident in the clarifier even prior to blanket accumulation.

Figures 4-10 and 4-11 present monthly average flows for the period of January 2000 through March 2002 for the Theresa Street and Northeast facilities respectively. The data for September 2001 through March 2002 are atypical and represent periods when flows were diverted from the Northeast facility to the Theresa Street facility.

Because the atypical data from September 2001 through December 2001 skew both the average and peak flow values for the entire year of 2001, only 2000 data was used to establish peak to average flow ratios for facility planning. These peak flow factors are represented in Table 4-3.

Table 4-3. Summary of Historical Peak Flow Factors

Peak Flow Factor[1]	**Theresa Street WWTF**	**Northeast WWTF**
	2000	**2000**
MMF to ADF[2]	1.11	1.15
PDF to ADF[2]	1.37	1.34
PHF to ADF[2]	1.93	1.95
PHF to MMF	1.74	1.70

[1]Includes wet weather flows occurring within the period indicated.
[2]See Chapter 5 for further definition of terms.
MMF = Maximum Monthly Average Daily Flow
PDF = Peak Daily Flow
PHF = Peak Hourly Flow
ADF = Annual Average Daily Flow

Figure 4-10
Theresa Street WWTF Monthly Average Flows

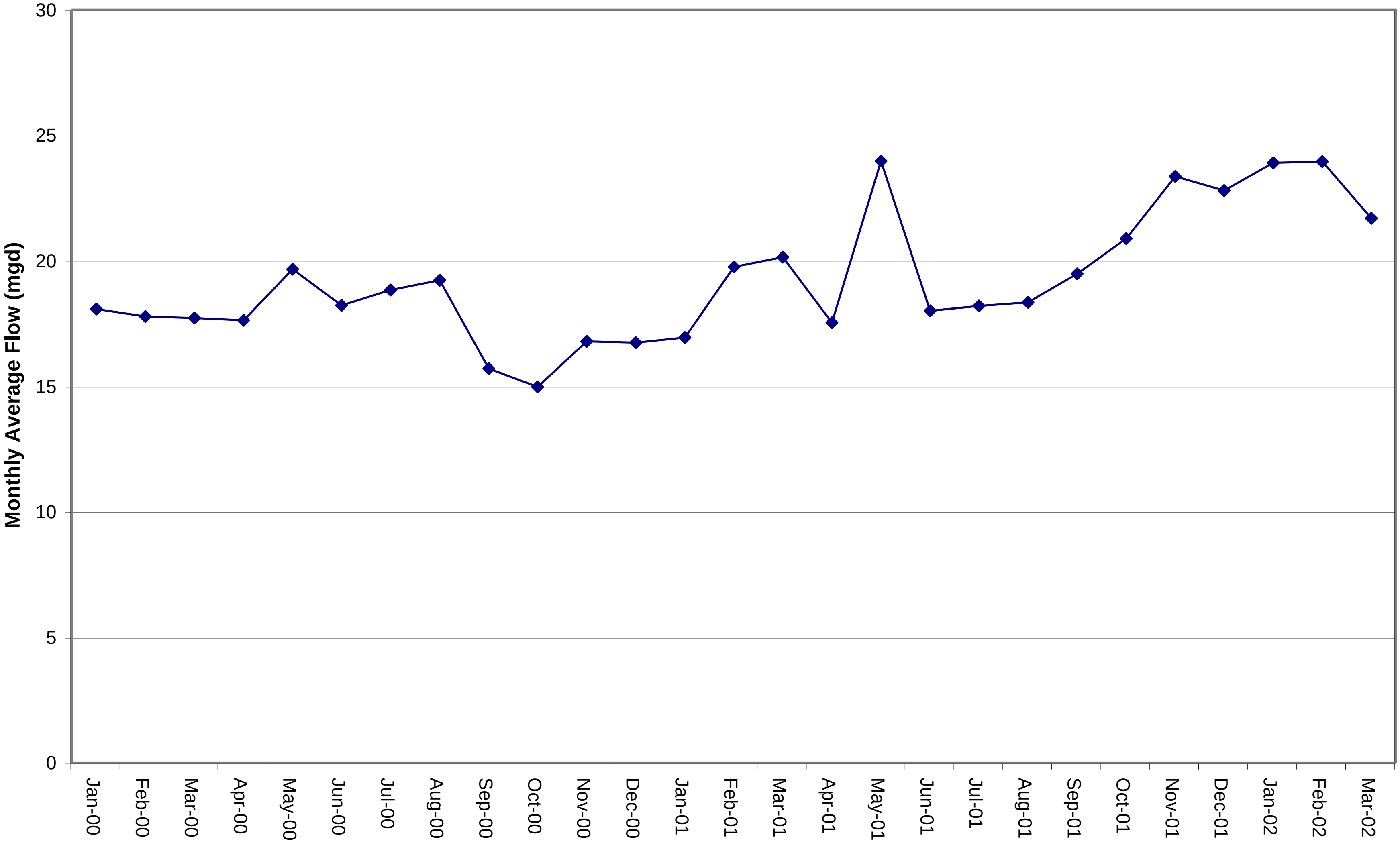

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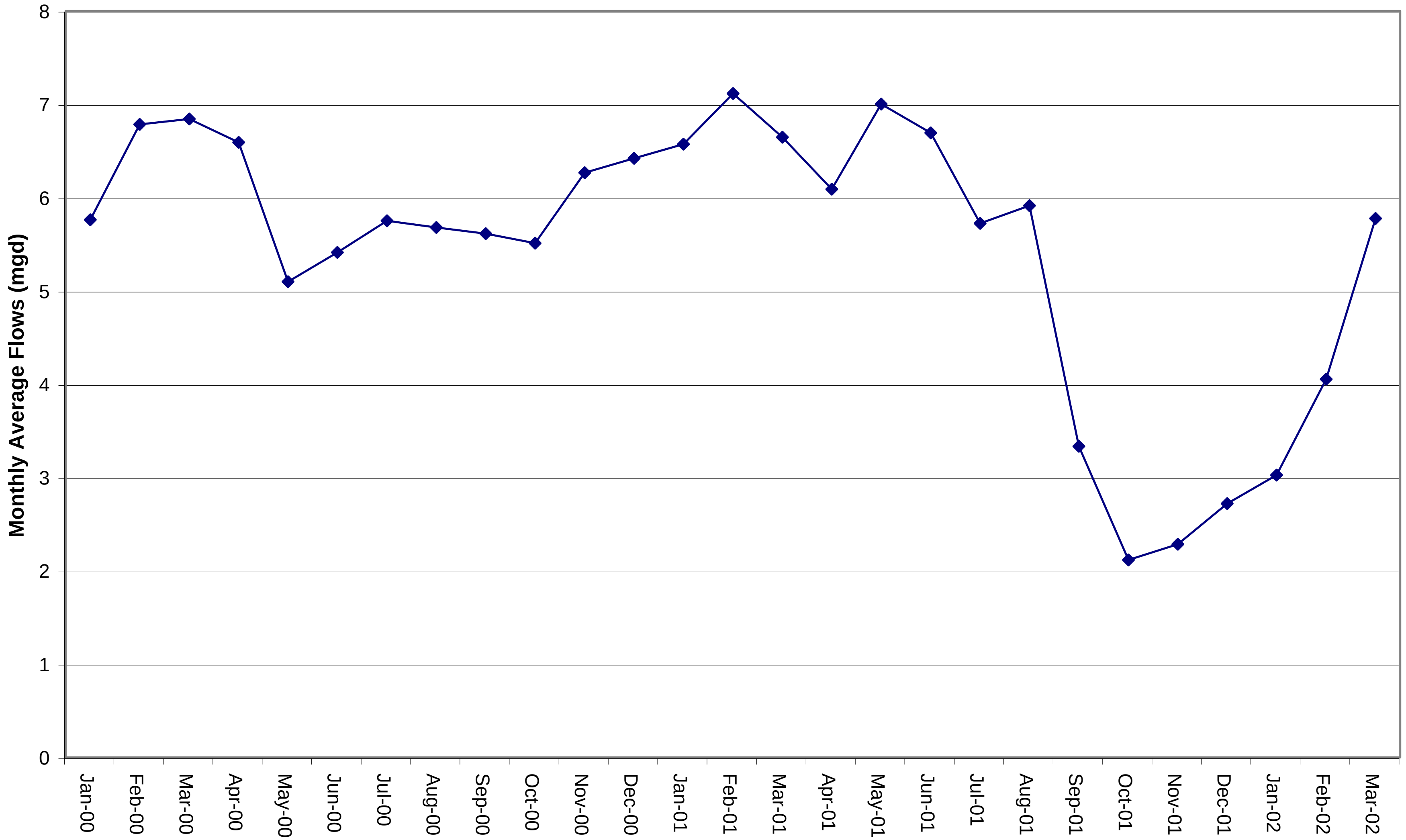
Figure 4-11
Northeast WWTF Monthly Average Flows
Note: Sept. 01 thru Feb. 02 reflect partial flows diverted to Theresa Street WWTF



Lincoln Wastewater System
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File: Fig 4-11. Hrly Flow NE.xls
Tab: FIG 4-11

