CITY OF WICHITA

WATER & SEWER DEPARTMENT/SYSTEM PLANNING

2005 Sanitary Sewer Master Plan Update

PEC PROJECT NO. 34-05703-0042

Professional Engineering Consultants, P.A. / Burns & McDonnell

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List of Abbreviations

ABS	Acrylonitrile Butadiene Styrene
ACP	Asbestos Cement Pipe
BNR	Biological Nutrient Removal
BOD_5	Biochemical Oxygen Demand
CCWQRF	Cowskin Creek Water Quality Reclamation Facility
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cfs	Cubic Feet per Second
CIP	Cured in Place
CMOM	Capacity Management Operation and Maintenance
CMP	Corrugated Metal Pipe
CWA	Clean Water Act
DIP	Ductile Iron Pipe
EFB	Extraneous Flow Basin
fps	Feet per Second
ft	feet
g/c/d	Gallons per Capita per Day
GBT	Gravity Belt Thickener
GIS	Geographical Information System
gpm	Gallons per Minute
HDPE	High Density Polyethylene Pipe
HDT	Hydraulic Detention Time
HP	Horsepower
I/I	Inflow and Infiltration
K.A.R	Kansas Administrative Regulations
KDHE	Kansas Department of Health and Environment

Kg/ha	Kilogram per Hectare
Kg/ha/yr	Kilograms per Hectare per year
MAPD	Metropolitan Area Planning Department
mg/Kg	Milligrams per Kilograms
mg/L	Milligrams per Liter
MGD	Millions gallons per day
ml	Milliliters
MPN	Most Probable Number
NACWA	National Association of Clean Water Agencies
NH_3	Ammonia
NPDES	National Pollutant Discharge Elimination System
NRDC	Natural Resources Defense Council
p/c/d	Pounds per capita per day
PDF	Peak Dry Weather Flow
PFRP	Process to Further Reduce Pathogens
PLC	Programmable Logic Controller
PLRCP	Plastic Lined Reinforced Concrete Pipe
POTW	Publicly Owned Treatment Facility
ppd	Pounds per Day
PSRP	Process to Significantly Reduce Pathogens
PVC	Polyvinyl Chloride
PWF	Peak Wet Weather Flow
RAS	Return Activated Sludge
RCP	Reinforced Concrete
RCRA	Resource Conservation and Recovery Act
SCFM	Standard Cubic Feet per Minute
SSO	Sanitary Sewer Overflow
TAZ	Traffic Analysis Zone
TDH	Total Dynamic Head
TKN	Total Kjeldahl Nitrogen
TMDLs	Total Maximum Daily Loads
TN	Total Nitrogen

TP	Total Phosphorus
TSS	Total Suspended Solids
U.S. EPA	United States Environmental Protection Agency
UV	Ultraviolet
VCP	Vitrified Clay Pipe
VFD	Variable Frequency Drive
WAS	Waste Activated Sludge
WWSD	Wichita Water and Sewer Department
WWTF	Wastewater Treatment Facility
µg/L	Micrograms per Liter

SECTION 1

Introduction

GENERAL

The City of Wichita Water & Sewer Department (WWSD) has initiated a strategic master planning program which encourages the department to update their long-term sanitary sewer system plan every 5 years. The previous Master Plan was completed in 2000 and included projections through the year 2050. This study is an update of the 2000 Master Plan and it analyzes the impact of growth and improvements since the previous plan and incorporates new growth areas as well as any major redistribution of population in the central service area. The WWSD has also determined that this 2005 Sanitary Sewer Master Plan Update shall plan for continued sewage service to the City of Wichita through the study period which has been set as the year 2050.

BACKGROUND

The population projections that are presented in this Master Plan Update were based on information provided by WWSD and the Wichita-Sedgwick County Metropolitan Area Planning Department (MAPD) Staff. The projections are influenced by many factors that can influence actual wastewater flows, and organic, ammonia and phosphorus loading amounts. These anticipated quantities are the values used for projecting conveyance system and treatment component sizes. Quantities developed for future analysis are related to the population projections, which can vary based on economic conditions, and are obviously impacted by some industrial activities. Since regional growth in the economic sector to the year 2050 is difficult to predict it will be important to continually review and update this plan at least every 5 years. This will allow confirmation or modification of projections and evaluation of the impact of these changes on the Sanitary Sewer Master Plan for the City of Wichita.

