
EXISTING WASTEWATER TREATMENT FACILITIES

5.1 THERESA STREET WWTF

5.1.1 Overview

The Theresa Street WWTF is the larger of the two wastewater treatment facilities owned and operated by the City. This WWTF is located at 2400 Theresa Street. The site is bordered by Salt Creek to the north, Nebraska State Fair property to the west and south, and residential property to the east. The 100-year floodplain elevation around the facility varies from near 1148 to 1149 feet above mean sea level (MSL). Nearly all structures in the treatment process have a top of wall elevation greater than the 100-year flood level to allow treatment during flood conditions at Salt Creek.

The original treatment facilities were constructed in 1923 and consisted of influent pumps, imhoff tanks, fixed nozzle trickling filters, secondary clarifiers, and sludge drying beds. A 1940's upgrade included primary clarifiers and additional trickling filters. Major improvements were made with the construction of a 10 mgd activated sludge process in 1973, and with the recently completed Nitrification Improvements Project which results in the current 27 mgd facility.

Since the addition of activated sludge treatment, there have been several other improvements that have increased the capacity of the treatment facility. The current configuration of the Theresa Street WWTF consists of preliminary, primary, and secondary treatment, followed by disinfection. The liquid process schematic for the current configuration is shown in Figure 5.1, and the hydraulic profile is shown in Figure 5.2. The hydraulic modeling calculations and description of the results are located in Appendix M. The solids generated at the facility are anaerobically digested and dewatered. The dewatered biosolids are then trucked to agricultural lands within Lancaster County for disposal. A schematic of the solids handling process is shown in Figure 5.3. Current aerial photographs of the facility are shown in Figures 5.4 and 5.5. An overview of the treatment facility processes is outlined below.

The current rated treatment capacity for the Theresa Street WWTF is shown in Table 5.1 below. A more detailed unit process design summary is located in Appendix E.

Current staffing for the Theresa Street WWTF and Northeast WWTF includes approximately 41 employees. These positions include administration, maintenance staff, treatment operators, laboratory staff, technicians, and control/instrumentation staff. The Theresa Street WWTF currently has seven fulltime certified Grade IV wastewater treatment operators that operate the facility 24 hours per day, seven days a week. The facility operators rotate on three 8-hour shifts per day. Figure 2.1 in Section 2 shows the organization chart for the Theresa Street WWTF.

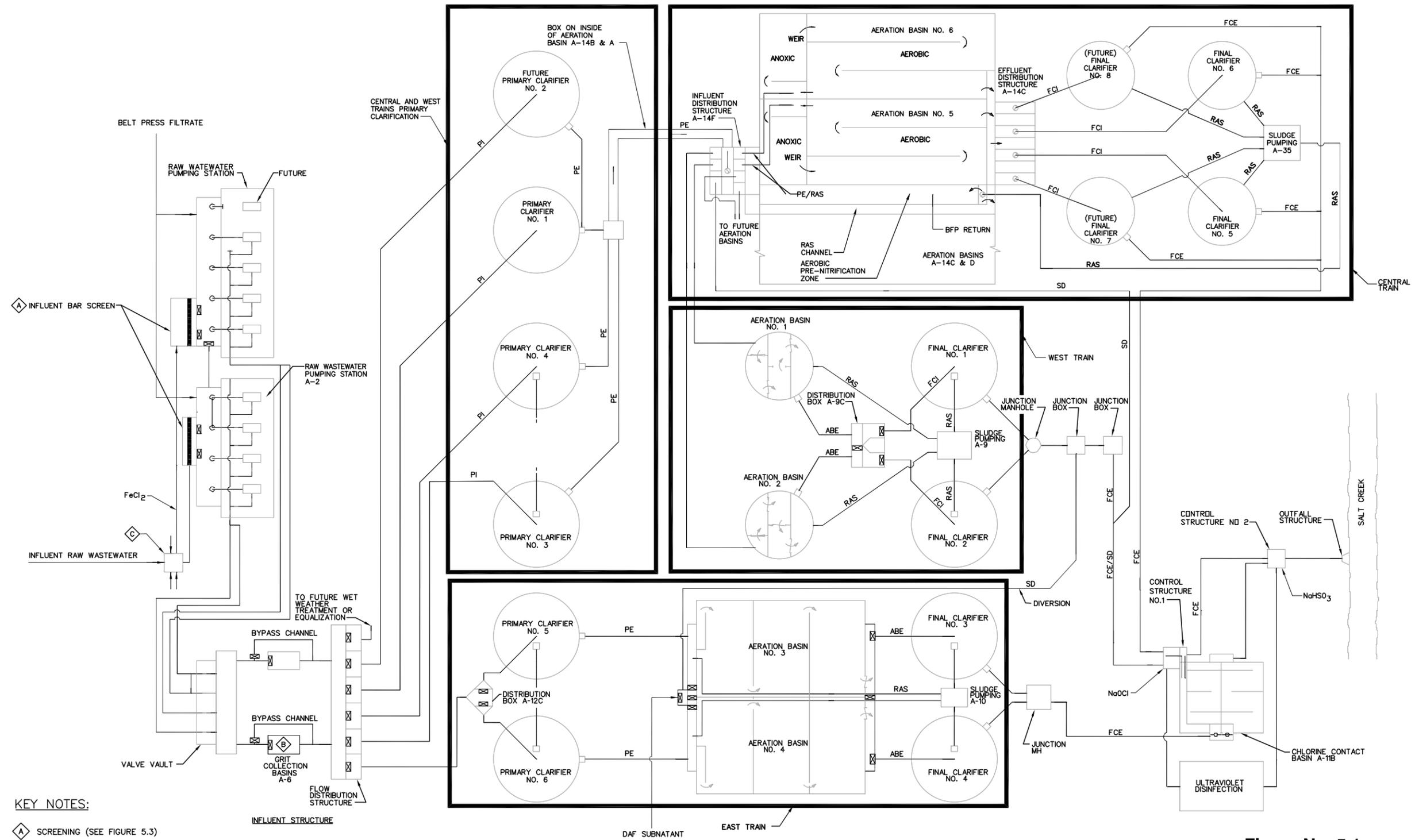


Figure No. 5.1
THERESA STREET WWTF LIQUID PROCESS FLOW DIAGRAM
WASTEWATER FACILITIES MASTER PLAN UPDATE - 2007
CITY OF LINCOLN, NEBRASKA



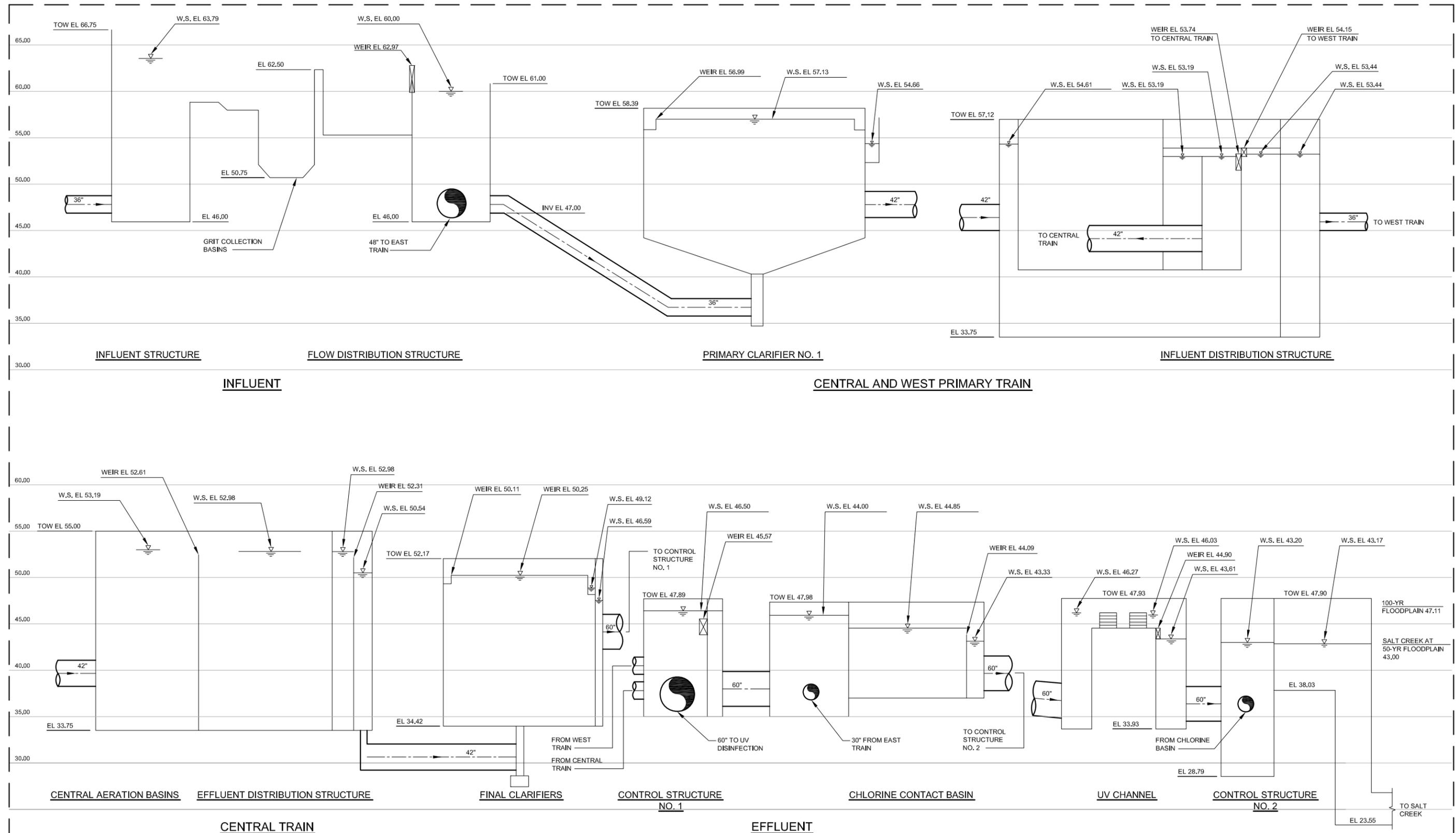


Figure No. 5.2A
TERESA STREET WWTW HYDRAULIC PROFILE CENTRAL TRAIN
WASTEWATER FACILITIES MASTER PLAN UPDATE - 2007
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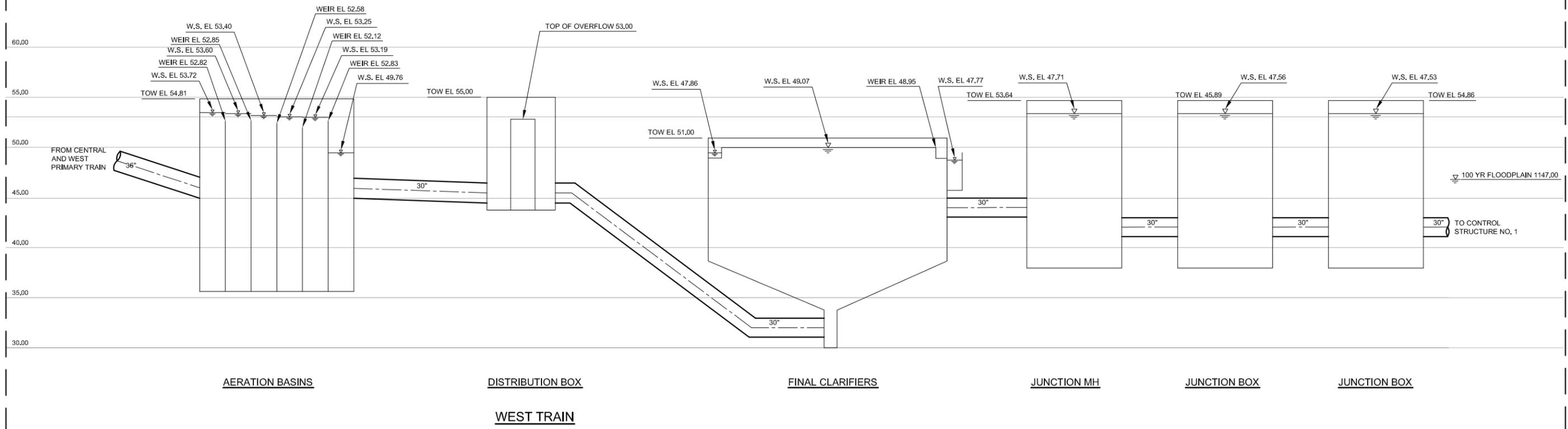
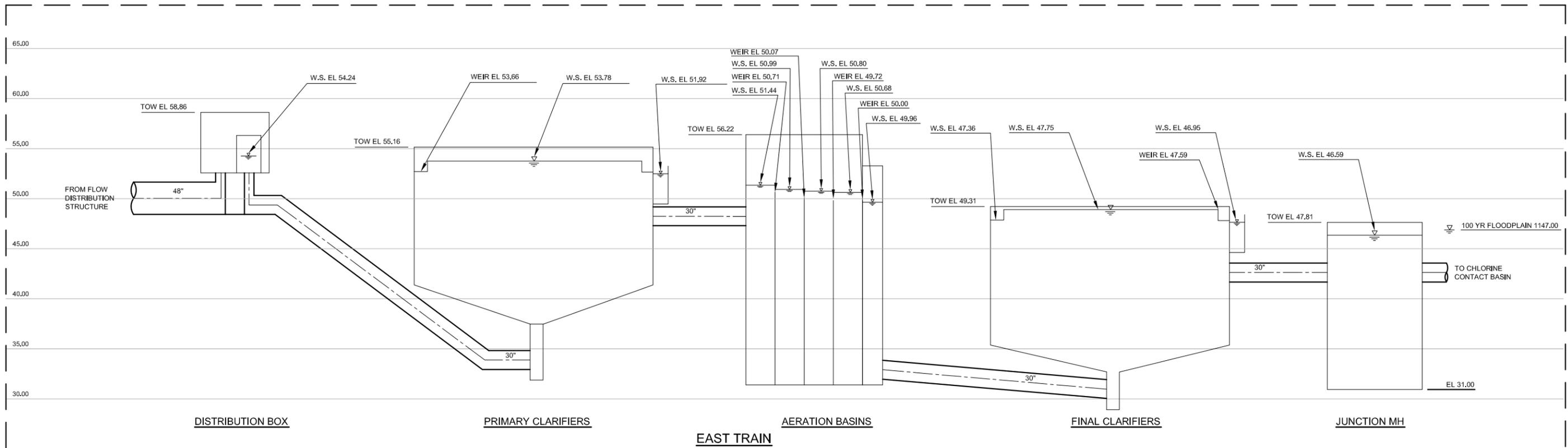


Figure No. 5.2B
THERESA STREET WWTW HYDRAULIC PROFILE EAST AND WEST TRAIN
WASTEWATER FACILITIES MASTER PLAN UPDATE - 2007
 CITY OF LINCOLN, NEBRASKA