During some previous years, considerably higher peaks have occurred due to low probability rainfall events. The capacity estimates prepared for this facility plan update do not consider these rare peaks as they fall under new regulations being negotiated by the US EPA related to SSOs. Recent improvements to the collection system to reduce stormwater inflow may have decreased the highest peaking factors. Rating an activated sludge system to provide for such high peaking factors would severely reduce the capacity of the overall system and is considered uneconomical. For excessive peak flows, those significantly higher than the 1.74 and 1.70 peak hour to maximum month factors for Theresa Street and Northeast respectively, side-stream treatment or other alternative treatment scenarios should be applied. This issue is discussed further in Chapter 8.

Operator Expertise. Operator knowledge and experience is a critical, but often overlooked, factor in determining the realistic capacity of an activated sludge system. Experienced and knowledgeable operators can successfully operate a given WWTF at organic loads and flows much higher than can inexperienced operators. Lincoln conducted activated sludge training during the startup of the West Side activated sludge system. During that training, the factors influencing capacity presented in this chapter were presented and discussed. The Lincoln operations staff gained additional knowledge of system capacity limits during a stress testing period following the training. During the stress testing period the hydraulic and organic loading to the West Side system was increased almost to the system capacity limits. The knowledge of the Lincoln wastewater operations staff was taken into consideration when evaluating the capacity of the Lincoln WWTFs.