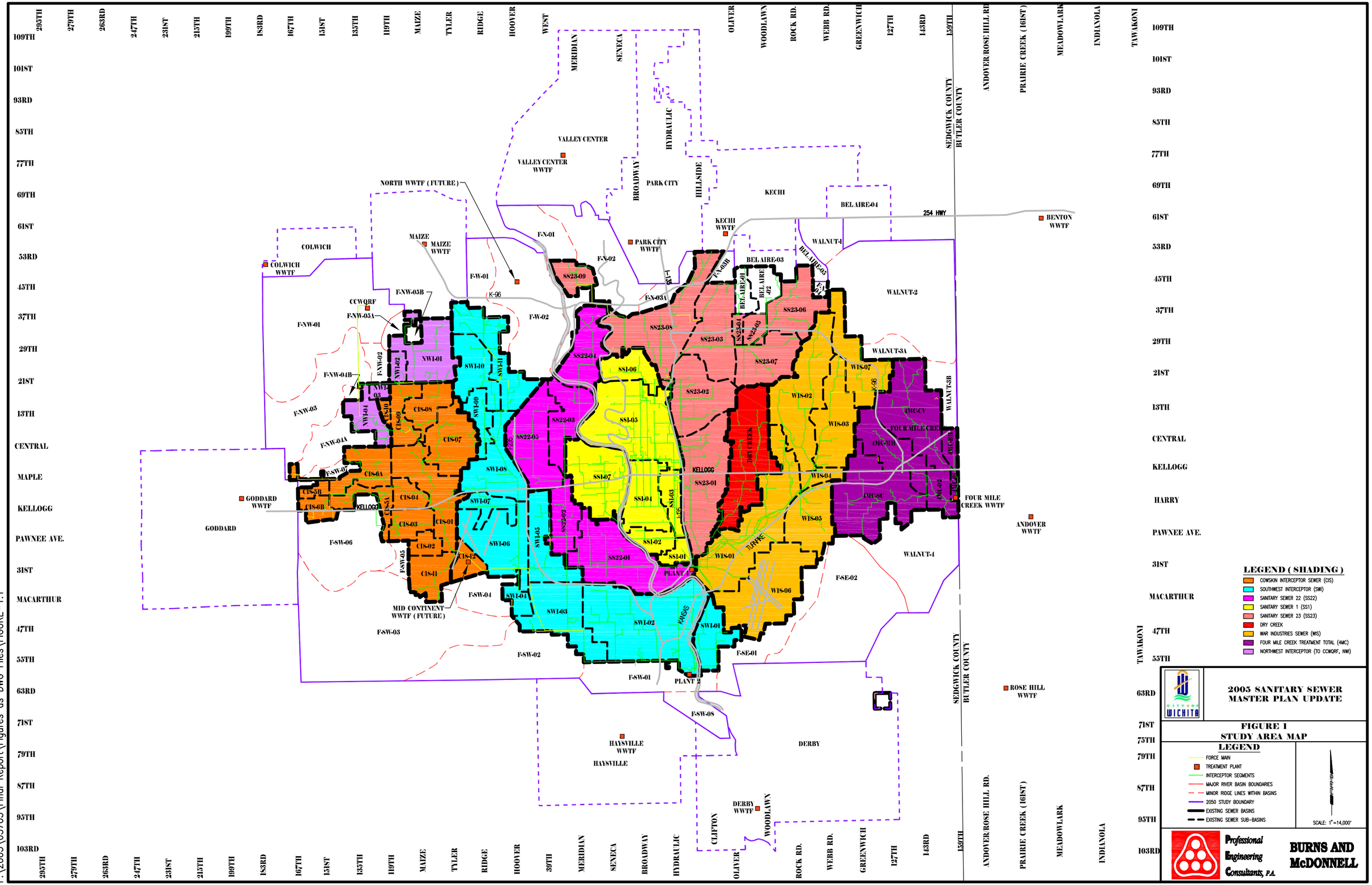
SERVICE AREA

The current combined service area for the WWSD Treatment Facilities is estimated to contain 105,742 acres. The 2050 study area is forecast to contain approximately 180,247 acres for 70% growth in service area. The study area is shown on Figure 1-1 which was prepared utilizing the City of Wichita's Geographic Information System (GIS) Mapping Data. By review of Figure 1-1, three distinct existing wastewater treatment service areas have been delineated and each treatment service area has been further divided into sewer service basins. These basins will be utilized throughout the study to analyze sewer system capacities and treatment facility capacity needs. The size of the treatment facility service areas are noted as follows:

- Plants No. 1 and No. 2: 92,678 acres
- Cowskin Creek Water Quality Reclamation Facility (CCWQRF): 3,523 acres
- Four Mile Creek: 9,542 acres

See Section 6 for a list of drainage basins. Past and present population, flow, organic loading, and nutrient loading data have been obtained from MAPD and WWSD. This information, along with future population projections provided by MAPD, is needed to evaluate and determine future projections of wastewater flow quantity and quality through the year 2050.