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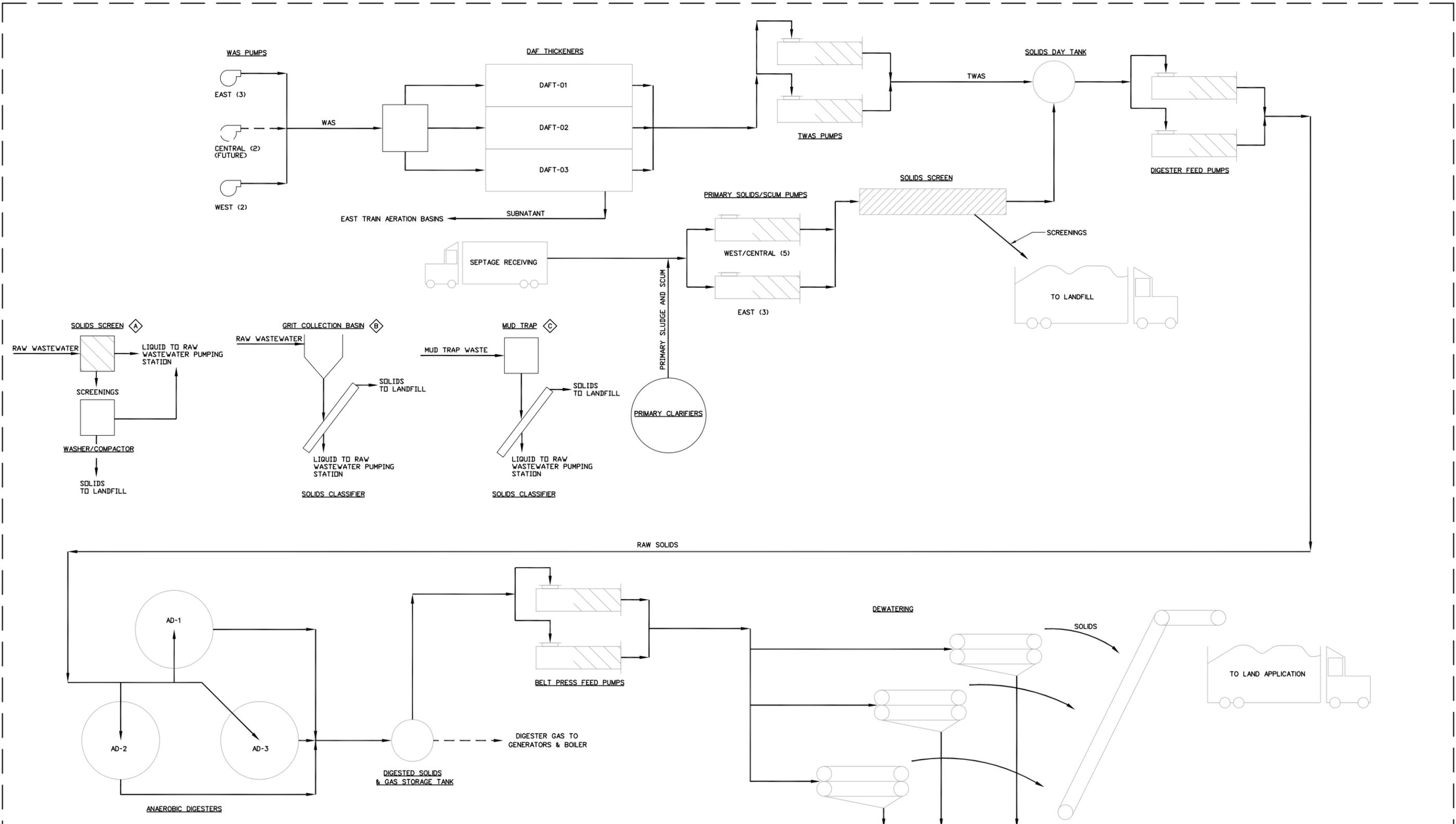


Figure No. 5.3
THERESA STREET WWTF SOLIDS PROCESS SCHEMATIC
WASTEWATER FACILITIES MASTER PLAN UPDATE - 2007
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1. Influent Pump Station / Headworks
2. Grit Removal Facilities
3. Primary Clarifiers
4. Recirculation Pump Station
5. Aeration Blower Building – Central Train
6. Pre-nitrification Basin
7. Aeration Basins
8. Final Clarifiers
9. Pre-Nitrification Basin
10. Solids Dewatering Building
11. Sludge Pumping Stations
12. Future Aeration Basins
13. Odor Control Facilities
14. Ultraviolet Disinfection Facilities
15. Chlorine Contact Basin
16. Digesters
17. Sludge Storage

18. Aeration/Solids Thickening Building
19. Scum Pump Building
20. Divisional/Administration Building
21. Main Electrical Switchgear Building
22. Collection System Operations and Maintenance Building
23. Electric Co-generation Building
24. Effluent Discharge Structure
25. Laboratory Building
26. Treatment Facility Maintenance Building
27. Liquid Waste / Grit Receiving Station
28. Liquid Waste / Septage Receiving Station



Figure 5.5
 Theresa Street WTF Aerial Photo (Oct. 12, 2006)
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska

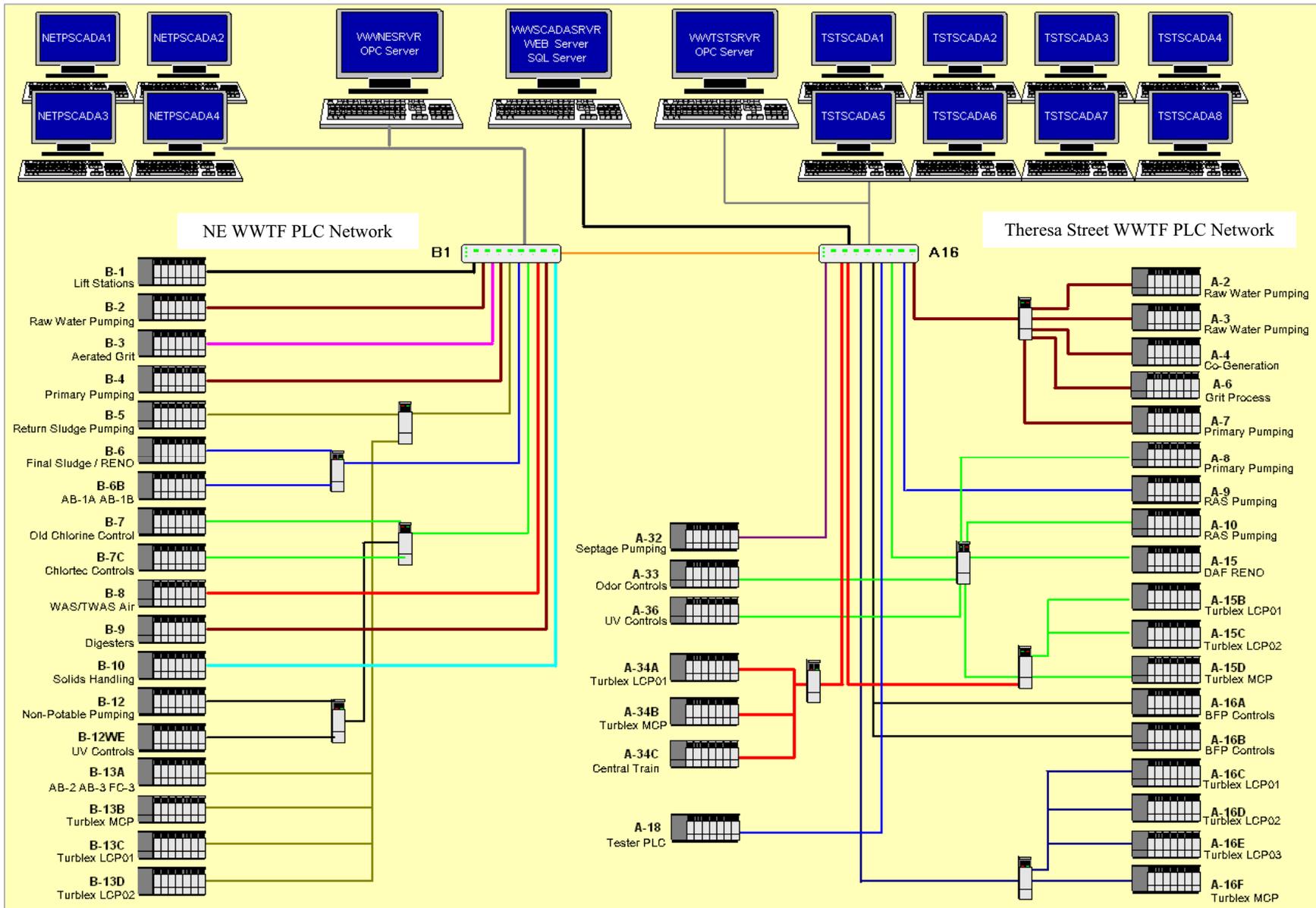
Table 5.1 Rated Capacity of the Theresa Street WWTF Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska				
Parameter	Units	AAD	MMAD	PHF
Flow ⁽¹⁾	mgd	24 ⁽⁵⁾	27.4 ⁽⁵⁾	87.0
Flow ⁽²⁾				68.2
Flow ⁽³⁾				65.0
BOD ₅	mg/l	260	329	N/A
	lbs/day	52,040 ⁽⁵⁾	74,080 ⁽⁵⁾	N/A
COD	mg/l	555	694	N/A
	lbs/day	111,088	156,275	N/A
NH ₃ ⁽⁴⁾	mg/l	23	30	N/A
	lbs/day	4,604	6,755	N/A
TKN ⁽⁴⁾	mg/l	40	50	N/A
	lbs/day	8,010 ⁽⁵⁾	11,260 ⁽⁵⁾	N/A
TSS	mg/l	270	333	N/A
	lbs/day	54,040 ⁽⁵⁾	74,990 ⁽⁵⁾	N/A

Notes:

1. Based on Influent firm pumping capacity.
2. Based on Secondary Clarifier Overflow Rates of 1,000 gpd/ft², with all six secondary clarifiers in service.
3. Based on Hydraulic Capacity (See Appendix M)
4. Does not include loadings from DAF subnatant to the East Train.
5. Certification of Wastewater Treatment Facility Capacities, City of Lincoln, Nov. 21, 2006

Many improvements to the Theresa Street WWTF SCADA control system have been completed in the past. The current system uses fiber optic connections between the Theresa Street WWTF and Northeast WWTF to monitor treatment processes and allow for changes to operations as needed. Both treatment facilities are converting the SCADA programming software to Iconics by Genesis. The new SCADA software will provide several improvements to the operations and control of the facilities including trending of process performance, data management, and daily summary printouts. A schematic of the SCADA control system for Theresa Street WWTF is shown in Figure 5.6.

In addition to the SCADA system, the City has used a computerized maintenance management system (MMS) database for approximately ten years to track and assign work orders for equipment maintenance at the facilities.



Notes:

NETP = Northeast WWTF

TST = Theresa Street WWTF

PLC = Programmable Logic Controller

*Image is from screenshot of SCADA control system monitoring station.



Figure 5.6
Treatment Facilities SCADA System Diagram
Wastewater Facilities Master Plan Update - 2007
City of Lincoln, Nebraska

This includes preventative maintenance scheduling, equipment checklists, and the ability to add additional information for each piece of equipment such as repair/replacement history, maintenance logs, and photographs. The MMS has been effective for efficient scheduling and reporting of equipment maintenance.

5.1.2 Liquid Treatment

Preliminary treatment consists of influent pumping, screening, and grit removal. The removed screenings and grit are hauled to the landfill for disposal. The firm influent pumping capacity is 87 mgd with the largest pump out of service and the total pumping capacity is 109 mgd with all pumps operating. There are three influent pumps rated at 10 mgd, one pump rated at 12 mgd, three pumps rated at 15 mgd, and one pump rated at 22 mgd. The current capacity of the grit handling facilities is 100 mgd.

Primary treatment consists of five primary clarifiers, two serving the east secondary treatment train, and three that serve the central and west secondary treatment trains. Each clarifier has sludge and scum equipment. The clarifiers range in size from 100 to 125 feet in diameter.

Secondary treatment consists of activated sludge process designed for BOD oxidation and nitrification. The secondary treatment process at this facility consists of three treatment trains. The capacity of each train is outlined in Table 5.2 below.

Table 5.2 Theresa Street WWTF Secondary Treatment Summary Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska			
Train	Rated MMAD Capacity	Number of Aeration Basins	Number of Clarifiers
East	10 mgd	2	2
Central	13 mgd	2	2
West	4.4 mgd	2	2
Total MMAD Capacity	27.4 mgd	N/A	N/A

The primary method of disinfection at the Theresa Street WWTF is provided by UV disinfection. The UV disinfection system is designed for a peak flow of 56 mgd. Flows above 56 mgd can be disinfected using the liquid sodium hypochlorite system that is also used for odor control. The chlorine system can also be used to provide redundancy and reliability in the event that the UV system is off line.

5.1.3 Biosolids Treatment

The solids generated at the Theresa Street Wastewater Treatment Facility are from three separate sources in the WWTF.

1. Primary thickening and surface scum from the primary clarifiers.
2. Waste activated sludge, scum, and aeration basin foam and scum from the final clarifiers.
3. Solids from the Septage Receiving Station.

The primary sludge and septage is screened using a Parkson Sieve Press prior to being mixed with the thickened waste activated sludge. The waste activated sludge (WAS) is thickened from 0.5 percent to 1.0 percent solids using the dissolved air flotation process to 4 percent to 5 percent solids. The thickened WAS, primary sludge, and septage is then pumped to a 6000-gallon solids equalization tank prior to being pumped to three egg-shaped anaerobic digesters that are operating in the mesophilic temperature range in parallel operation.

The digester bio-gas generated by the anaerobic digestion process is used for heating of the digesters and to produce electricity. The electricity is produced in two Waukesha internal combustion engines that drive two 450-kilowatt generators. The waste heat from the engines is used to heat the digesters, digester facility building, and co-generation building. The electricity that is produced averages 440,000 kw-hrs/month and supplements the power provided by Lincoln Electric System local electric utility. This electrical generation provides approximately 40 to 60-percent of the Theresa Street facility electrical needs and reduces overall operating costs.

Following the 18 to 20 day detention time in the digesters, overflow from the digesters goes to a 500,000-gallon sludge storage tank. The resultant digested biosolids are dewatered by three, two-meter belt filter presses to a solids content ranging from 15 to 22 percent. The belt presses operate approximately 45 to 50 hours per week generating approximately 1,100 cubic yards of dewatered digested sludge or biosolids per week.

The dewatered biosolids generated by the belt presses are loaded into 32-yard transport trailers and then transported to agricultural ground located in Lancaster County as part of the Land Application Program. The Land Application Program is a partnership between the City of Lincoln and the University of Nebraska Cooperative Extension in Lancaster County. This partnership began in 1992 just after the egg-shaped anaerobic digesters came into operation. Prior to 1992, raw solids were hauled to the sanitary landfill.

County Extension manages the distribution of biosolids to the participants and determines the appropriate cropland loading rates, maps and records applications using GIS software, and educates local farmers on the benefits of biosolids usage. Typically, there are 20 to 25 farmers participating in the program.

If weather conditions prevent hauling biosolids to the field, the biosolids are hauled to the Bluff Road Sanitary Landfill to a dedicated holding facility where biosolids can be stored until field conditions improve. At the present time, the Land Application Program only includes the Theresa Street facility.