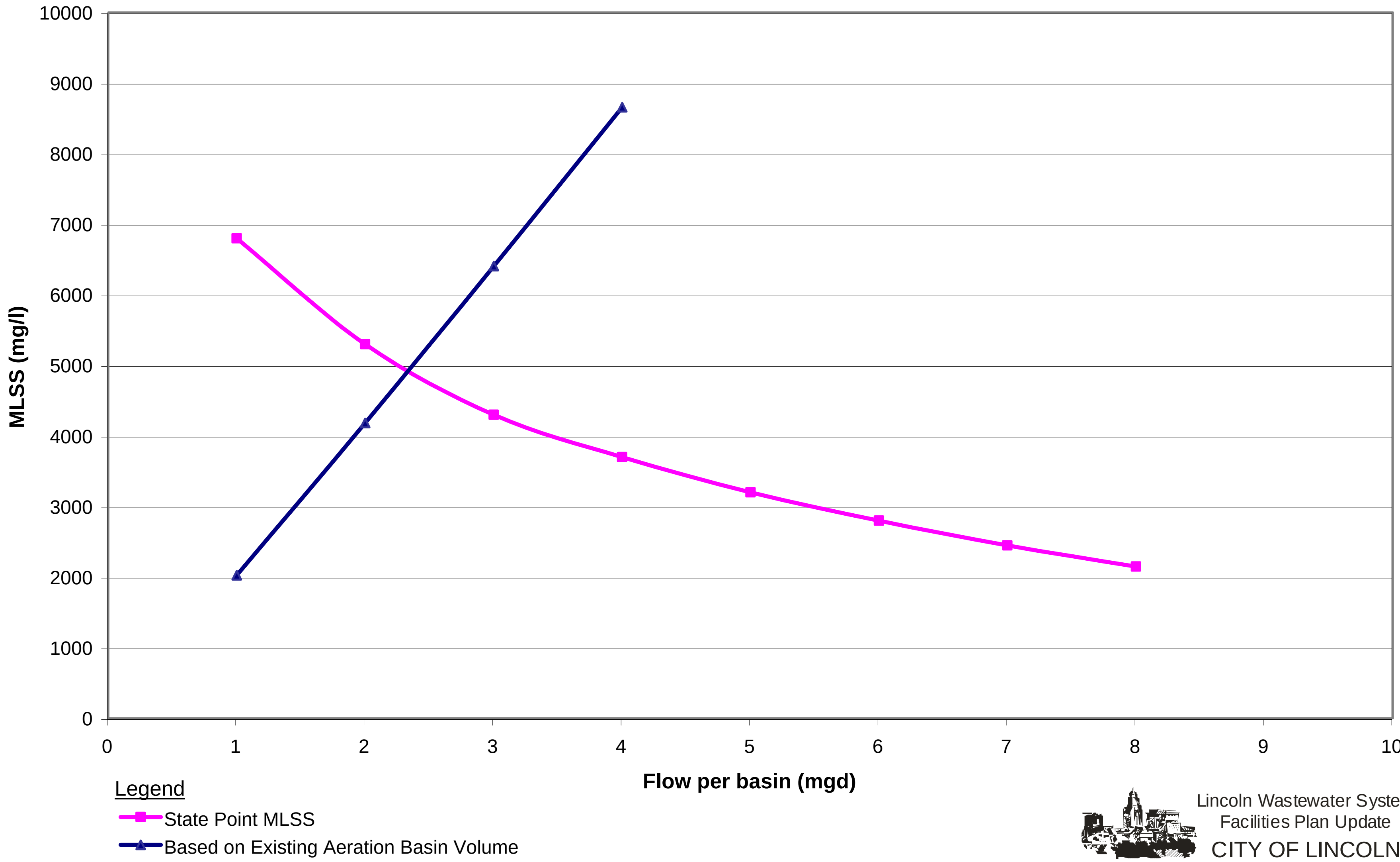
Capacity Estimate Methodologies. The above discussion indicates that numerous factors influence the capacity of an activated sludge system. The capacity estimating models applied to the Lincoln WWTFs account for each of these factors. The model provided considerable detail which allows the relative effect of each of these factors to be observed. This detailed model output promotes the development of alternative concepts and the data for the evaluation. This approach to capacity analysis avoids applying the most limiting value of each of the parameters concurrently, a common approach which can result in extremely conservative capacity estimates that do not represent situations likely to be experienced in actual facility operation.

Theresa Street WWTF Capacity Estimate. The capacity analysis applied the BioWin™ simulation model and Brown and Caldwell's State Point Analysis program to both the East Side and West Side activated sludge systems at the Theresa Street Facility. The trickling filter treatment train at Theresa Street is considered incapable of consistently removing ammonia during cold weather periods and therefore does not represent nitrifying capacity.

Assuming an average maximum month PE COD concentration of 450 mg/L, a temperature of 13°C and an SVI of 150 mL/g, Figures 4-12 and 4-13 present the capacity rating for operation to achieve nitrification sufficient to meet the ammonia limits shown in Table 4-2 for 2025 results for the West and East Side systems, respectively. Table 4-4 summarizes the results.