This Master Plan re-examines the previous Plan's projections, and summarizes population, wastewater flows and loading projections for the City of Wichita Treatment Facilities along with assumptions that formed the basis of the projections.



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SECTION 2

Population Projections

GENERAL

To make the Master Plan Update a useful tool for the WWSD it must be able to anticipate the needs of WWSD customers, now and in the future. To accomplish this effort the sewer service planning area defined in 2000 must be reviewed and modified to incorporate new and projected growth patterns for the utility and its users. The target year for this Plan will be 2050. Intermediate planning years of 2010, 2020, 2030, and 2040 will also be evaluated.

In previous years, the MAPD had established boundaries called Traffic Analysis Zones (TAZ's) for the purpose of breaking down the population within Sedgwick County into small sections. A detailed analysis of estimated 2002 dwelling units and population was performed by the MAPD for each TAZ. This data was then compared to the outer boundary of the sewer service area to determine an estimated 2002 sewer service population.

Population distribution is another invaluable parameter. By utilizing the provided population by TAZ for 2002 as well as projected population by TAZ for 2015, 2030, and 2050 it was possible to determine the distribution of customers by sewer service basins. Population projections for 2010, 2020 and 2040 have been interpolated. This projection method allows the WWSD to estimate both where its current customers are and where its future consumers will be located, thereby providing a expected loading on each main sewer line and treatment facility as well as determining the future loadings for existing as well as new systems.

The population analysis for the City of Wichita's current service area is divided into 9 drainage basins and 64 sub-basins. The potential additional service area consists of 6 drainage basins and 29 sub-basins. Therefore, the total number of drainage basins for the study area as a whole is 15, with 93 sub-basins. The populations for nine (9) surrounding communities were also evaluated. A map of the study area is presented in Figure 1-1 Boundary Map at the end of the previous Section. Appendix

A lists the detailed population projections by sewer basin and sub-basins from the TAZ analysis.

2002 Sewer Service Population

To analyze the current capacity of the sanitary sewer system, it was necessary to determine the population of the existing service area and future study area by sewer drainage basin. To allow for correlation to interceptor flows, the service areas were further broken down into basins and sub-basins. Figure 1-1 illustrates the boundaries adopted within the study area. A computer overlay between the TAZ boundaries and the sewer service boundaries allowed a spatial evaluation to be performed which determined the percentage of each TAZ area inside each sewer drainage basin boundary. The percentages could then be applied to the TAZ populations to obtain an estimated population within each sewer basin. The results of the apportionment of the 2002 Sedgwick County population to the existing sewer service area are shown in Table 2-1.

Table 2-1. Sewer Service Population

Existing Sewer Service Basin	*2002 Sewer Service Population*
*Cowskin Interceptor Sewer (CIS)	42,508
Southwest Interceptor Sewer (SWI)	45,749
Sanitary Sewer No. 22 (SS22)	49,290
Sanitary Sewer No. 1 (SS1)	64,525
Sanitary Sewer No. 23 (SS23)	59,025
Dry Creek Sewer	21,894
War Industries Sewer (WIS)	51,888
*Northwest Interceptor (NWI-01,02) (Plant 3)	5,492
Four Mile Creek (4MC)	13,764
TOTAL	**354,135**

* Note: Population for two NWI sub-basins (NWI-03 and NWI-04) had not yet been diverted to CCWQRF in 2002. Therefore, for 2002, those service populations temporarily appear in the CIS basin.

Updated Population Projections

To estimate the future sewer service population within the study area, the MAPD's projections by TAZ for 2015, 2030, and 2050 were utilized. The future TAZ projec-

tions were applied to the same spatial analysis performed for determining the current sewer service population. Values for 2010, 2020, and 2040 were then interpolated.