Table 5.3 shows the annual volumes for biosolids applied on cropland for the Land Application Program.

Table 5.3 Theresa Street WWTF Annual Biosolids Land Application Volumes Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska	
Year	Biosolids Volume (cy)
2000	33,555
2001	40,992
2002	42,752
2003	49,488
2004	60,149
2005	52,867
2006	60,253

The biosolids program has been very successful. The participants are realizing the benefits of using the biosolids and there have been very few complaints from surrounding neighbors.

5.1.4 Odor Control

The Theresa Street WWTF has recently completed an odor control project for the East Treatment Train. The City's current program is to identify sources of odors, contain and scrub them prior to discharge. To further eliminate odors, the City has recently authorized an Odor Abatement Study by Huber, a copy of which is located in Appendix L. The recommendations of this report are currently being incorporated into the CIP program for future implementation.

5.1.5 Recently Completed Improvements

Since the last Master Plan Update in 2003, the following projects that were identified have been completed at the Theresa Street WWTF.

1. Raw wastewater increased pumping capacity improvements.
2. Replacement of two influent bar screens and screenings dewatering and handling improvements.
3. Vortex grit removal and handling improvements.
4. UV effluent disinfection improvements - UV and liquid sodium hypochlorite system.
5. Odor control improvements for the east treatment train.
6. Replacement of West treatment train aeration blowers.

7. East treatment train process and fine bubble aeration system improvements.
8. Central train nitrification improvements project (currently under construction).
9. Addition of redundant electrical substation improvements and other miscellaneous electrical improvements.

5.1.6 Historical Influent Flows

Historical influent annual average daily (AAD) flows to the Theresa Street WWTF from 1980 through 2006 are shown in Figure 5.7. Table 5.4 and Figure 5.8 show the influent flows to the Theresa Street WWTF from 2000 to 2006. The flows shown represent the annual averages for the annual average daily flow (AAD), maximum monthly average day flow (MMAD), and peak daily flow (PDF). Ratios of MMAD:AAD and PDF:AAD are provided to show the changes in average and peak flows on a daily basis and to be used for future capacity evaluation. The maximum annual peak flow and the maximum PDF:AAD ratio is also provided to show the variability in peak flows throughout the year.

Year	AAD (mgd)	MMAD (mgd)	Avg. year PDF (mgd)	Max. Day PDF (mgd)	MMAD:AAD Ratio	Avg PDF:AAD Ratio	Max. PDF:AAD Ratio
2000	16.8	18.6	30.3	80.0	-	-	-
2001	19.3	22.5	34.9	61.5	-	-	-
2002	20.0	23.2	36.7	64.6	1.16	1.84	3.23
2003	18.8	21.7	36.2	57.2	1.15	1.92	3.04
2004	19.5	22.4	31.0	64.3	1.15	1.59	3.29
2005	18.6	21.7	30.2	51.7	1.16	1.62	2.78
2006	19.1	21.2	30.6	49.4	1.11	1.61	2.59
Avg.	18.9	22.4	32.8	61.2	1.16	1.71	2.99

The average MMAD:AAD ratio at the Theresa Street WWTF for this time frame is 1.16. AAD has been relatively consistent throughout this period. The average of the daily peak flows indicates the high point in the diurnal curve that the WWTF treats on a daily basis. The average yearly PDF:AAD ratio is 1.71. The maximum PDF for each year is used to estimate the peak flows that the WWTF has to accommodate. This is an important factor to consider with respect to hydraulic design of structures, pipes, and pumps. The max PDF:AAD ratio is used to estimate the daily peak flows. The PDF:AAD ratio varied from 3.23 to 2.59 with an average of 2.99 over this time period.

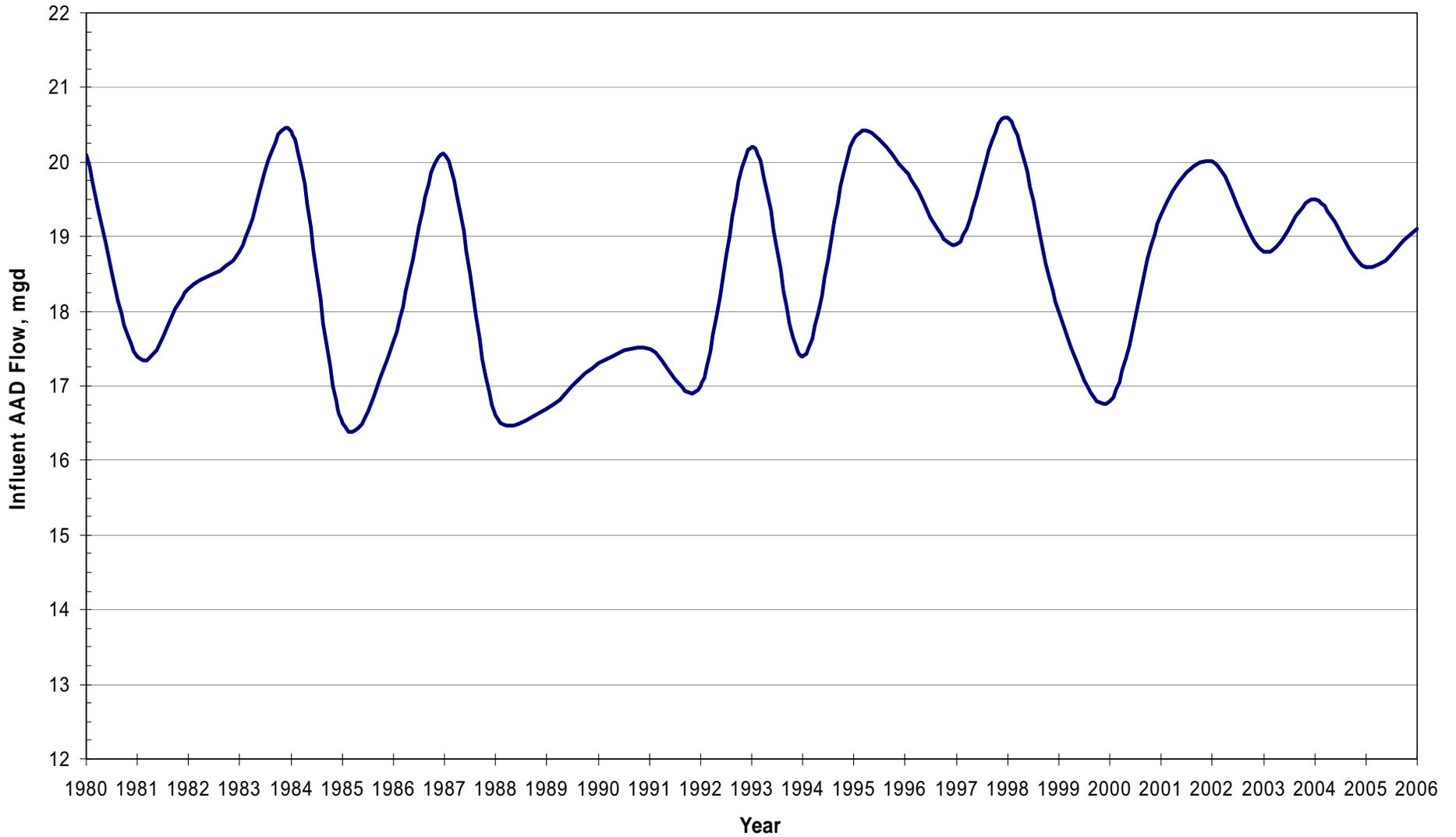


Figure 5.7

Theresa Street WWTF Historical Influent Flows
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska



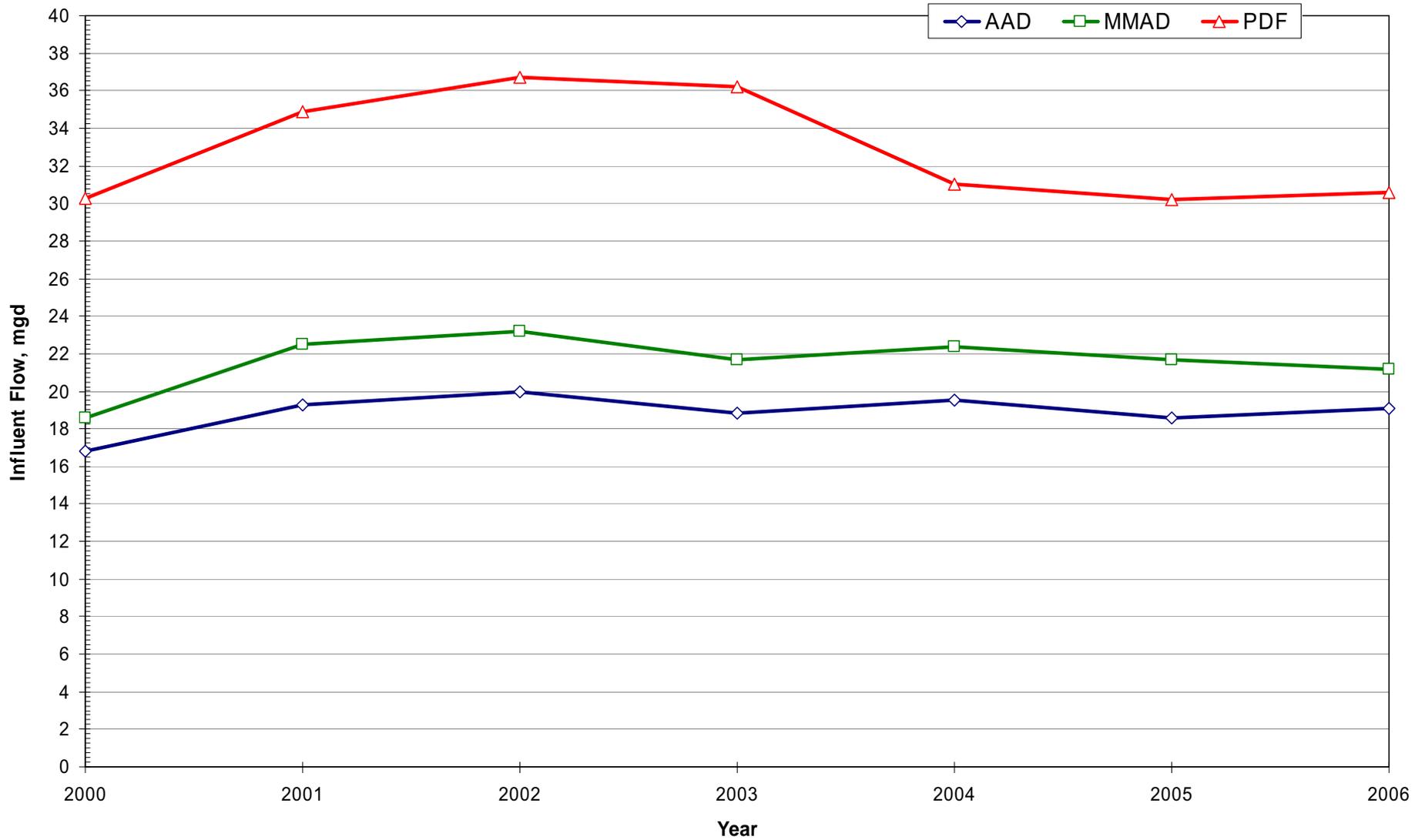


Figure 5.8

Theresa Street WWTF Influent Flow Comparison
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska

Oak Creek, Lynn Creek, Salt Creek system, Little Salt, and East Campus basins discharge to the Theresa Street WWTF. Computer modeling of these basins was used to determine peak hour flows (PHF) at the treatment facility. The current modeled PHF at the treatment facility is 93.7-mgd (144.9-cfs). This results in a PHF:MMAD ratio of 4.46 and a PHF:AAD ratio of 4.90 for the current flows at the treatment facility. The PHF:AAD ratio of 4.90 matches well with the peak to average flow ratio of 5 used in the City's flow equation.

5.1.7 Historical Influent Quality

Influent loading to the Theresa Street WWTF is shown in Table 5.5 and Figure 5.9. The AAD and MMAD concentration values for the influent BOD₅, COD, and TSS are shown for years 2000 to 2006 and CBOD values are provided for years 2004 to 2006. It should be noted that these values compare extremely well with the design criteria outlined in Table 5.1 above. In addition to the concentrations, the influent mass loadings are shown in Table 5.6 and shown graphically in Figure 5.10.

Year	BOD (mg/l)		CBOD (mg/l)		COD (mg/l)		TSS (mg/l)		TKN (mg/l)	
	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD
2000	235	271	-	-	517	619	251	284	42	48
2001	231	273	-	-	528	593	286	326	42	49
2002	270	312	-	-	564	616	276	317	43	48
2003	286	320	-	-	612	685	304	339	47	52
2004	281	324	244	284	574	646	299	336	48	54
2005	289	330	271	311	563	646	275	337	51	57
2006	256	281	223	250	517	563	232	256	51	54
AAD/MMAD	264	330	246	311	553	685	275	339	46	57
Notes:										
1. AAD = Annual average day from City daily records.										
2. MMAD = Maximum month average day from City daily records.										

Table 5.6 Theresa Street WWTF Average Influent Mass Loading Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska										
Year	BOD (lbs/day)		CBOD (lbs/day)		COD (lbs/day)		TSS (lbs/day)		TKN (lbs/day)	
	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD
2000	32,926	42,039	-	-	-	-	-	-	-	-
2001	37,182	51,228	-	-	-	-	-	-	-	-
2002	45,036	60,368	-	-	94,075	119,189	46,037	61,336	7,172	9,287
2003	44,843	57,913	-	-	95,957	123,970	47,665	61,352	7,369	9,411
2004	45,699	60,528	39,682	53,056	93,350	120,683	48,626	62,770	7,806	10,088
2005	44,831	59,723	42,039	56,284	87,335	116,912	42,659	60,990	7,911	10,316
2006	40,779	49,683	35,523	44,202	82,355	99,543	36,956	45,263	8,124	9,548
AAD/MMAD	41,614	60,528	39,081	56,284	90,614	123,970	44,389	62,770	7,677	10,316
Notes: 1. AAD = Annual average day from City daily records. 2. MMAD = Maximum month average day from City daily records.										

5.1.8 Treatment Facility Performance

The average effluent concentrations of BOD₅, CBOD, COD, TSS, and ammonia (NH₃-N) are shown in Table 5.7 and Figure 5.11 and reflect the level of treatment being provided by the Theresa Street WWTF for the years 2000 to 2006. Table 5.8 reflects the pollutant removal being accomplished by the WWTF for the same period.