BROWN AND CALDWELL
MWH
MONTGOMERY WATSON HARZA

Figure 4-12
West Side Capacity Vs. MLSS Concentration



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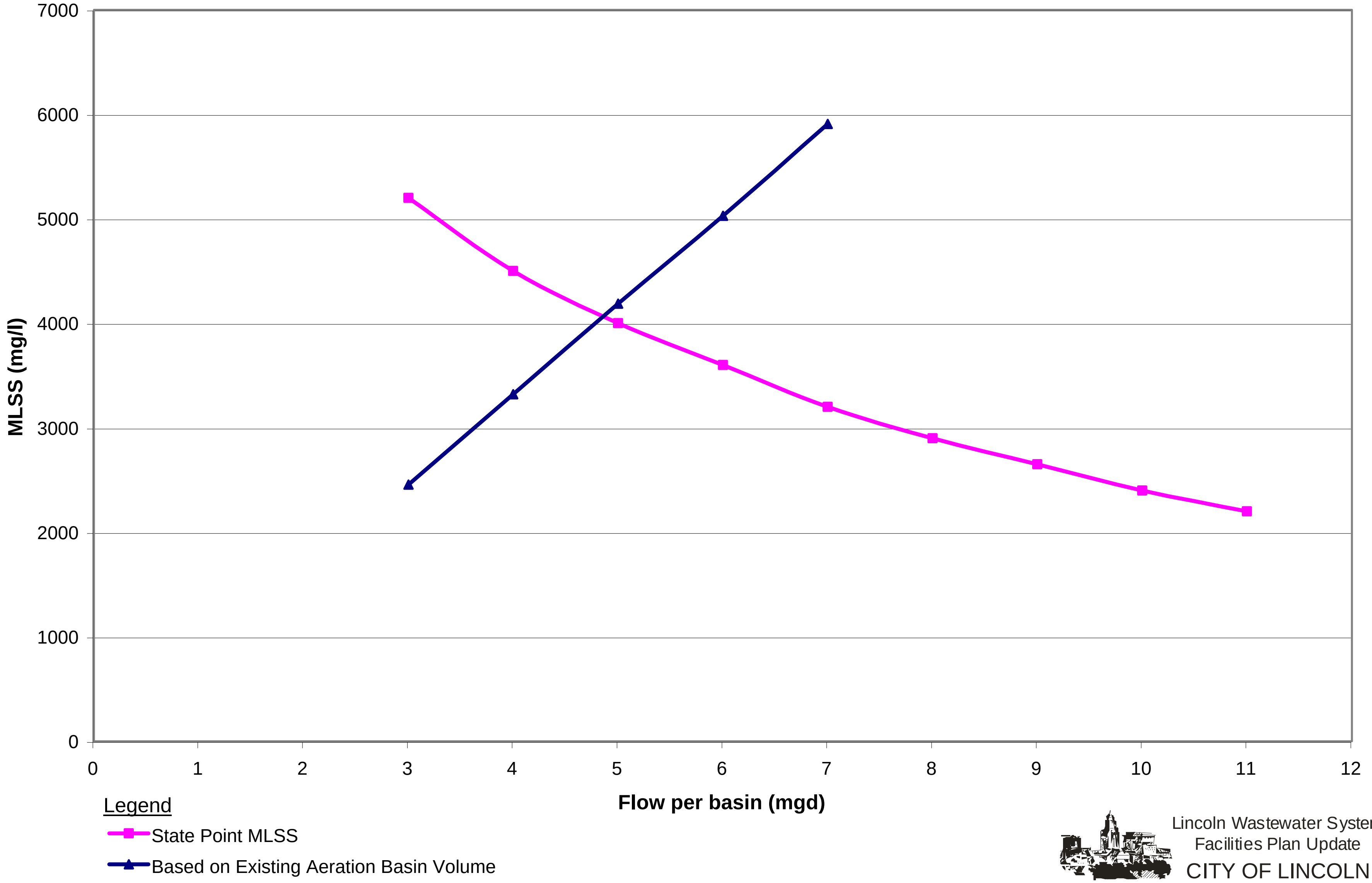
File: Fig 4 - 12 and 13.T-Street Capacity.xls
Tab: fig 4-12

BROWN AND CALDWELL

MWH
MONTGOMERY WATSON HARZA

Figure 4-13
East Side Capacity Vs. MLSS Concentration



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File: Fig 4 - 12 and 13.T-Street Capacity.xls
Tab: fig 4-13

Table 4-4. Nitrification Capacity Summary - Existing Theresa Street WWTF

Treatment System	Capacity* (mgd)
West (MMF)	4.7
East (MMF)	9.7
Total (MMF)	14.4

* Wastewater flows, loadings, and temperatures occurring during the month of March represent the capacity limiting considerations. The treatment capacity is limited by a combination of the aeration basin size, the clarifier solids loading rate and spring time (March) operating conditions.

As indicated in Table 4-4, the overall Theresa Street WWTF system nitrification capacity is rated at 14.4 mgd.

Northeast WWTF Capacity Estimate. In November 1999, Brown and Caldwell completed a process rating study to estimate the capacity of the Northeast WWTF. The study utilized the best available process data, including the data generated during two special sampling periods. The capacity evaluation approach utilized was similar to that used to rate the Theresa Street WWTF capacity. Due to available data limitations, assumptions for the capacity estimate were somewhat more conservative than the assumptions applied to the Theresa Street facility.

Assuming "maximum month" primary effluent COD concentration of 300 mg/L, a wintertime temperature of 15°C, and an SVI of 150 mL/g, the capacity of the Northeast WWTF was determined in the 1999 Study to be 4.0 mgd. This was based on the limiting solids loading rate for the final clarifiers.

As part of this Facility Plan Update, additional analysis of the Northeast WWTF nitrifying capacity was performed by comparing PE COD and aeration basin and clarifier capacities at the Northeast facility with those of the Theresa Street West Side facility. This comparison was made because the two facilities are similar in both size and configuration. The additional analysis was performed using the most recent ammonia discharge limit information and has been stress tested to confirm the limits of nitrifying capability. The comparison assumed that the Northeast facility could accommodate a food to microorganism ratio and specific clarifier solids loading rate similar to what the West Side facility can treat. The results of this comparison are shown in Table 4-5 and represent the system capacity under spring loading conditions.

Table 4-5. Nitrification Capacity Summary - Existing Northeast WWTF

Parameter	Capacity
Northeast WWTF	
Capacity (MMF)	4.4 mgd

* Wastewater flows, loadings, and temperatures occurring during the month of March represent the capacity limiting conditions The treatment capacity is limited by a combination of the aeration basin size, the clarifier solids loading rate and spring time (March) operating conditions.

The values presented for treatment capacity of the Northeast WWTF are considered to be the best available without further in-depth modeling and stress testing the facility.

Improving Capacity Estimates. The following parameters significantly impact the capacity estimates of the two plants and, because of the limited data available during facility planning, merit further study at both WWTFs during subsequent preliminary design:

1. Temperature: The data evaluated for the Northeast WWTF indicated a minimum wastewater temperature of 15°C during the winter. The critical month temperature assumed for the Theresa Street facility was 13°C. Heat loss in colder months through the biotowers at the Northeast plant suggest that Northeast temperatures would be expected to be lower than temperatures at the Theresa Street facility. More aeration basin temperature data should be obtained at both facilities to develop a more accurate temperature database.