Table 2-2. Population Projections

Basin	*2002*	*2010*	*2020*	*2030*	*2040*	*2050*
Existing Service Area of City of Wichita Treatment Plants 1 and 2						
CIS	42,508[(2)]	44,869	47,044	48,444	48,840	49,237
SWI	45,749	47,763	49,726	51,135	51,735	52,336
SS22	49,290	49,332	49,364	49,376	49,378	49,379
SS1	64,525	65,437	66,534	67,587	69,268	70,950
SS23	59,025	60,270	61,280	61,744	62,445	63,147
Dry Creek	21,894	21,895	21,895	21,895	21,903	21,912
WIS	51,888	53,083	54,057	54,510	54,562	54,615
Kechi	2,000	2,427	3,111	3,947	4,583	5,220
Existing Service Area of City of Wichita Treatment Plants 1 and 2 Total	338,879	345,076	353,011	358,638	362,714	366,796
Existing Service Area of City of Wichita Four Mile Creek Treatment Total	13,764	16,547	19,544	22,059	22,825	23,591
Existing Service Area of City of Wichita CCWQRF Total	5,492[(2)]	8,398	9,136	9,362	9,575	9,788
Potential Additional Service Area						
City of Wichita						
Walnut		3,562	6,142	9,495	14,765	20,036
Future Southeast Basin (F-SE)		2,832	3,240	3,852	5,441	7,030
Future North Basin (F-N)		5,748	6,447	7,065	7,507	7,950
Future West Bain (F-W)		1,923	2,682	3,052	3,755	4,458
Future Northwest Basin(F-NW)		4,117	8,500	14,109	19,138	24,168
Future Southwest Basin (F-SW)		10,099	12,743	15,607	17,791	19,975
Potential Additional Service Area Total		28,281	39,754	53,180	68,397	83,617
Surrounding Communities						
Goddard	7,030	7,871	8,964	10,099	11,452	12,805
Colwich	1,682	1,839	2,022	2,192	2,637	3,081

Basin	*2002*	*2010*	*2020*	*2030*	*2040*	*2050*
Valley Center	9,022	10,445	12,035	13,435	15,013	16,591
Haysville	13,823	15,988	18,450	20,666	22,863	25,059
Bel Aire	5,417	6,599	7,809	8,749	9,144	9,538
Derby	23,845	27,972	32,788	37,259	41,053	44,847
Park City	7,808	9,489	11,521	13,482	15,530	17,578
Maize	3,181	3,812	4,504	5,098	5,690	6,282
Surrounding Communities Total	71,808	84,051	98,093	110,980	123,382	135,781
GRAND TOTAL STUDY AREA		482,317	519,538	554,219	586,893	619,573

Notes:

1. 2010, 2020 and 2040 values were interpolated.
2. Population for NWI-03 and NWI-04 had not yet been diverted to CCWQRF in 2002, but diversion is projected to be in-place by 2010.

Comparison to 2000 Master Plan Projections

Difference in Service Area

Since the 2000 Master Plan Update, the sanitary sewer service area for the WWSD has changed with the following modifications occurring.

1 During the 2000 Update, some residents within the city limits were not served by the WWSD because their wastewater was transported to and treated by Sedgwick County's Four-Mile Creek facility. In 2001, the WWSD entered into a contract to purchase the Four Mile Creek Treatment Facility and has been since responsible for providing operation and maintenance services for Plant and associated collection system. This added a significant number of customers to the WWSD.

2 The WWSD also was providing sanitary sewer service to the communities of Bel Aire and Oaklawn which during the 2000 Master Plan Update resided outside of the Wichita Corporate limits. As of December 2002, the City of Bel Aire no longer sends daily wastewater flows to the City of Wichita. Bel Aire is still capable of directing flows into the Wichita system in the event of an emergency; however they have not done so as of the release of this report.

3 Following the 2000 Master Plan Update, the City of Kechi elected to abandon its existing treatment facility and transfer its wastewater to the City of Wichita for treatment. Wichita began providing this service to Kechi in November of 2003.

4 All flows attributed to basin NWI (formally known as P3-EX) that were previously transported to Plant 2 are now treated at the CCWQRF.

5 Since the 2000 Master Plan Update, the City of Wichita has reached agreements with such entities as Maize, Valley Center, Kechi, and Bel Aire regarding the boundary of sewer service limits between them and WWSD.

6 MAPD has changed boundaries and re-projected anticipated land use for some basins and sub-basins, resulting in a change in populations for the basins and sub-basins.