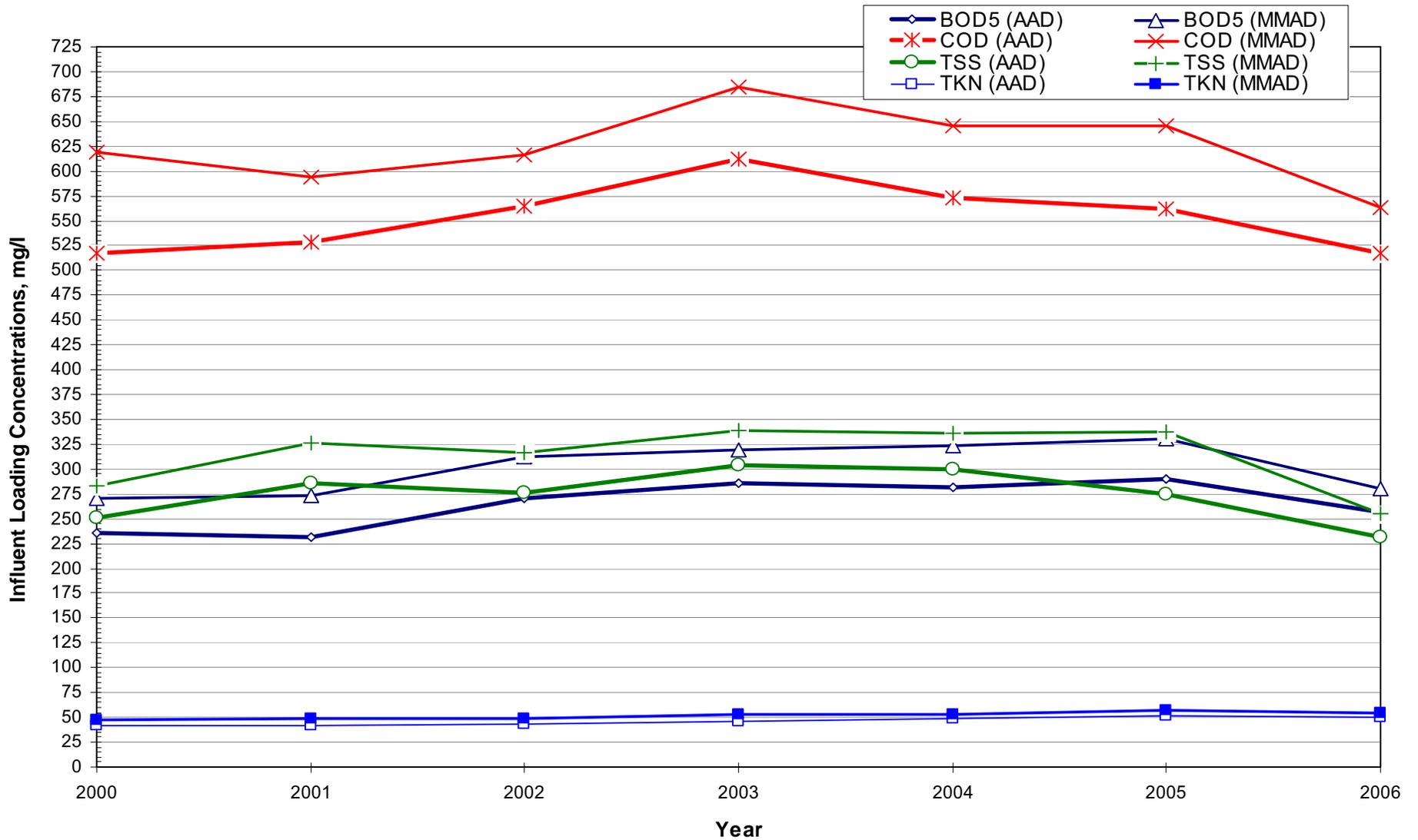


Figure 5.9
Theresa Street WWTF Influent Loading
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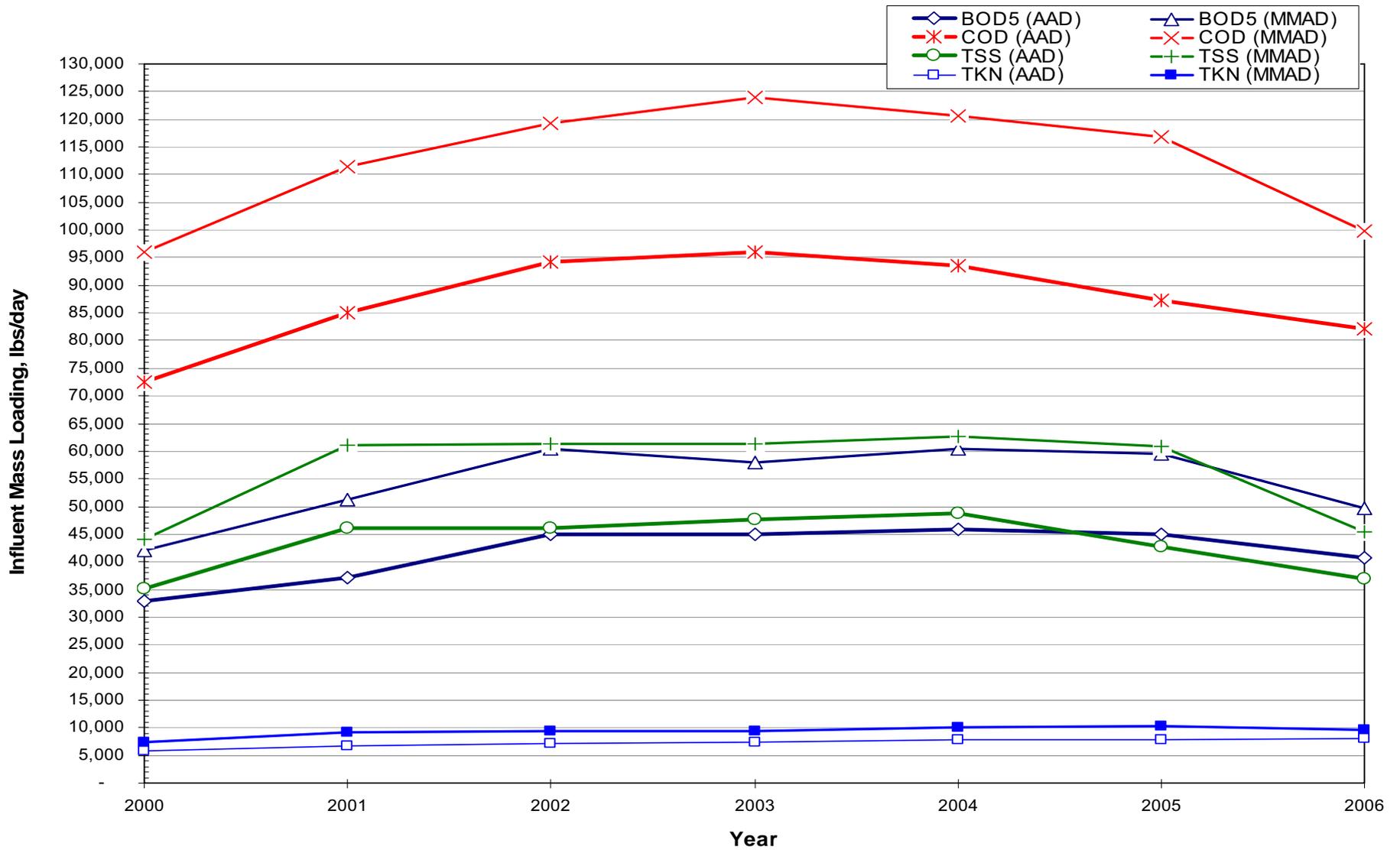


Figure 5.10

Theresa Street WWTF Influent Mass Loading
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska



5.1.9 Discharge Permit

The National Pollutant Discharge Elimination System (NPDES) effluent discharge permit for the Theresa Street WWTF is located in Appendix F. The permit limits require the Theresa Street WWTF to meet a monthly average CBOD of 25 mg/l and a monthly average TSS of 30 mg/l throughout the year. The current WWTF is meeting the permit requirements for CBOD and TSS.

The discharge limitations for NH₃ vary based on the time of the year and are divided into three separate seasonal requirements (spring, summer, and winter). The current permit limits from March 1 to May 31 require the monthly average NH₃-N to be 8.1 mg/l or less. For the period from June 1 to October 31, the monthly average NH₃-N limit is 2.9 mg/l. For the period from November 1 to February 28 (29), the monthly average NH₃-N limit is 8.1 mg/l. Currently, the Theresa Street WWTF is undergoing an expansion to provide full nitrification. The WWTF implemented nitrification treatment in the east and west trains in 2004. This is indicated by decrease in effluent NH₃-N values compared to the previous years as shown in Table 5.7. When the current expansion project is completed in 2007, it is envisioned that the Theresa Street WWTF will provide complete nitrification and meet the discharge limits.

The NPDES permit requires a seasonal limit of fecal coliform in the effluent from May 1 to September 30. The permit limits the monthly geometric mean of fecal coliform in the effluent sample to a maximum of 200 CFU per 100 ml with no more than 10-percent of monthly samples to exceed 400 CFU per 100 ml. Table 5.9 presents the effluent fecal coliform concentrations for years 2005 and 2006 at the Theresa Street WWTF. The current WWTF is meeting the fecal coliform requirements.

5.1.10 Future Capacity

The Theresa Street WWTF is designed for expansion from a MMAD treated flow of 27 mgd to a MMAD treated flow of 45 mgd. This is planned to be accomplished with a 13 mgd Central Train expansion and a 5 mgd East Train expansion. Future treatment facility expansion requirements and timing are discussed in more detail in Chapter 24.

Year	BOD₅ (mg/l)	CBOD (mg/l)	COD (mg/l)	TSS (mg/l)	NH₃-N (mg/l)
2000	23.3	-	68.1	17.5	19.4
2001	20.4	-	46.1	11.4	10.4
2002	21.9	-	55.4	15.4	16.6
2003	31.2	12.7	62.6	23.1	17.0
2004	26.5	8.6	47.5	18.5	11.9
2005	23.3	8.6	45.0	12.9	10.8
2006	24.6	6.5	41.0	10.4	8.4
Average	24.4	9.1	52.2	15.6	13.5

Notes:
1. AAD = Annual average day from City daily records.
2. MMAD = Maximum month average day from City daily records.

Year	BOD (%)	CBOD (%)	COD (%)	TSS (%)
2000	90.1	-	86.8	93.0
2001	91.2	-	91.3	96.0
2002	91.9	-	90.2	94.4
2003	89.1	-	89.8	92.4
2004	90.6	96.5	91.	93.8
2005	91.9	96.8	92.0	95.3
2006	90.4	97.1	92.1	95.5
Average	90.8	96.8	90.5	94.4

Notes:
1. The percent removal is based on annual average influent and effluent values.

Table 5.9 Theresa Street WWTF Effluent Fecal Coliform Concentrations ⁽¹⁾ Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska		
Month	Monthly Geometric Mean (CFU/100ml)	Percent of Monthly Samples > 400 CFU/100ml
May-05	7.3	3.4%
Jun-05	20.3	6.7%
Jul-05	10.1	3.2%
Aug-05	14.1	0.0%
Sep-05	16.8	3.3%
May-06	33.1	0.0%
Jun-06	156.9	3.3%
Jul-06	35.4	3.2%
Aug-06	19.8	3.2%
Sep-06	35.4	0.0%
Average	34.9	2.6%
Notes:		
1. Data provided by City for NPDES monitoring from May through September of 2005 and 2006.		

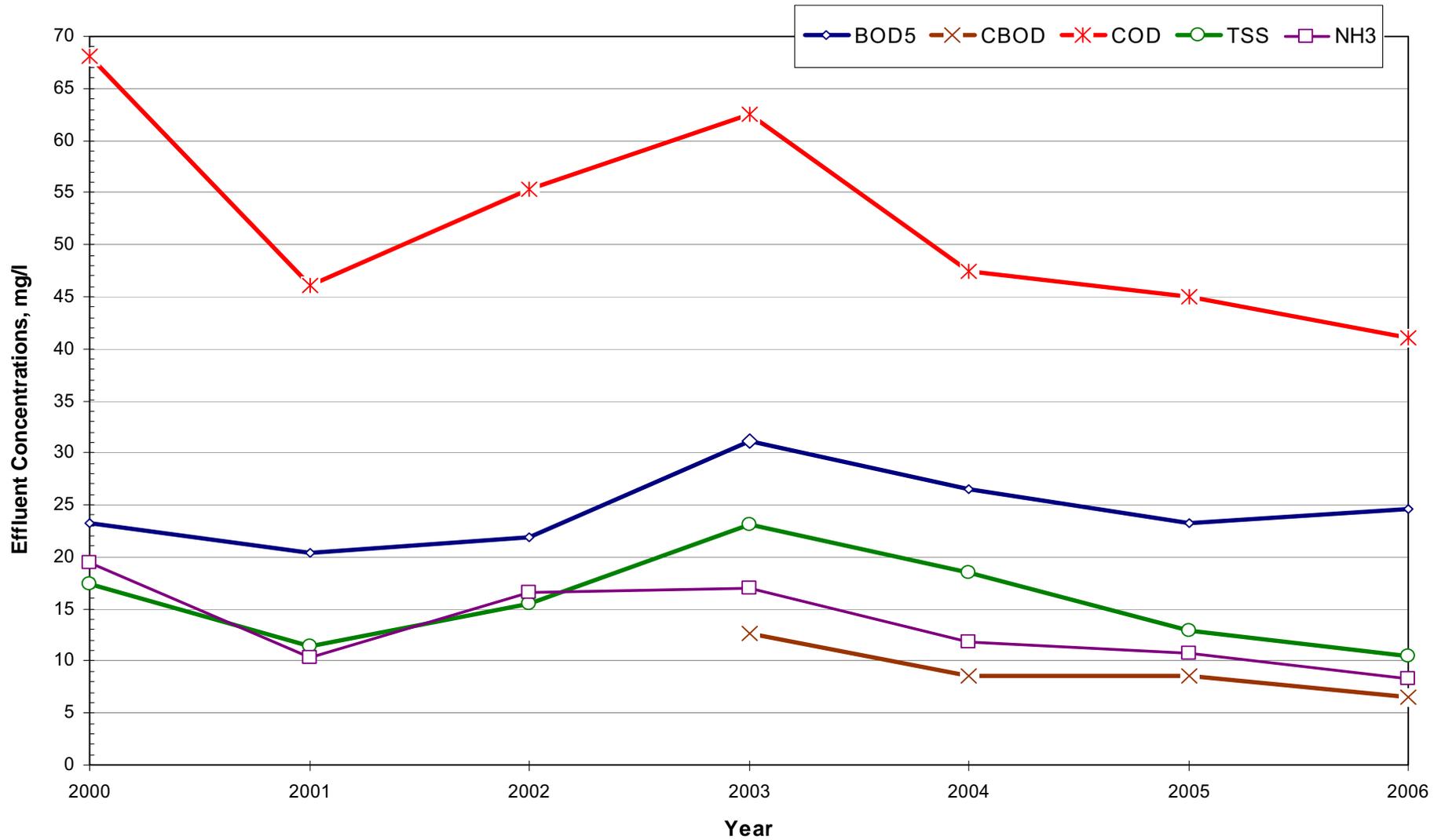


Figure 5.11
Theresa Street WWTF Effluent Concentrations
Wastewater Facilities Master Plan Update - 2007
City of Lincoln, Nebraska

5.2 NORTHEAST WWTF

5.2.1 Overview

The Northeast WWTF is the smaller of the two wastewater treatment facilities owned and operated by the City. The treatment facility is located at 7000 North 70th Street. The site is bordered by Salt Creek to the north, City of Lincoln property to the west and east, and private property to the south. Generally, the site is undeveloped and is readily usable for future expansion. The 100-year floodplain elevation is 1131.75 feet above mean sea level (MSL). Nearly all structures in the treatment process have a top of wall elevation greater than the 100-year flood level to allow treatment during flood conditions at Salt Creek.