2. Nitrifier Washout Solids Retention Time: Modeling completed for the Theresa Street facilities indicated that a 9.5 day SRT with 25 percent of the reactor volume unaerated, should be above the nitrifier washout SRT for all conditions. Modeling completed for the Northeast facility assumed that a 12.0 day SRT would be required in the aeration basins to prevent nitrifier washout. This assumption represents the major difference in the value of the capacity estimates and should be investigated through additional modeling efforts and field stress testing. The City of Lincoln has been operating the Northeast facility in a nitrification mode during relatively warm wastewater temperature periods. Additional experience during cold temperatures would be very useful in further refining the system capacity.

Hydraulic Capacity Analysis

Hydraulic Profile Modeling. Hydraulic and energy grade lines were calculated for the Theresa Street WWTF (East Side and West Side) and Northeast WWTF using Brown and Caldwell's software program called PROFILE. This program models flow through the WWTF by calculating the total energy grade (elevation head, pressure head and velocity head). When water surface elevation data were available, the model was calibrated for the given flow, and plant hydraulic capacity was determined by subsequent runs of the calibrated model at increased flow rates. When no elevation data were available, typical energy loss coefficients were used.

The WWTFs were assumed to have reached capacity when the water surface for a particular element came within 6 inches of the top of the wall or a controlling weir was submerged.

The hydraulic analysis was based upon record drawing information provided by the City of Lincoln. In order to accurately calibrate the model, field verification of all key hydraulic elements is needed. In the absence of this field verification, the hydraulic capacity estimates provided herein may vary significantly from actual capacities. The detailed results of the modeling effort are included in Appendix E.

Theresa Street WWTF. Hydraulic modeling was conducted only for the East and West Side systems at the Theresa Street WWTF. Decommissioning of the trickling filter system is planned for the near future, so hydraulic modeling of this system was not performed. A relative 100-year flood elevation of 1,147 feet above mean sea level (amsl) in Salt Creek was used initially in the modeling effort. The UV system designer provided headloss information through the proposed UV disinfection system.

East Side System. The hydraulic capacity of the East Side System was performed assuming concurrent flow through the West Side equal to one-half the flow through the East Side System.

The capacity of the East Side process train was reached at approximately 24 mgd as indicated by the water surface levels in the Final Junction Manhole, Chlorine Basin, Distribution Box (before the Chlorine Manhole), Final Clarifier, and the Aeration Basin. At 26 mgd the water surface is less than 6 inches from the top of the Final Manhole, and the top of the wall is surpassed in the Chlorine Contract Basin and Distribution Box. The launder in the Final Clarifier and final weir in the Aeration Basin are submerged at 26 mgd and the top of the wall of the Final Clarifier is surpassed at 33 mgd. The Primary Clarifier launder is submerged at 33 mgd. The Aerated Grit Basin appears to have a capacity of 30 mgd. The other major elements not mentioned have capacities in excess of 33 mgd.

The City has embarked on the design of a new grit removal system and a new UV disinfection system. These projects will include streamlining the flow through the headworks and the disinfection facilities. These improvements should mitigate the following flow restrictions through these facilities and accommodate future treatment trains and wet weather facilities. Factors limiting hydraulic capacity include:

- Piping between the outfall and the Chlorine Contact Basin: contributes to much of the headloss from the Distribution Box downstream.
- Initial channel in the Chlorine Contact Basin: generates high headloss and experiences high water levels.
- Piping and other elements between the Final Clarifier and the Aeration Basin: contributes to the submergence of the final weir in the Aeration Basin.
- Aerated Grit Basin inlet and discharge channels: generate high headlosses and high water levels. (This appears to be caused by both the piping and other elements between the Distribution Box and Aerated Grit Basin and the Aerated Grit Basin itself.)

West Side System. The model run assumed flow through the West Side System would equal to one-half of the flow through East Side System. The capacity for this process train was reached at 12 mgd as indicated by the water surface levels in the Chlorine Contact Basin and Distribution Box. The water surface in the Final Manhole exceeded the top of wall at 15 mgd. The Primary Clarifier launder became flooded at 15 mgd. All other elements appear to have capacities in excess of 15 mgd. Factors limiting hydraulic capacity include:

- Piping between the outfall and the Chlorine Contact Basin: contributes to much of the headloss from the Distribution Box downstream.

- Initial channel in the Chlorine Contact Basin: generates high headloss and experiences high water levels.

- Initial channel in the Aerated Grit Basin: generates high headloss and experiences high water levels.

New vortex grit basins and UV disinfection facilities are currently being planned for the Theresa Street WWTF. Construction of the new grit basins will not impact the hydraulic capacity of the East Side or the West Side Systems. Since the Chlorine Contact Basin and Distribution Box are limiting elements in the hydraulic capacity of both the East and West Side Systems, installation of the new UV disinfection system could serve to increase the hydraulic capacities of both systems. Design of the UV system should be directed toward substantially reducing the headloss through the disinfection system and thereby eliminating this hydraulic limitation.

Analysis was also performed to determine the impact of a 100-year flood level in Salt Creek at the point of the Theresa Street discharge. The 100-year flood elevation in Salt Creek at the point of the Theresa Street discharge is 1,147 feet amsl. The water level in Salt Creek at this elevation will cause major hydraulic problems at the Theresa Street facility. The top of the final junction manhole is 1,146 feet. A creek water surface elevation of 1,147 feet would be above the top of this manhole and the manhole would be totally submerged. The elevation of the top of the chlorine contact basin walls is 1,147.16 feet, just 2 inches above the creek water surface. At a wastewater flow of less than 10 mgd, wastewater would begin to flow over the top of the contact basin walls. Treatment processes prior to disinfection would be less drastically impacted.