7 The population projections indicate that while the total population projections for Sedgwick County have not changed significantly there appears to be in increase in the population projections for the surrounding communities. This validates the decrease in population projections within the current and potential Wichita service areas.

For these reasons, the population projections for this 2005 Master Plan Update have been recalculated and the projections show a slightly smaller service area population than the 2000 Sanitary Sewer Master Plan Update.

SECTION 3

Flow Quantity Projections

GENERAL

Historical flow data for 2003 through 2005 was obtained from the City's Sewage Treatment Division. Daily flow data for these three years was evaluated to determine average monthly and average annual flow for Plant No. 1, Plant No. 2, CCWQRF and the Four Mile Creek Treatment Facility. Detailed historical flow information from 2003 through 2005 for these facilities is provided in Appendix B and summarized below in Table 3-1.

Table 3-1. 2003-2005 Plant Flows

	Average Daily	*Max Day*	*Min Day*
Plant No. 1&2	35.50	64.26	23.24
CCWQRF	0.47	1.25	0.13
Four Mile Creek	1.90	7.80	0.98
TOTAL	37.92		

EVALUATION OF RECENT FLOW DATA

Future flows at each treatment facility are projected by establishing a historical per capita flow in gallons per day per capita (g/c/d). Since the historical population and flow data was not available for the same year, the historical flow data for each study area was estimated back into 2002. This was accomplished by plotting the average daily flow plus one standard deviation for each month available (2003-2005). A trend line was fitted to the data and a logarithmic equation was used to calculate flow values in 2002.

Table 3-2. Historical Per Capita Flows

	Time Period Evaluated	*Evaluation Results (MGD)*	*Values Selected to Represent 2002 Conditions*
Plants 1&2 Average Daily Flow (MGD)	2002		34.89
	2003	35.09	
	2004	35.66	
	2005	35.77	
Plants 1&2 Average Daily Flow plus one standard deviation (MGD)	2002		37.05
	2003	38.66	
	2004	39.41	
	2005	40.48	
CCWQRF Average Daily Flow (MGD)	2002		0.36
	2003	0.36	
	2004	0.50	
	2005	0.53	
CCWQRF Average Daily Flow plus one standard deviation (MGD)	2002		0.41
	2003	0.41	
	2004	0.62	
	2005	0.63	
Four Mile Creek Average Daily Flow (MGD)	2002		1.35
	2003	1.68	
	2004	1.88	
	2005	2.13	
Four Mile Creek Daily Flow plus one standard deviation (MGD)	2002		1.69
	2003	1.93	
	2004	2.33	
	2005	2.51	

Plants No. 1 and No. 2

The flows listed above include residential, commercial, and industrial sources. Since the majority of Wichita's industrial flows are included in the flows arriving at Plants No. 1 and 2, their total average annual flows plus one standard deviation were com-

bined (37.05 MGD) and the 2002 sewer service population which results in a rate of 110 g/c/d.

Recent flows for industrial contributors were obtained from the City's Sewage Treatment Division. In order to determine the residential and commercial flows, which will be primarily the development type in the future, the industrial flows were removed. The total industrial flow was reported to be 7.81 MGD (23 g/c/d). Appendix C lists the significant industrial users and their contributing flows. Removing this from the average combined annual flow of 37.05 MGD, the flow is reduced to 29.24 MGD. Applying this flow rate to the 2002 population, results in a per capita flow rate of approximately 87 g/c/d.

For the purposes of projecting theoretical residential and commercial flows, 90 g/c/d will be applied to the residential population in each basin. This method is supported by the likelihood that light commercial development such as restaurants, gas stations, stores, clinics, etc. will occur together with residential development.

The top four industrial contributors (Boeing, Raytheon, Cessna, and McConnell AFB) will be handled individually. The values in Table 3-3 reflect the flows from these four industries remaining constant at their 2004 values. Remaining industry, excluding top four, equals approximately 4.02 MGD (12 g/c/d). It is projected that moderately sized industries such as these will increase proportionally with population increases and therefore industrial flow (excluding top four) is projected at 12 g/c/d.

Consequently, flows projected from the current Plants No. 1 and No. 2 service areas will be 102 g/c/d (90+12) plus flows expected from the top four industrial contributors.