The original treatment facilities were constructed in 1980 with a capacity of 8 mgd and included two treatment trains consisting of influent screening and pumping, aerated grit removal, primary clarification, trickling filters, aeration basins, final clarifiers, and chlorine disinfection. Effluent disinfection improvements consisting of ultraviolet light (UV) and liquid sodium hypochlorite disinfection facilities were completed in 2003 and are used to disinfect flows up to 16 mgd. Flows in excess of 16 mgd are disinfected by the liquid sodium hypochlorite system.

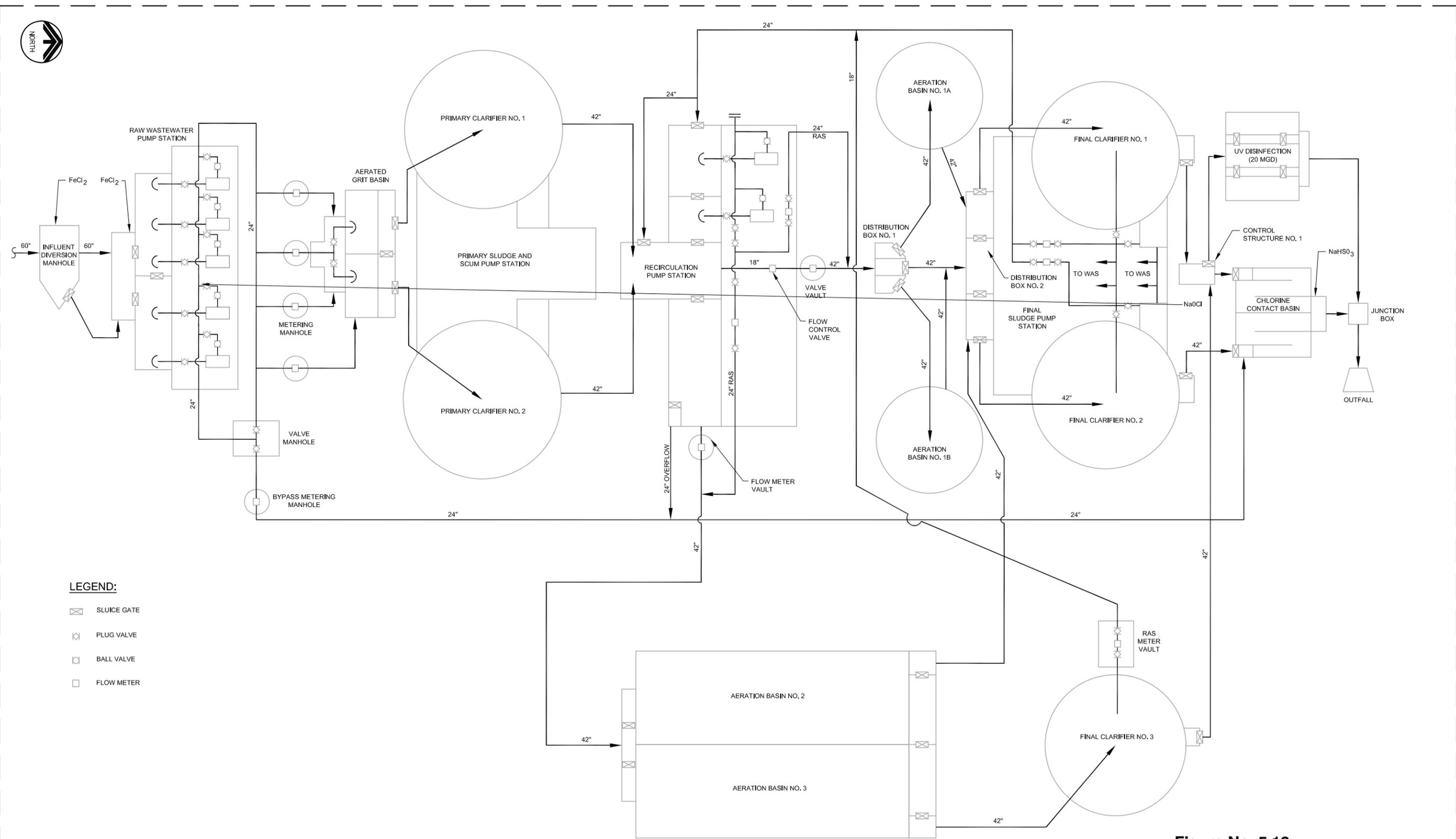
A treatment facility expansion in 2004 increased the maximum month treatment facility nitrification capacity to 10 mgd with the construction of a new treatment train, process upgrades, and modifications to the existing treatment system. The 2004 expansion included construction of two new aeration basins, new aeration blowers and building, and one new final clarifier. The original trickling filter towers were demolished at this time as well.

The liquid process schematic for the current configuration is shown in Figure 5.12, and the hydraulic profile is shown in Figure 5.13.

The solids generated at the facility are thickened, anaerobically digested, and transferred to a biosolids storage lagoon prior to subsurface injection. The City has approximately 440-acres for biosolids injection on property about 2 miles north of the Northeast WWTF. The locations of injection sites are shown in Figure 5.14. Excess liquid biosolids can be trucked to the Theresa Street WWTF for dewatering.

A schematic of the solids handling process is shown in Figure 5.15. Current aerial photographs of the facility are shown in Figure 5.16 and 5.17. An overview of the treatment facility processes is presented below. The current rated capacity for the Northeast WWTF is shown in Table 5.10, Appendix E provides detailed unit process capacities.

Current staffing for the Theresa Street WWTF and Northeast WWTF includes approximately 41 employees. These positions include administration, maintenance staff, treatment operators, laboratory staff, technicians, and control/instrumentation staff. The Northeast WWTF currently has one fulltime certified Grade IV wastewater treatment



LEGEND:

-  SLUICE GATE
-  PLUG VALVE
-  BALL VALVE
-  FLOW METER

Figure No. 5.12
NORTHEAST WWTf LIQUID PROCESS FLOW DIAGRAM
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CITY OF LINCOLN, NEBRASKA

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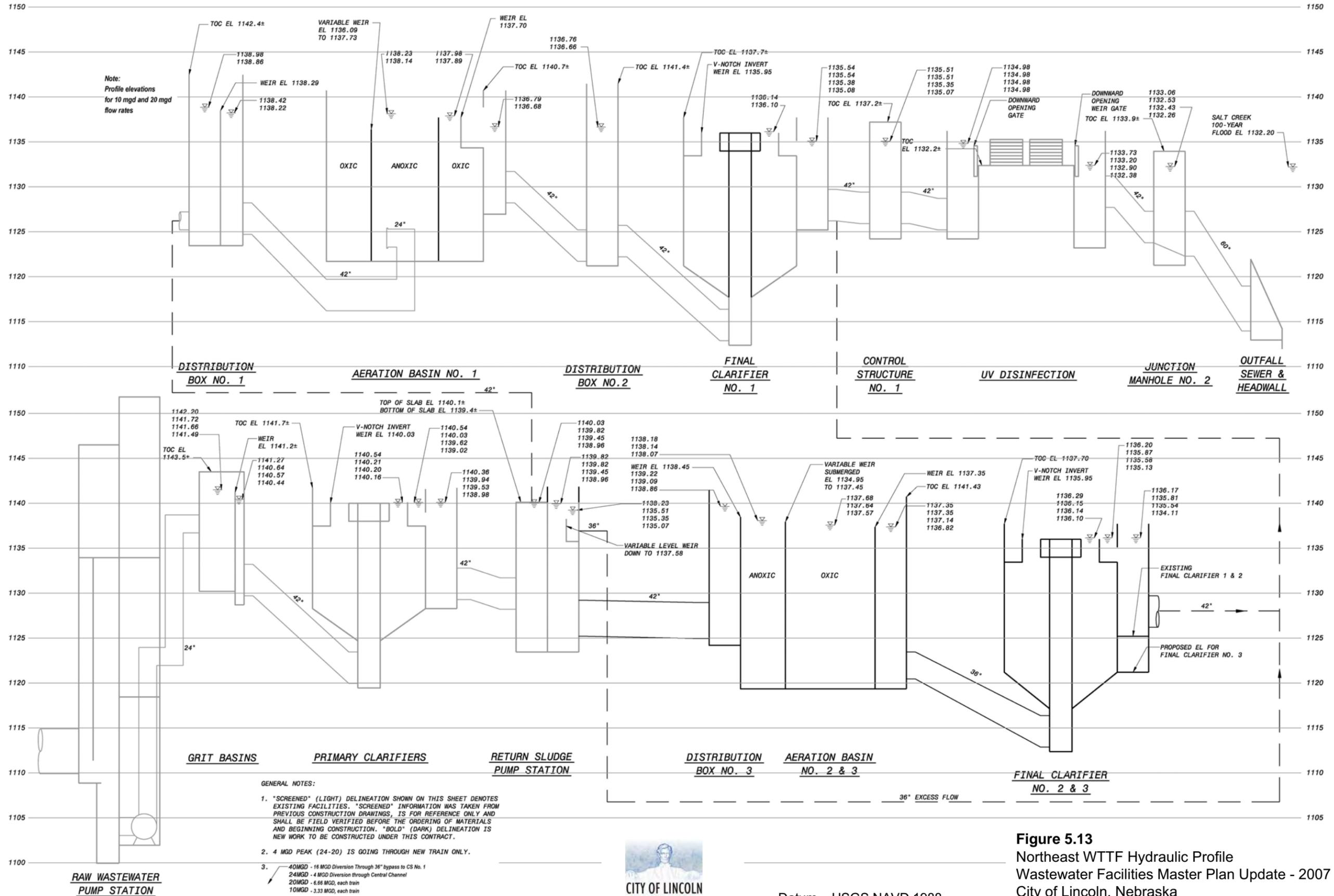
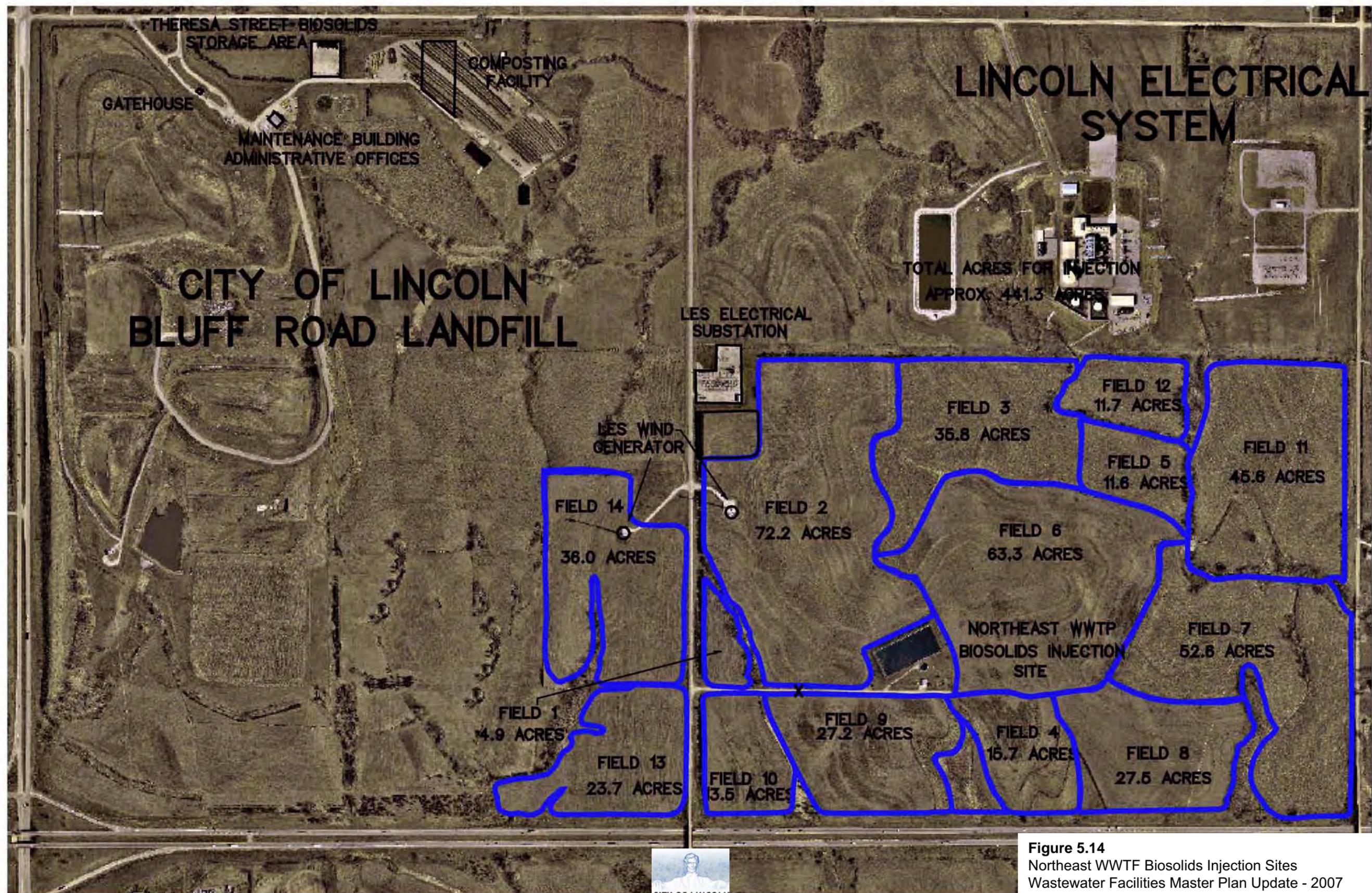


Figure 5.13
 Northeast WTTW Hydraulic Profile
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska



CITY OF LINCOLN
NEBRASKA

Figure 5.14
 Northeast WWTf Biosolids Injection Sites
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska

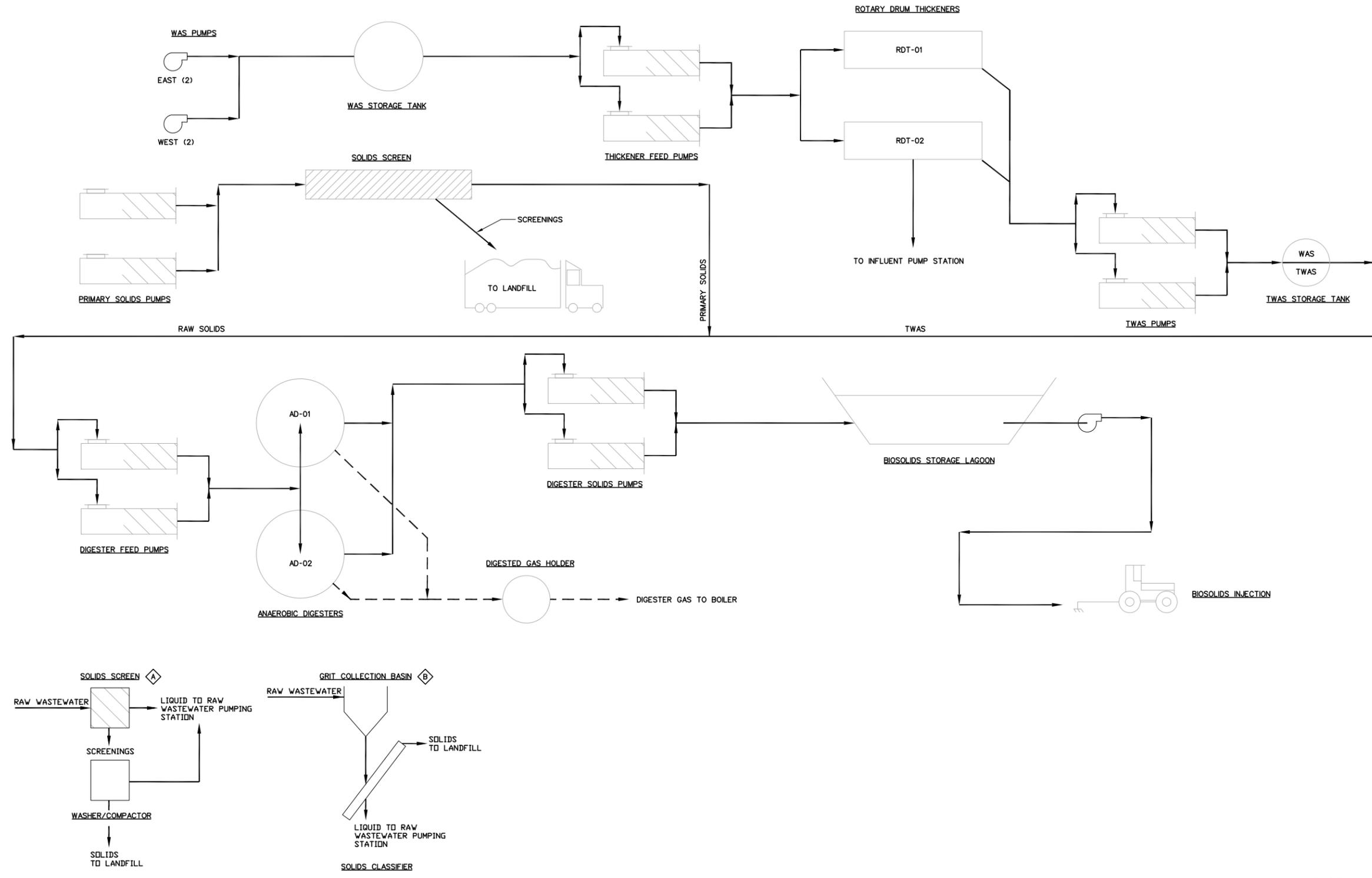


Figure No. 5.15
NORTHEAST WWTF SOLIDS PROCESS SCHEMATIC
WASTEWATER FACILITIES MASTER PLAN UPDATE - 2007
CITY OF LINCOLN, NEBRASKA



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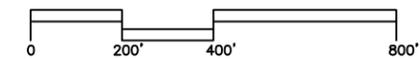


Figure No. 5.16
NORTHEAST WWTF AERIAL PHOTO
WASTEWATER FACILITIES MASTER PLAN UPDATE - 2007
CITY OF LINCOLN, NEBRASKA



1. Raw Water Pump Station / Headworks
2. Grit Basins
3. Primary Clarifiers
4. Recirculation Pump Station
5. Aeration Blower Building
6. Aeration Basins
7. Final Clarifiers
8. UV/Liquid Sodium Hypochlorite Disinfection Facilities
9. Chlorine Contact Basins
10. Solids Handling Building
11. WAS Storage
12. TWAS Storage
13. Primary Digester
14. Digester Control House
15. Secondary Digester
16. Gas Storage
17. Liquid Sodium Hypochlorite Building
18. Site Maintenance Building
19. Lincoln Electric System Treated Effluent Pumping Station
20. Control Building



Figure 5.17
 Northeast WTF Aerial Photo (Oct. 12, 2006)
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska



operator at the site each day. The treatment facility is staffed nine hours a day and is unstaffed and monitored with SCADA from the Theresa Street WWTF from 4:00PM to 7:00AM. Figure 2.1 in Section 2 shows the organization chart for the Northeast Street WWTF.

5.2.2 Liquid Treatment

Preliminary treatment consists of influent pumping, screening, and aerated grit removal. The removed screenings and grit are hauled by truck to the landfill for disposal. The firm influent pumping capacity is 34 mgd with the largest pump out of service and the total pumping capacity is 44 mgd with all pumps operating. There are three influent pumps rated at 8 mgd and two pumps rated at 10 mgd. The current average daily flow capacity of the grit handling facilities is 8 mgd.

Primary treatment consists of two primary clarifiers serving the two secondary treatment trains. Each clarifier has sludge and scum equipment. The clarifiers range in size from 100 to 125 feet in diameter.

Secondary treatment consists of activated sludge process designed for BOD oxidation and nitrification. The secondary treatment process at this facility consists of three treatment trains. The capacity of each train is outlined in Table 5.11 below.

UV disinfection facilities are used for most flows. The rated capacity of the UV disinfection facilities is 16 mgd. If flow through the treatment facility exceeds 16 mgd, the excess flow is disinfected with the liquid sodium hypochlorite system.

5.2.3 Odor Control

The NE WWTF is somewhat remote and there are no houses or businesses adjacent to the site. This is expected to change in the future, due in part to the recently constructed Stevens Creek Trunk Sewer Phase I project. Currently there is very odor control in place at this facility. The City is planning for future ongoing odor control projects as growth dictates.

Table 5.10 Rated Capacity of the Northeast WWTF Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska				
Parameter	Units	AAD	MMAD	PHF
Flow ⁽¹⁾	mgd	9.0 ⁽⁴⁾	10.0 ⁽⁴⁾	20.0
Flow ⁽²⁾				19.0
Flow ⁽³⁾				20.0 ⁽⁴⁾
BOD ₅	mg/l	183	200	N/A
	lbs/day	13,740 ⁽⁴⁾	16,680 ⁽⁴⁾	N/A
COD	mg/l	555	694	N/A
	lbs/day	41,658	57,880	N/A
NH ₃	mg/l	23	30	N/A
	lbs/day	1,725	2,502	N/A
TKN	mg/l	29	32	N/A
	lbs/day	2,180 ⁽⁴⁾	2,670 ⁽⁴⁾	N/A
TSS	mg/l	193	210	N/A
	lbs/day	14,490 ⁽⁴⁾	17,514 ⁽⁴⁾	N/A

Notes:

1. Based on Influent pumping capacity.
2. Based on Secondary Clarifier Overflow Rates of 1,000 gpd/ft², with all three secondary clarifiers in service.
3. Based on Hydraulic Capacity
4. Certification of Wastewater Treatment Facility Capacities, City of Lincoln, Nov. 21, 2006

Table 5.11 Northeast WWTF Secondary Treatment Summary Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska			
Train	Capacity	Number of Aeration Basins	Number of Clarifiers
1 A&B	3.34 mgd	2	1
2	3.33 mgd	1	1
3	3.33 mgd	1	1
MMAD Capacity	10.00 mgd	N/A	N/A

5.2.4 Biosolids Treatment

Solids at the Northeast WWTF are generated from three separate sources in the WWTF.

1. Primary thickening and surface scum from the primary clarifiers.
2. Waste activated sludge, scum, and aeration basin foam and scum from the final clarifiers.

The primary sludge at this facility is screened using a Parkson strain press prior to being pumped to anaerobic digesters. The waste activated sludge (WAS) solids are thickened using rotary drum thickeners (RDT's). The WAS thickening facilities include WAS pumps to pump from the clarifiers to storage, aerated WAS storage tanks, thickener feed pumps, two RDT's, thickened waste activated sludge (TWAS) pumps, polymer feed equipment, and a TWAS solids storage tank. WAS is typically thickened to 5-percent to 6-percent solids.

Primary solids and TWAS are pumped separately to the anaerobic digesters. The anaerobic digestion facilities include two anaerobic digesters, a membrane type gas holder, pumping equipment, piping, and heat exchangers. Digested solids are pumped to an 8-million gallon onsite biosolids storage lagoon. Liquid biosolids are hauled from the lagoon by truck and injected in City owned land north of the treatment facility. The historical biosolids and constituent loading for this site is summarized in Appendix K. Excess liquid biosolids are hauled by truck to the Theresa Street WWTF for dewatering.

5.2.5 Recently Completed Improvements

Since the last Master Plan Update in 2003, the following projects have been completed at the Northeast WWTF.

1. Replacement of influent mechanical screens and new screening compaction and handling improvements.
2. Solids thickening digestion and handling improvements including converting original aerobic digesters to WAS and TWAS storage basins, adding two new rotary drum thickeners, adding one new strain press, and improvements to existing primary and secondary digesters.
3. Effluent UV disinfection capacity improvements consisting of UV and liquid sodium hypochlorite system.
4. Improvements to treatment processes including: demolition of trickling filters, removal of recirculation pumps, RAS pumping improvements, modification to original aeration basins and construction of new aeration basins with anoxic selector zones, construction of new blower building and modifications to existing blower building, and construction of new final clarifier and modifications to existing final clarifiers to match new clarifier design.
5. Influent bar screening replacement and screenings compaction and handling improvements.
6. Electrical and SCADA instrumentation control improvements.
7. Miscellaneous site work including piping, access roads, and site grading for floodplain protection.

5.2.6 Historical Influent Flows

Historical influent annual average daily (AAD) flows to the Northeast WWTF from 1981 through 2006 are shown in Figure 5.18. Table 5.12 and Figure 5.19 show the influent flows to the Northeast WWTF from 2000 to 2006. The flows represent the annual averages for the annual average daily flow (AAD) and maximum monthly average daily flow (MMAD). Peak daily flow measurements for the Northeast WWTF were not available for this report. Ratios of MMAD:AAD are provided to show the changes in average and maximum monthly flows to be used for future capacity evaluation.

Table 5.12 Northeast WWTF Annual Average Flows Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska			
Year	AAD (mgd) ⁽¹⁾	MMAD (mgd)	MMAD:AAD Ratio
2000	6.8	7.8	-
2001	5.1	6.1	-
2002*	3.6	5.6	1.54
2003*	4.5	6.0	1.34
2004	4.7	5.3	1.14
2005	4.3	4.9	1.15
2006	4.6	4.9	1.06
Average	4.8	5.4	1.25
Notes:			
1. Previous studies influent flow data used for 2000 and 2001. City daily records for effluent flow used for 2002 and 2003 since influent data was not available for this period. City daily records for influent flow used for 2004 to 2006.			

Dead Mans Run, Havelock, and Steven's Creek Basins discharge to the Northeast Street WWTF. Computer modeling of these basins was used to determine peak hour flows (PHF) at the treatment facility. The current PHF calculated at the treatment facility is 24.1 mgd (37.3 cfs). This results in a PHF:MMAD ratio of 4.90 and a PHF:AAD ratio of 5.24 for the current flows at the treatment facility. The PHF:AAD ratio of 5.24 matches well with the peak to average flow ratio of 5 used in the City's flow.

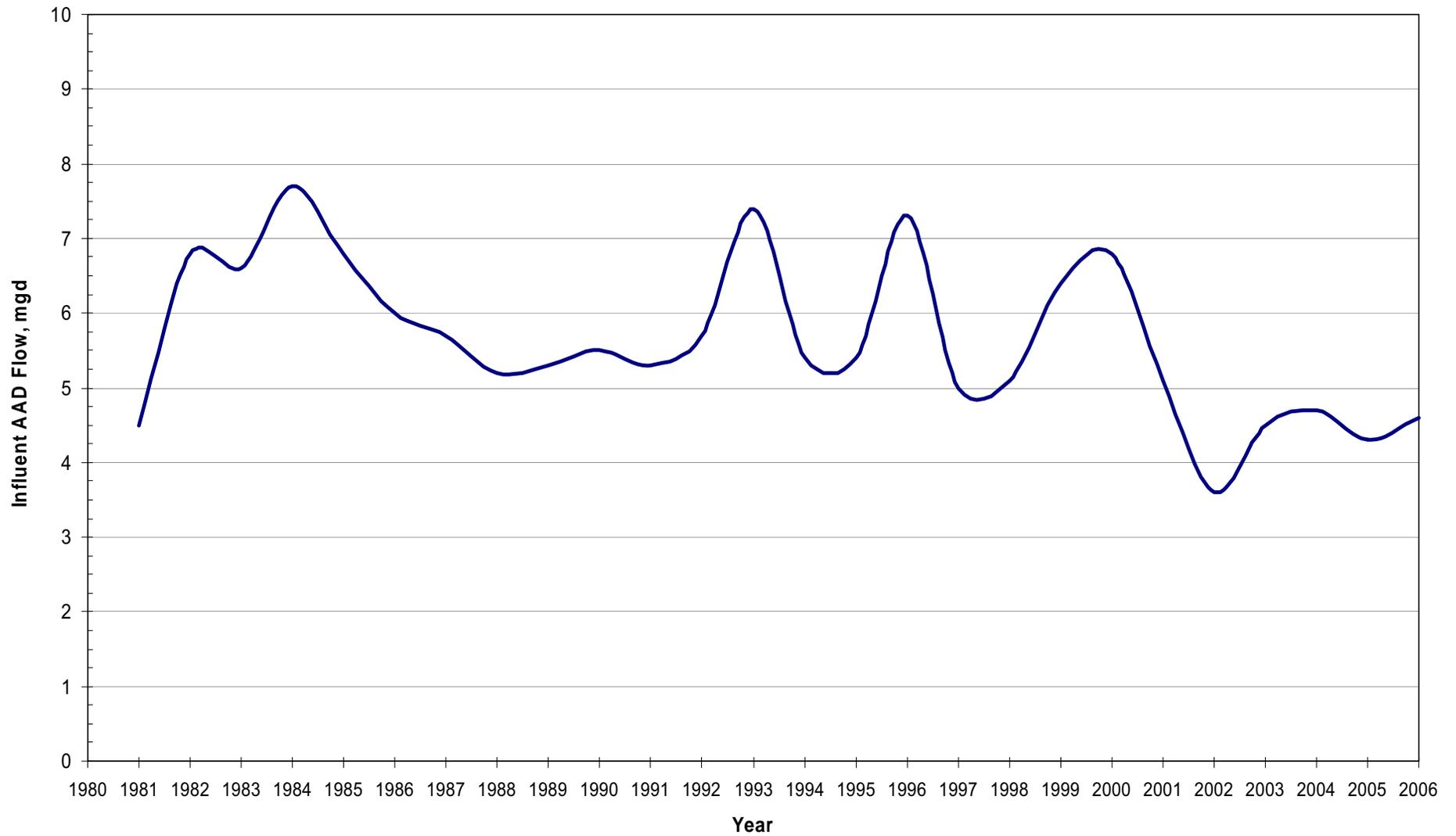


Figure 5.18
 Northeast WWTF Historical Influent Flows
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska

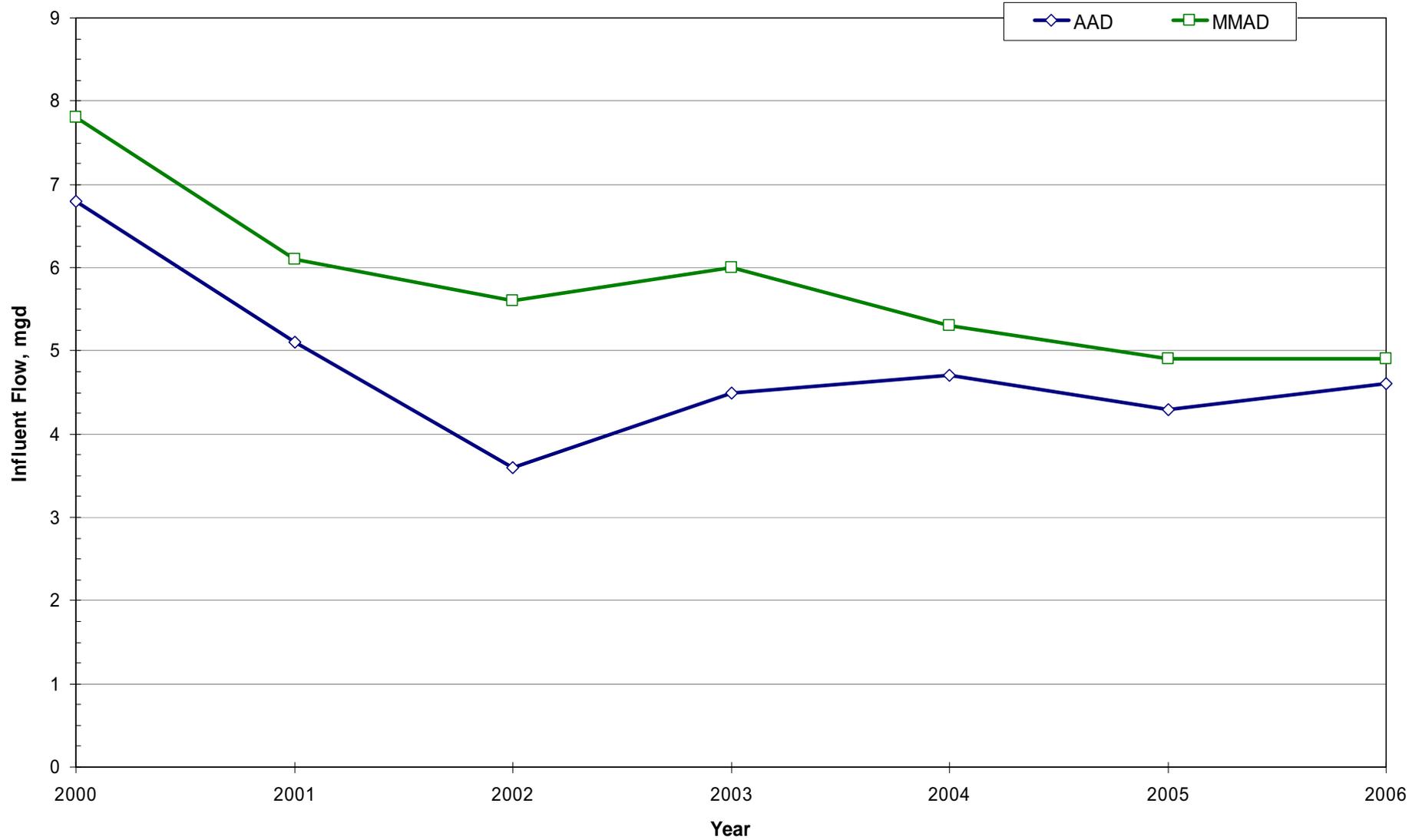


Figure 5.19
 Northeast WWTF Influent Flow Comparison
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska

5.2.7 Historical Influent Quality

Influent loading to the Northeast Street WWTF is shown in Table 5.13 and Figure 5.20. The values for the AAD and MMAD for BOD₅, COD, and TSS are provided for years 2000 to 2006 and CBOD values are provided for years 2004 to 2006. In addition to the concentrations, the influent mass loadings are shown in Table 5.14 and shown graphically in Figure 5.21.

Influent average BOD₅ appears to show a slight increase over in the last seven years ranging from a low of 192-mg/l in 2000 to a high of 269-mg/l in 2006 with an average of 232-mg/l. As indicated by the relatively close values of CBOD to BOD₅ for each year, most of the influent BOD₅ is in the carbonaceous form as expected.

Table 5.13 Northeast WWTF Average Influent Loading Concentrations Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska										
Year	BOD (mg/l)		CBOD (mg/l)		COD (mg/l)		TSS (mg/l)		TKN (mg/l)	
	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD
2000	194	244	-	-	482	531	204	218	33	41
2001	192	233	-	-	489	574	221	252	34	40
2002	255	320	-	-	598	760	292	471	36	43
2003	224	305	-	-	494	686	224	313	37	44
2004	226	255	193	234	483	549	213	241	39	46
2005	262	296	243	271	516	605	234	251	38	42
2006	269	286	228	251	556	583	251	278	38	41
Average/Max	232	320	221	271	517	760	234	471	36	46
Notes:										
1. AAD = Annual average day from City daily records.										
2. MMAD = Maximum month average day from City daily records.										

Table 5.14 Northeast WWTF Average Influent Mass Loading Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska										
Year	BOD (lbs/day)		CBOD (lbs/day)		COD (lbs/day)		TSS (lbs/day)		TKN (lbs/day)	
	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD
2000	11,002	15,873	-	-	27,335	34,543	11,569	14,181	1,871	2,667
2001	8,167	11,854	-	-	20,799	29,202	9,400	12,820	1,446	2,035
2002	7,656	14,945	-	-	17,954	35,495	8,767	21,998	1,081	2,008
2003	8,407	15,262	-	-	18,540	34,327	8,407	15,663	1,389	2,202
2004	8,859	11,272	7,565	10,343	18,933	24,267	8,349	10,653	1,529	2,033
2005	9,396	12,096	8,714	11,075	18,505	24,724	8,392	10,257	1,363	1,716
2006	10,320	11,688	8,747	10,257	21,330	23,825	9,629	11,361	1,458	1,676
Average/Max	9,115	15,873	8,342	11,075	20,485	35,495	9,216	21,998	1,448	2,667
Notes: 1. AAD = Annual average day from City daily records. 2. MMAD = Maximum month average day from City daily records.										

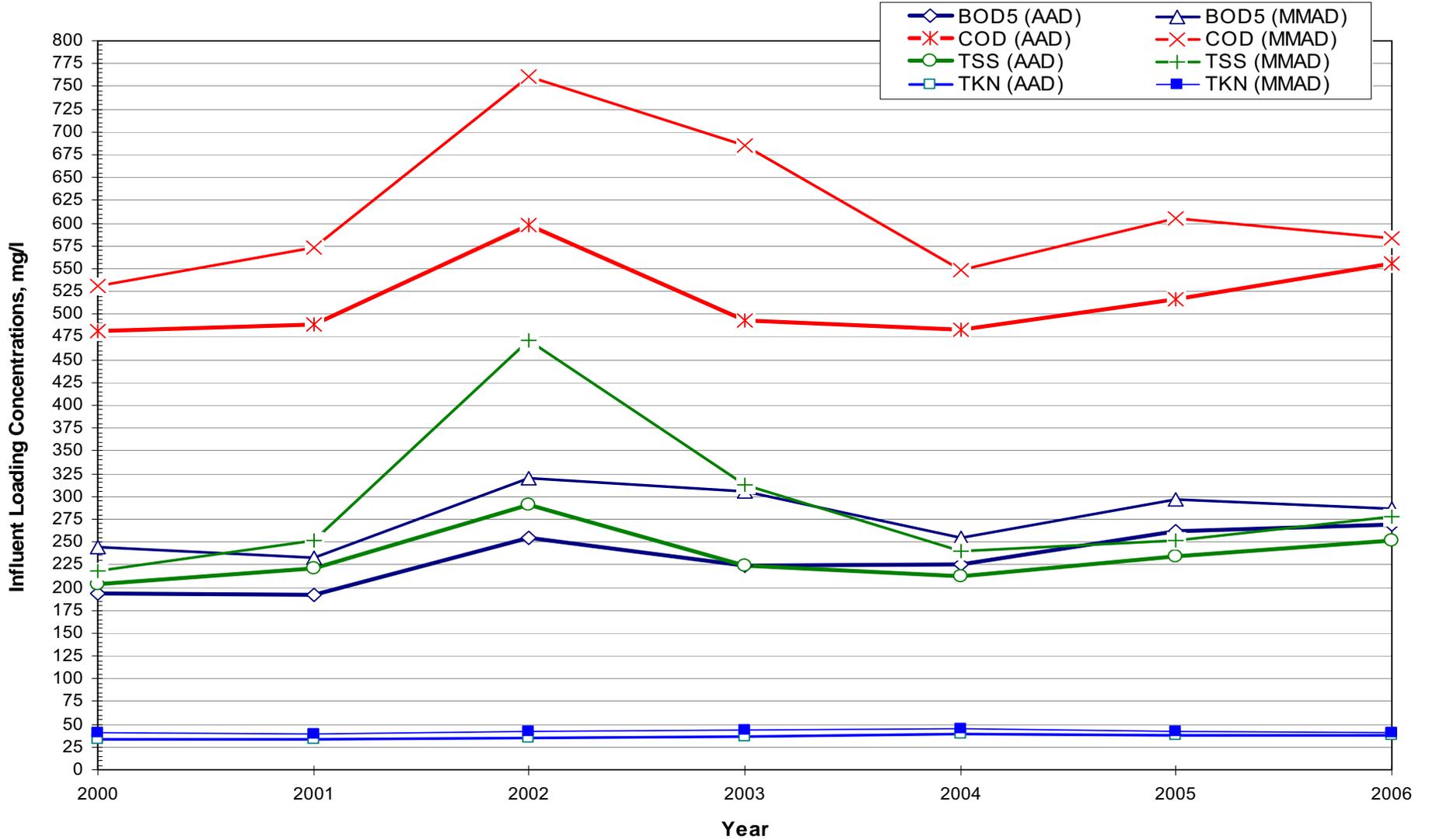


Figure 5.20
 Northeast WWTF Influent Loading Concentrations
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska



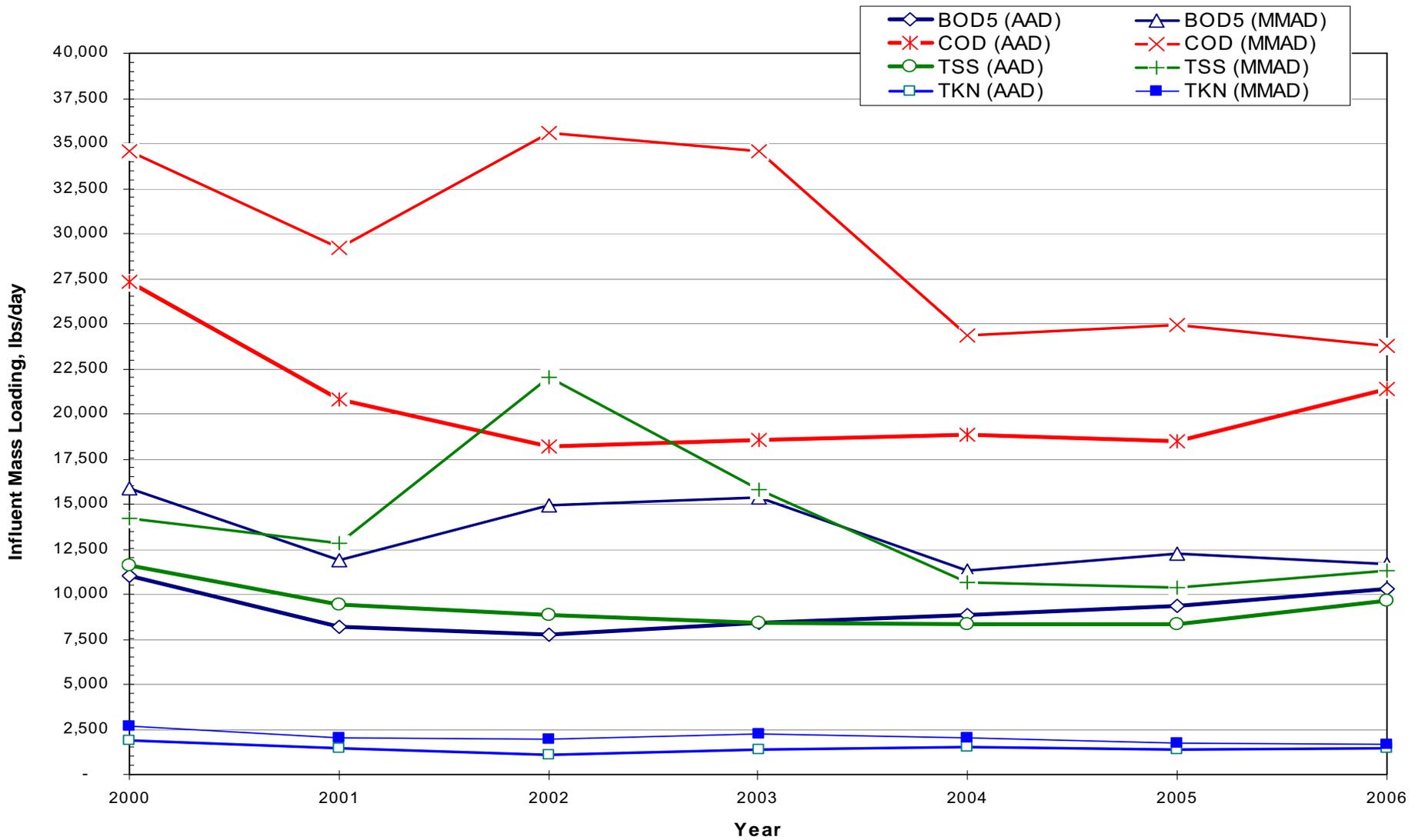


Figure 5.21

Northeast WWTF Influent Mass Loading
Wastewater Facilities Master Plan Update - 2007
City of Lincoln, Nebraska



5.2.8 Treatment Facility Performance

Effluent concentrations of BOD, CBOD, COD, TSS, and ammonia (NH₃-N) show the level of treatment provided by the Northeast Street WWTF. Tables 5.15, 5.16, and Figure 5.22 present effluent discharge concentrations and percent removal values for years 2000 to 2006. Effluent CBOD data is shown for years 2003 to 2006. Previous years CBOD data were not available for this report.

The Northeast WWTF implemented an advanced treatment project and improvements using nitrification process in 2006 to reduce levels of ammonia in the effluent. Prior to implementation of these treatment improvements, the effluent ammonia averaged from 3.5-mg/l to 19.4-mg/l from 2000 to 2005. After the new nitrification treatment system began operating in 2006, effluent ammonia values decreased to an average of 0.3-mg/l.