Northeast WWTF. The hydraulic capacity of the Northeast WWTF was reached at 37 mgd as indicated by the water surface levels in the Chlorine Contact Basin and Aeration Basin. In the Chlorine Contact Basin and Aeration Basin the final weirs were submerged at this flow rate but the walls of the basins were not. Approximately 40 mgd can pass through the Primary Distribution Box and the Tower before the water surface exceeds the weir in the Primary Distribution Box or reaches the bottom of the media in the Tower. The Final Clarifier weir was submerged at flows of 50 mgd, but the water surface level did not surpass the top of the walls of the clarifier. All other units experienced no problems regarding high water surfaces at flows up to 50 mgd. Specific hydraulic limitations include:

- The flow restrictions in the Chlorine Contact Basin and downstream piping cause submergence of the final clarifier weirs; however, flow will still pass through up to at least 50 mgd without surpassing any walls.

- Piping and other elements between the Final Distribution Box and the Aeration Basin cause submergence of the final weir in the Aeration Basin.

- Piping and other elements between the Aeration Basin and the Tower cause the water level to exceed the weir in the Primary Distribution Box and submerge the bottom of the media in the Tower at flows of 40 mgd.

High flow experienced during a wet weather period in 1993 indicated that the hydraulic capacity of the Northeast WWTF was significantly less than these hydraulic calculations predict. It is recommended that a more detailed investigation of the Northeast WWTF be conducted to identify what structure, pipe, or piece of equipment limited the hydraulic capacity in 1993 to less than 37 mgd.

Lincoln Wastewater Residuals Management

Residuals are generated from several different treatment processes at the Lincoln Wastewater Treatment Facilities. The following sections discuss regulations relating to, and the disposal of, residuals resulting from:

- Influent Screening
- Grit Removal
- Primary Clarification
- Secondary Treatment

Screenings and Grit. The residuals generated from the screening and grit removal processes are disposed by trucking them to the Lancaster County landfill. The regulation governing this disposal practice is the Federal Resource Conservation and Recovery Act (40 CFR 258 or RCRA). The particular portion of the regulation involved is generally referred to as "Subtitle D". This regulation is discussed in greater detail in Chapter 6, Regulatory Requirements.

At both the Theresa Street and Northeast WWTFs, screenings and grit are of a character and sufficiently dewatered to meet the Subtitle D requirements.

Primary and Secondary Sludges

Biosolids generated in the primary and secondary treatment processes at the Lincoln WWTFs are applied to agricultural lands in the Lincoln area. At a minimum, the biosolids must meet:

1. The Pollutant Ceiling Limits for metals,
2. Class B requirements for Pathogen Reduction, and
3. Vector Attraction Reduction Requirements.

Biosolids from both treatment facilities are well within the Pollutant Ceiling Limits. Biosolids from the Theresa Street and Northeast facilities are treated with anaerobic digestion to meet both the Pathogen Reduction and Vector Attraction Reduction requirements. Vector Attraction Reduction Requirements can be met by either processing or with appropriate physical barriers at the application sites.

Theresa Street WWTF Digested Sludge Handling and Disposal

A summary of the sizes and treatment capacities of the anaerobic digesters at the Theresa Street WWTF is provided in Table 4-6.

Table 4-6. Theresa Street WWTF Anaerobic Digester Size and Loading Summary

Parameters	Value
No. of Digesters	3
Volume of each Digester	1,100,000 gallons
Total Digester Volume	3,300,000 gallons
Historical Sludge Production (maximum month)	8,062 gal/mg 2,609 lbs/mg
Historical Volatile Sludge Production (maximum month)	1,930 lbs VS/mg
Required Digester Hydraulic Detention Time	18 days
Design Digester Volatile Solids Loading	0.15 lbs VS/day/cu ft
Digester Design Capacity	23 mgd

Anaerobically digested sludge from the Theresa Street WWTF is dewatered by belt filter presses prior to hauling to the land application sites. A summary of the sludge dewatering facilities at the Theresa Street facility is provided in Table 4–7.

Table 4-7. Theresa Street Sludge Dewatering Facility Summary

Parameters	Value
No. of Belt Filter Presses	3
Average Dry Solids Produced (following anaerobic digestion)	25,881 lb/day (~1,500 lbs/MG of wastewater treated)
Typical operation time	32 hours/week (Mon., Tues., Thur., Fri.)
Capacity of each BFP	3,300 lbs/hr
Firm Sludge Dewatering Capacity (1 bfp out of service)	105,600 ppd (operated 16 hrs/day) ~70 mgd of wastewater treatment capacity
Typical Dewatered Sludge Solids Concentration	20.8%
Average BFP filtrate	625 gpm

The information presented in Table 4-7 indicates that the belt filter presses at the Theresa Street WWTF have adequate capacity to treat the sludge generated from all contemplated wastewater flows.

The historical nitrogen concentration of the anaerobically digested sludge from the Theresa Street WWTF is approximately 54,000 mg/L or 5.4 percent. The rate at which Theresa Street WWTF biosolids can be applied to agricultural lands depends on the crops grown and the quantity of biosolids or other nitrogen containing fertilizers applied previously. If corn is the primary crop grown and biosolids application has been occurring for several years at agronomic rates, approximately 5,900 pounds (lbs) of dry weight biosolids can be applied to each acre of cropland each year. This is based on an agronomic nitrogen requirement of 200 lbs per acre per year and the assumption that 50 lbs of the nitrogen is available from biosolids or other fertilizers previously applied. At an annual application rate of 5,900 lbs of dry sludge per acre, approximately 0.26 acres are required for every million gallons of wastewater treated. At this application rate approximately 1,600 acres are required for biosolids application at current flow rates and just over 2,300 acres will be required to accommodate 2025 biosolids production.