CCWQRF

The CCWQRF has been online since spring 2003 which limits the amount of historical data available. The actual data available suggests that the current flow loading is approximately 75 g/c/d which is significantly lower than the other service areas. Since it is not generally reliable to use such a low number for projections, and we can expect future growth in the area to more closely resemble flow loadings from Plants 1 and 2 in the future, the flow projections for CCWQRF utilize 90 g/c/d. It is not anticipated that this service area will see significant industrial contributions, therefore the projections will not allow for these types of flows.

Four Mile Creek

The recent historical data for Four Mile Creek gives a flow per capita of approximately 130 g/c/d. The plant was purchased from Sedgwick County by the City of Wichita in 2001 and has since undergone extensive improvements and expansion. The collection system that was included with the purchase of the plant is thought to have significant I/I flow. The City has committed to reducing such types of added flows to the collection system, and has been very successful with those efforts in relation to Plants 1 and 2 collection system. It is assumed that the City will begin efforts to reduce (inflow and infiltration) I/I in the Four Mile Creek collection system, and that by 2050 they will have decreased I/I by 15% which results in a 110 g/c/d flow in 2050. The flow projections use a straight line relationship to project the amount of I/I reduction in each projection year. These projections should be adjusted in future updates to more closely represent the actual amount of I/I reduction achieved within a certain time period.

Potential Service Areas

Potential service areas include residents that:

1 currently use some other form of wastewater treatment such as septic tanks
2 are considered undeveloped areas
3 are defined as smaller surrounding communities.

These potential service areas make up a significant portion of the flow that could be expected at each the individual plants around the City. In order to project these flows, it was assumed that each would have an average of 90 g/c/d.

FLOW PROJECTIONS

The flow projections for the service areas shown in Table 3-3 take into account the assumptions made above. A more detailed flow projection table (by sub-basin) is located in Appendix D.

Table 3-3. Flow Projections

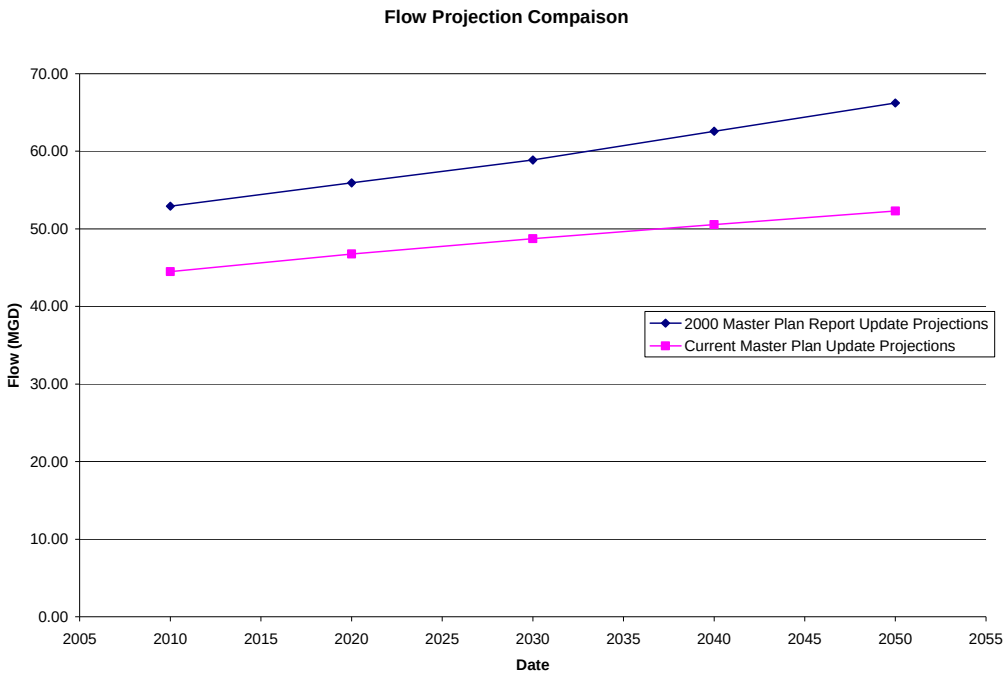
	2010 Flow (MGD)	*2020 Flow (MGD)*	*2030 Flow (MGD)*	*2040 Flow (MGD)*	*2050 Flow (MGD)*
Plants 1 & 2 (Current Service Area)	39.00	39.84	40.38	40.81	41.21
CCWQRF (Current Service Area)	0.76	0.84	0.86	0.87	0.88
4MC (Current Service Area)	2.15	2.44	2.65	2.62	2.60
City of Wichita Potential Service Areas	2.57	3.63	4.86	6.24	7.61
Surrounding Communities Service Areas	7.54	9.26	9.92	11.28	12.13
Total	52.01	56.02	58.66	61.82	64.43

COMPARISON TO 2000 MASTER PLAN PROJECTIONS

The 2002 Sanitary Sewer Master Plan Update reported the historical combined flow of Plant 1 and Plant 2 in 1997 was 41.14 MGD, and the 1997 sewer service population was 330,997 which resulted in a rate of 124 (g/c/d) that included residential, commercial, and industrial sources. Projections were made through 2050 based on this data.