Year	BOD (mg/l)		CBOD (mg/l)		COD (mg/l)		TSS (mg/l)		NH ₃ -N (mg/l)	
	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD	AAD	MMAD
2000	17.9	30.2	-	-	71.7	79.6	6.6	13.3	10.0	17.9
2001	9.7	25.3	-	-	66.7	91.4	5.2	7.9	3.5	9.4
2002	9.7	23.2	-	-	71.0	88.5	6.4	9.7	8.4	16.6
2003	12.8	19.6	6.6	10.3	68.5	125.7	8.3	12.6	16.6	20.2
2004	16.2	24.5	3.7	12.5	35.6	49.0	5.8	13.0	7.7	15.0
2005	16.5	23.6	11.7	16.1	59.2	72.5	12.5	25.1	19.4	22.4
2006	7.0	10.1	3.7	4.8	35.4	42.0	5.8	7.3	0.3	0.9
Average	12.8	30.2	6.4	16.1	58.3	125.7	7.2	25.1	9.4	22.4

Notes:
 1. AAD = Annual average day from City daily records.
 2. MMAD = Maximum month average day from City daily records.

Table 5.16 Northeast WWTF Average Influent Removal ⁽¹⁾ Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska				
Year	BOD (%)	CBOD (%)	COD (%)	TSS (%)
2000	90.7	-	85.1	96.8
2001	94.9	-	86.4	97.6
2002	96.2	-	88.1	97.8
2003	94.3	-	86.1	96.3
2004	92.8	98.1	92.6	97.3
2005	93.7	95.2	88.5	94.7
2006	97.4	98.4	93.6	97.7
Average	94.3	97.2	88.6	96.9
Notes: 1. The percent removal is based on annual average influent and effluent values.				

5.2.9 Discharge Permit

The National Pollutant Discharge Elimination System (NPDES) effluent discharge permit for the Northeast WWTF is located in Appendix F. The permit limits require the WWTF to meet a monthly average CBOD of 25 mg/l and a monthly average TSS of 30 mg/l. As indicated in Table 5.15 the Northeast WWTF is meeting these requirements.

The discharge limitations for NH₃ vary based on the time of the year and are divided into three separate seasonal requirements (spring, summer, and winter). The current permit limits from March 1 to May 31 require the monthly average NH₃-N to be 15.6 mg/l or less. For the period from June 1 to October 31, the monthly average NH₃-N limit is 10.1 mg/l. For the period from November 1 to February 28 (29), the monthly average NH₃-N limit is 14.8 mg/l. The Northeast WWTF implemented full nitrification treatment in 2006. As a result, the effluent ammonia-nitrogen concentrations have been reduced significantly and are well below the discharge permit limits.

The NPDES permit requires a seasonal limit of fecal coliform in the effluent from May 1 to September 30. The permit limits the monthly geometric mean of fecal coliform in the effluent sample to a maximum of 200 CFU per 100 ml with no more than 10-percent of monthly samples to exceed 400 CFU per 100 ml. Table 5.17 presents the effluent fecal coliform concentrations from years 2005 and 2006 at the Northeast WWTF. The current WWTF is consistently meeting the fecal coliform requirements with one exception over this time period of 12-percent of samples exceeding 400 CFU/100ml in May 2005.

Table 5.17 Northeast WWTF Effluent Fecal Coliform Concentrations ⁽¹⁾ Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska		
Month	Monthly Geometric Mean (CFU/100ml)	Percent of Monthly Samples > 400 CFU/100ml
May-05	18.9	12.9%
Jun-05	5.5	0.0%
Jul-05	6.6	3.2%
Aug-05	8.0	0.0%
Sep-05	5.3	0.0%
May-06	4.8	3.2%
Jun-06	6.1	3.3%
Jul-06	4.0	0.0%
Aug-06	4.2	0.0%
Sep-06	4.2	0.0%
Average	6.8	2.3%
Notes:		
1. Data provided by City for NPDES monitoring from May through September of 2005 and 2006.		

5.2.10 Future Capacity

The Northeast WWTF has is rated for a MMAD flow of 10.0 mgd. Future expansion and improvements will require construction of new facilities on land adjacent to the existing facilities. Future treatment facility expansion requirements and timing are discussed in more detail in Section 24.

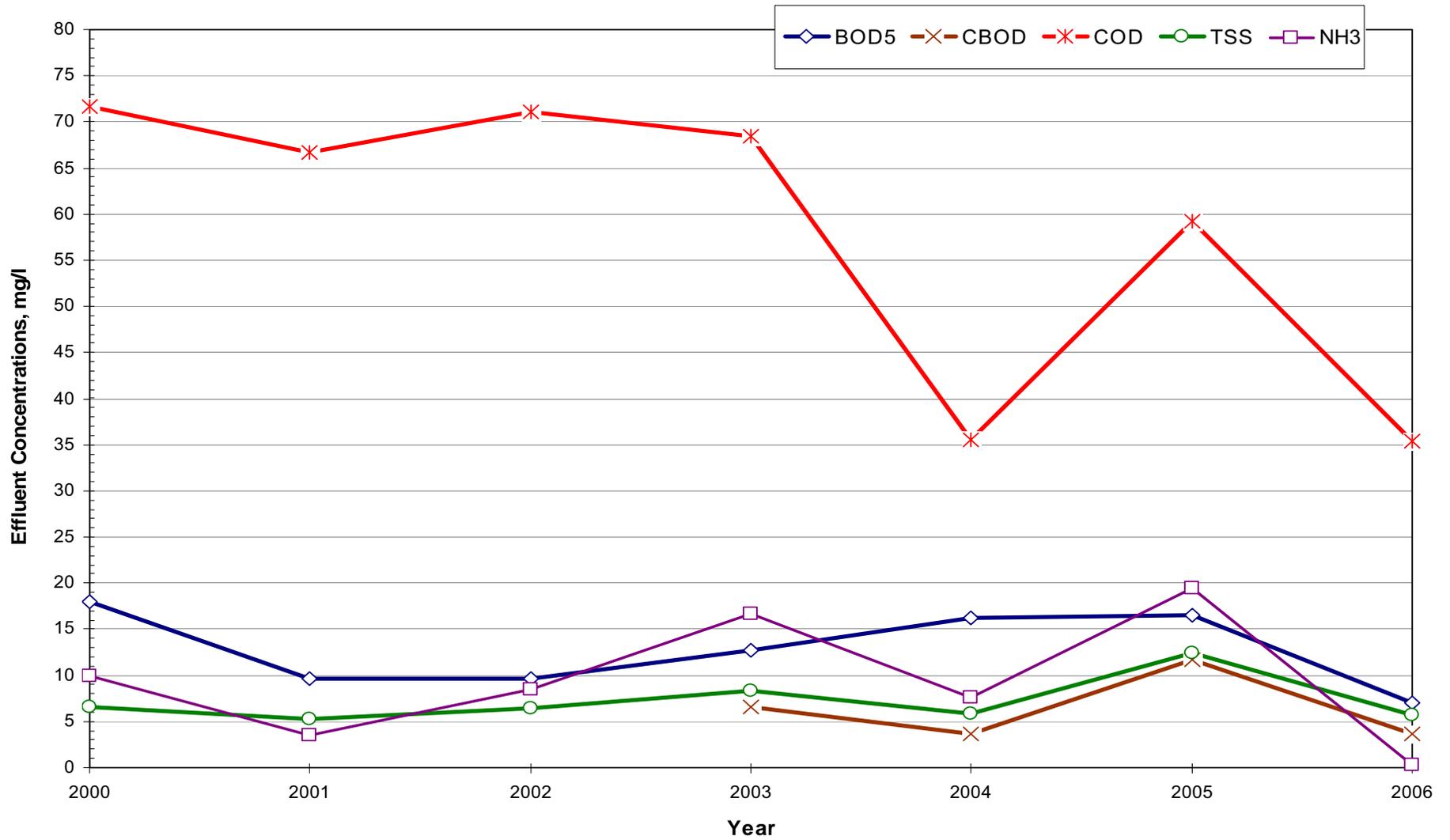


Figure 5.22
 Northeast WWTF Effluent Concentrations
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska

5.3 COMPARISON OF WATER USAGE TO WASTEWATER FLOW

Data provided by the City was used to compare the wastewater flows as recorded at the two wastewater treatment facilities to the water consumption for the City. Table 5.16 shows the average annual influent flows at both wastewater treatment facilities as well as the water use for each year from the City drinking water system. The winter months of December, January, and February were used to compare the values since water loss from irrigation, lawn watering, and other outdoor uses and the influence of rain events are minimal during the winter months. The winter season wastewater flows when compared to the water consumption for the same period provides an indication of the 'water tightness' of the collection system. Additionally, this data should correlate and be relatively constant over time, with the wastewater flows being slightly less than the water consumption values. As shown in Table 5.18, the City's collection system has averaged approximately 85-percent of the water consumption over the last five years, which is a good correlation.

Year ⁽¹⁾	Theresa St WWTF Flow (MGD)	Northeast WWTF Flow (MGD)	Total WW Flow (MGD)	Total Water Usage ⁽²⁾ (MGD)	Percent (%)
1999	17.6	6.0	23.5	27.2	86.4
2000	16.7	6.3	23.0	29.2	78.7
2001	16.5	6.3	22.8	27.8	82.1
2002	23.0	3.3	26.3	28.1	93.7
2003	17.8	2.9	20.7	27.7	74.7
2004	17.1	5.3	22.4	25.7	87.0
2005	18.2	4.9	23.1	25.8	89.6
2006	19.4	3.8	23.3	26.8	87.0
Period Average					84.9
Notes:					
1. Winter months only - December of year indicated through February of the following year.					
2. Total flow from drinking water system. Source: City of Lincoln metered water records.					

5.4 HISTORICAL PER CAPITA WASTEWATER FLOW

Figure 5.23 shows the average historical per capita wastewater flow for the City treatment facilities. The total annual average flow from both Theresa Street WWTF and Northeast WWTF was divided by the City of Lincoln population for a given year to determine the average per capita wastewater flow. As shown in Figure 5.23, the average per capita wastewater flow has been declining over the last 25 years. This decline is a result of improved sewer construction practices, replacement of older sewers, increased water conservation practices by industry and consumers, and possibly by the recent lower than normal precipitation accumulations. The 2005 per capita contribution is approximately 95 gpcd. As shown in the figure, the yearly values vary. To compensate for this variation a linear trend line was included to provide a means for determining per capita flows.

5.5 INDUSTRIAL CONTRIBUTIONS

The City of Lincoln currently has 44 dischargers that are classified as industrial. Thirty-four of these dischargers are tributary to the Theresa Street WWTF, and the remaining 10 are tributary to the Northeast WWTF as identified in the Industrial Audit located in Appendix G.

The combined flow for Fiscal Year 05/06 (September 2005 to August 2006) averaged about 2.2 mgd or 9.4 percent of the combined wastewater flow. A summary of the industrial dischargers contributions to flows and loadings at both the Theresa Street and Northeast WWTF's is presented in Table 5.20 below. Additional information is located in Appendix G.

Parameter	Theresa St	Northeast	Combined
Flow (mgd)	7.6 %	18.7 %	9.6 %
TSS (lbs/day)	6.7 %	24.4 %	10.0 %
BOD ₅ (lbs/day)	27.3 %	43.3 %	30.2 %
COD(lbs/day)	23.2 %	46.3 %	27.5 %
TKN (lbs/day)	7.3 %	16.2 %	8.5 %

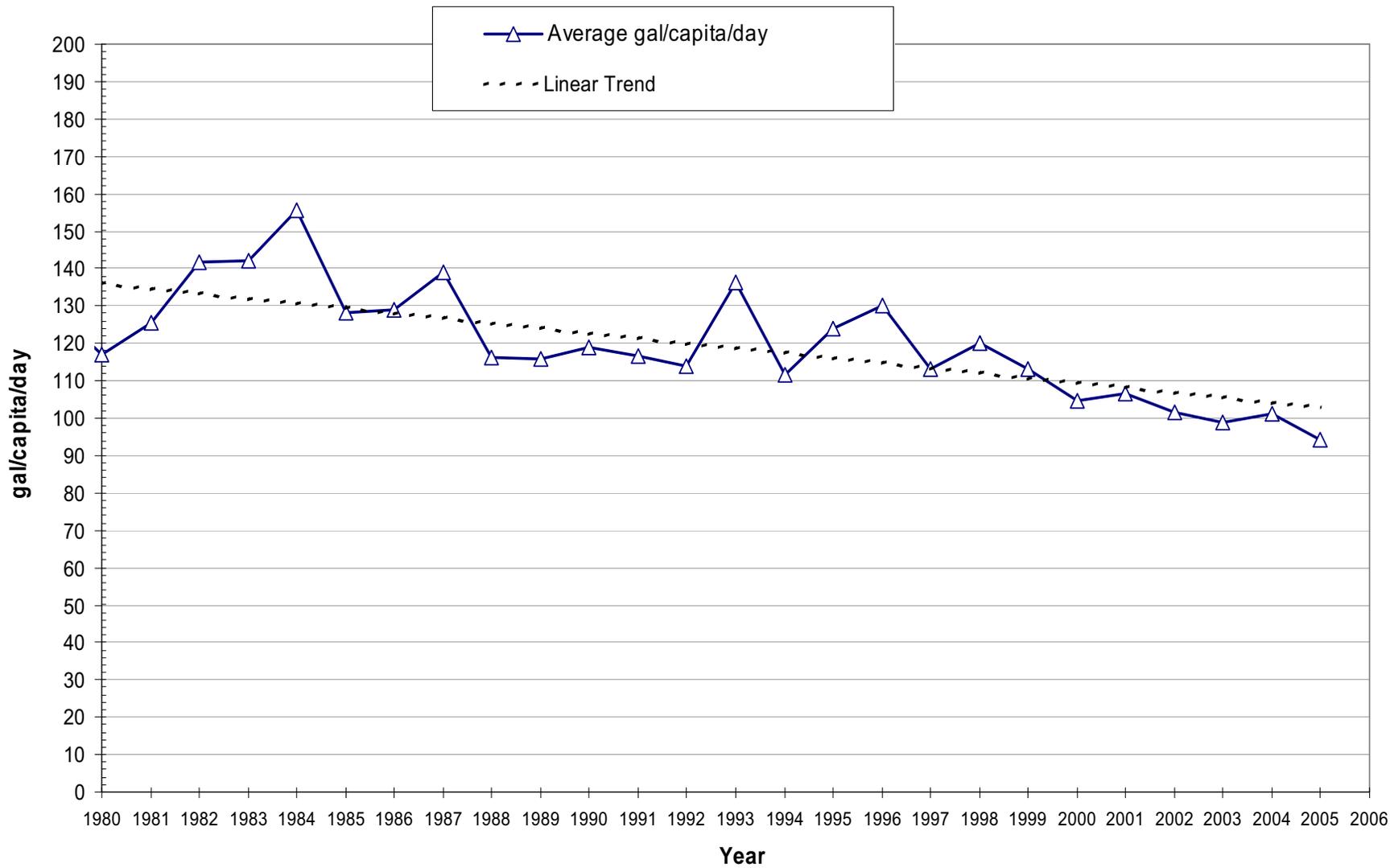


Figure 5.23
 Historical Per Capita Wastewater Flow
 Wastewater Facilities Master Plan Update - 2007
 City of Lincoln, Nebraska