In addition to the agronomic rate limitations for biosolids application, total cumulative application limits are applied to biosolids not meeting the "high quality" criteria for metals concentration. A summary of the 40 CFR 503 requirements for metals and historical metal concentrations of Theresa Street biosolids are presented in Table 4-8.

Table 4-8. Theresa Street Biosolids Pollutant Concentration Data

Pollutant	Theresa Street Biosolids Concentration (mg/kg)	Ceiling Limits (mg/kg)	"High Quality" Limits (mg/kg)	Annual Loading Rate (kg/ha/yr)	Cumulative Loading Rate (kg/ha)
Arsenic	14.7	75	41	2.0	41
Cadmium	15.6	85	39	1.9	39
Chromium	107.2	3,000	1,200	150	3,000
Copper	650.4	4,300	1,500	75	1,500
Lead	69.5	840	300	15	300
Mercury	0.01	57	17	0.85	17
Molybdenum	20.4	75	18	0.90	18
Nickel	80.5	420	420	21	420
Selenium	2.8	100	36	5.0	100
Zinc	704.7	7,500	2,800	140	2,800

Based on the information presented in Table 4-8, the Theresa Street biosolids may be applied at rates up to about 6,500 kg/ha/yr (approximately 5,900 lbs/acre/yr), for over 100 years before any cumulative metal loading rates are reached. It should be noted that the biosolids generated at Theresa Street are within the requirements for "High Quality" biosolids with the exception of molybdenum. It is recommended that the source of molybdenum in the wastewater be identified to determine if its discharge to the wastewater collection system could be reduced to the level necessary to allow the Theresa Street biosolids to meet "High Quality" requirements.

The filtrate generated by the dewatering process at Theresa Street is returned to the wastewater treatment stream for treatment. This filtrate is high in ammonia and other pollutants and represents a significant load on the treatment system. In addition, since the belt filter processes are generally operated only during the day on week days and not at all on weekends, the recycle of filtrate also introduces significant “slug loads” or high strength intermittent loading on the liquid treatment process. Equalizing the filtrate return to the wastewater treatment system so it is returned constantly over a 24-hour period each day would significantly reduce its impact on the activated sludge treatment process. This or some other method of reducing the negative impact of this “side-stream” on the activated sludge process is recommended.

Northeast WWTF Digested Sludge Handling and Disposal

The solids handling system at the Northeast WWTF is currently under construction. Sludge is being hauled to the Theresa Street WWTF for treatment during the construction project. The construction project includes:

- Conversion of the existing secondary anaerobic digesters to submerged cover primary digesters,
- Installation of a double membrane gas storage system,
- Installation of a new boiler,
- Hot water loop replacement,
- Conversion of the existing aerobic digesters to WAS thickeners, and
- Addition of a dewatering building.

Under normal operating conditions digested sludge from the Northeast WWTF is pumped to holding lagoons near the land application site for storage prior to land application. Sludge from the lagoons is injected beneath the surface of City owned agricultural land near the lagoon site. Supernatent from the lagoon is returned to the WWTF.

Table 4-9 provides a summary of the sizes and treatment capacities of the anaerobic digesters at the Northeast WWTF.

Table 4-9. Northeast WWTF Anaerobic Digester Capacity Summary

Parameters	Value
No. of Digesters	2
Volume of each Digester	467,000 gallons
Total Digester Volume	934,000 gallons
Historical Sludge Production (maximum month)	5,613 gal/mg 1,813 lbs/mg
Historical Volatile Sludge Production (maximum month)	1,341 lbs VS/mg
Required Digester Hydraulic Detention Time	18 days
Design Digester Volatile Solids Loading	0.15 lbs VS/day/cu ft
Digester Design Capacity	9 mgd

A summary of the capacities of the land application facilities at the Northeast WWTF is provided in Table 4-10.

Table 4-10. Northeast WWTF Land Application Facilities

Parameters	Value
No. of Lagoons	1
Usable volume of Lagoon	289,080 gallons
Injection Field Size Number of field connections	 440 acres 30

The digested sludge generated at the Northeast WWTF has historically contained approximately 60,100 mg/L or 6 percent nitrogen. As with the Theresa Street WWTF, the rate at which Northeast WWTF biosolids are applied to agricultural lands depends on crops grown and the quantity of biosolids or other nitrogen containing fertilizers applied previously. If corn is the primary crop grown on the agricultural lands and biosolids application has been occurring for several years at agronomic rates, approximately 4,000 lbs of Northeast sludge can be applied to each acre of cropland each year. This is based on an agronomic nitrogen requirement of 200 lbs per acre per year and the assumption that 50 lbs of the nitrogen is available from biosolids or other fertilizers previously applied. At an annual application rate of 4,000 lbs of dry weight biosolids per acre, approximately 0.23 acres are required for every million gallons of wastewater treated. At this application rate approximately 575 acres of land are required for biosolids application at current flow rates and approximately 840 acres will be required in 2025.

The quantity of land required varies considerably with the crops grown, method of biosolids application, etc. Further evaluation of biosolids handling practices should be undertaken before determining how much additional land should be procured for biosolids application.

In addition to the agronomic rate limitations for biosolids application, total cumulative application limits are applied to biosolids not meeting the “high quality” criteria for metals concentration. A summary of the 40 CFR 503 requirements for metals and historical metal concentrations from Northeast biosolids are presented in Table 4-11.

Table 4-11. Northeast Biosolids Pollutant Concentration Data

Pollutant	Northeast Biosolids Pollutant Concentration (mg/kg)	Ceiling Limit (mg/kg)	"High Quality" Limit (mg/kg)	Annual Loading Rate (kg/ha/yr)	Cumulative Loading Rate (kg/ha)
Arsenic	12.8	75	41	2.0	41
Cadmium	8.1	85	39	1.9	39
Chromium	49.4	3,000	1,200	150	3,000
Copper	1330.4	4,300	1,500	75	1,500
Lead	132.0	840	300	15	300
Mercury	3.1	57	17	0.85	17
Molybdenum	63.1	75	18	0.90	18
Nickel	73.4	420	420	21	420
Selenium	9.7	100	36	5.0	100
Zinc	2744.6	7,500	2,800	140	2,800

Based on the information presented in Table 4-11, the Northeast biosolids may be applied at rates up to 4,500 kg/ha/yr (approximately 4,000 lbs/acre/yr) for over 50 years before the cumulative pollutant loading limits are reached. The biosolids generated at the Northeast WWTF meet the quality requirements for "High Quality" biosolids except for molybdenum. Zinc is also close to the "High Quality" limit. It is recommended that the sources of these two pollutants be identified to determine if their discharge to the wastewater collection system could be curtailed to the point that the "High Quality" limits could be met.

Supernatant from the biosolids lagoons is returned to the Northeast wastewater treatment stream for treatment. This supernatant is high in ammonia and other pollutants and represents a significant load on the treatment system. Since the same pipeline used to transport biosolids to the lagoons is used to return supernatant to the wastewater treatment process, supernatant return is typically accomplished in relatively large batches, which introduces significant ammonia "slug loads" on the wastewater treatment process. Constructing a separate pipeline to allow the constant return of supernatant from the lagoons to the wastewater treatment system would significantly reduce the impact of the supernatant return on the wastewater treatment process. This or some other method of reducing the negative impact of this side-stream load on the secondary/nitrification treatment process is recommended.

Identification of Needs

In addition to the need for increased nitrification capacities cited, the following list of "additional needs" has been developed for the Theresa Street and Northeast WWTFs. The Lincoln wastewater staff was instrumental in developing this list.

Theresa Street WWTF.

- Preliminary Treatment Improvements
  - South raw wastewater pumping station

- North raw wastewater pumping station
- Grit handling facilities

- Cogeneration facility improvements
- Anaerobic Digester complex improvements
  - Additional digester
  - Gas equalization or storage facility
  - Replace sludge valves on heating loop
  - Replace gas mixers/compressors
- West Side process improvements
  - Primary sludge pump replacement
  - Replace RAS pumps
  - New blowers
  - Secondary clarifier improvements
- East Side process improvements
  - Primary sludge pump replacement
  - Aeration system improvements
  - Secondary clarifier improvements
- DAF improvements
- Dewatering system improvements
- Maintenance shop rehabilitation
- Electrical improvements
- Collection system shop improvements
- Splitter structure improvements
- Administration building improvements
- Liquid waste handling facility improvements
- General system improvements
  - Wet weather flow facilities
  - Side-stream flow equalization
  - Hydraulic capacity improvements
- General plant/site improvements
  - Replace potable water distribution system
  - On-line process control instrumentation facilities
  - Plant site flood protection
  - Outside lighting improvements
  - Pavement rehabilitation
  - Gas line service replacements

Northeast WWTF.

- Upgrade operations control center
- Replace raw wastewater pumps 1, 2, and 3
- Improve grit removal facilities

- Primary Sludge Pumping Building & Clarifiers
  - Replace clarifier sludge collector assemblies in a 5-10 year period
  - Replace weirs
  - Scum pits need rehab due to corrosion.
- Refurbish biotowers
- Secondary clarifier improvements
- Maintenance shop improvements
- Sludge handling system improvements
  - Digester improvements
  - Sludge utilization system improvements
- General system improvements
  - Wet weather flow facilities
  - Sludge storage return flow equalization
- General plant/site improvements
  - Replace outside facility lighting – needs new conduit & circuit
  - Repair and replace sidewalks and roads as required
  - Upgrade entrance gate structure

The capital improvement program should incorporate these needs.

Treatment Facility Capacity Summary

When discussing the capacity of a treatment plant, it is important it be clear on the basis of the capacity being discussed. The discussion should indicate whether hydraulic or process capacity is involved and, when process capacity is being discussed, the influent quality, effluent limitations, and other key factors should be identified. Table 4-12 summarizes hydraulic and process or "Nitrification" capacities at each treatment facility.

Table 4-12. Nitrification Capacity Summary – Existing Lincoln Wastewater Treatment Facilities

Facility	Hydraulic Capacity*	Nitrification Capacity**
Theresa Street WWTF	36 mgd	14.4 mgd
Northeast WWTF	37 mgd***	4.4 mgd

* The hydraulic capacity indicated represents the most hydraulically limiting segment of the treatment facility. For the Theresa Street facility the most limiting segments are the disinfection and outfall segments. For the Northeast facility the most limiting segments are the aeration basins and the chlorine contact basin.
** The nitrification capacity of both facilities is limited by the combination of aeration basin size and clarifier sizes.
*** High flows experienced in 1993 indicate that Northeast WWTF hydraulic capacity is significantly less than 27 mgd. Further research should be conducted to identify hydraulic limitations experienced in 1993.

The rated capacity of a treatment plant is generally accepted as being the capacity of the most limiting hydraulic or process component within the system. The limiting component is the component with the lowest capacity rating.

As discussed previously in this chapter, the hydraulic capacity of the Theresa Street WWTF is limited by the capacity of chlorine contact basin and adjacent facilities. The limiting process at both Lincoln treatment plants is the nitrification process. As indicated in Table 4-12, the Theresa Street WWTF has an overall capacity of 14.4 mgd based only on the capacity of the East and West Side activated sludge systems. The Northeast WWTF capacity is also limited by the biological process and is rated at 4.4 mgd. In both cases, the capacities are based on the need to meet anticipated effluent ammonia limits during spring time weather conditions.