Since the 2000 Update was prepared, the City staff has worked to reduce the amount of I/I flow into the distribution system. The result of their efforts is a 10.5 % reduction in total flow per capita. The difference in overall flow projections for Plants 1 and 2 are shown on Figure 3-1.

Figure 3-1. Flow Projection Comparison



SECTION 4

Organic Loading Projections

GENERAL

To determine the ability of a wastewater treatment facility to meet future demands, the facility is analyzed based on its hydraulic capacity and its organic loading capacity. The hydraulic capacity is simple and is based on the size of components and their capability to pass the liquid volume through without bypassing or exceeding certain overflow rates, velocity constraints, pumping rates, etc. The organic load capacity is defined by each treatment component's ability to remove organics to comply with regulatory requirements. The organic material is measured in terms of Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), and nutrients which consist of nitrogen and phosphorus. The regulatory requirements are defined by state and federal agencies as those standards which need to be met to maintain water quality in the receiving stream. These regulatory requirements are defined in Section 5. This Section will establish the organic loading which is arriving at the Treatment Facility currently and project the future organic loading that each facility must handle in future years.

The influent organic loading projections included in this report were estimated using historical data points (2003-2005) for each of the City's four wastewater treatment facilities. The influent data for Plant No. 1 and Plant No. 2 were averaged since the flows from Plant No. 1 are combined with Plant No. 2 and treatment for both occurs only at Plant No. 2. Data for Four Mile Creek and CCWQRF were examined individually.

Loading analysis must take into account the present and future demographics of the area. Any major change in demographics for an area could greatly affect the influent water quality characteristics in terms of concentration or mg/L, while the population change impacts the total quantity or pounds per day (ppd) expected.

The demographics for each of the three areas analyzed are not expected to change dramatically before 2050. Plant No. 1 and Plant No. 2 receive a considerable amount of the overall industrial and commercial flow which is expected to remain

constant through 2050. CCWQRF has some industry and commercial users, but is expected to remain primarily residential. Four Mile Creek is principally a residential treatment plant and growth is expected to continue. These expectations for demographic consistency within each area suggest that there will be no significant change in the influent water quality characteristics for any one treatment facility.

To project the influent water quality, the historical data provided by the City was used to calculate monthly and annual averages for water quality characteristics such as BOD_5, TSS, Ammonia (NH_3), total Kjeldahl Nitrogen (TKN), and total Phosphorus (TP).

After historical concentration data has been analyzed, the total historical mass loading of each of these parameter expected is calculated by multiplying concentration by flow and converting to standard units of ppd. This total daily mass is often correlated to population in a method similar to the per capita flow presented previously. The estimated service population chosen to represent conditions for a specific plant and year were used to determine pounds per capita per day (p/c/d) loading rates. To create a more cohesive picture of the loading trends, this data is then compared to the previous report and historical data. The information is then interpreted as a whole to minimize deviation due to anomalies present in the data.

BIOCHEMICAL OXYGEN DEMAND

BOD_5 is the measurement of the dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter measured over a 5 day period. A high BOD_5 typically corresponds with a higher load of organics in the wastewater.

BOD_5 data was obtained from the City for all three plants. A BOD_5 loading was calculated for each plant and assumptions were then made to calculate projections through 2050.

Plants 1& 2 Historical Data

The recent data for Plants 1 and 2 span from January 2003 to August of 2005 and can been seen in Appendix E. The data was analyzed and appears to decline drastically in 2003 from the data in the 2000 Master Plan Update before returning to levels at or above those of that report. There was no satisfactory explanation for the occurrence of this anomaly.

The ppd from both sets of data approach or exceed 90,000 ppd. This value was used in conjunction with the 2002 population data to calculate a loading of 0.27 p/c/d

which corresponds to the previous report's loading value. BOD_5 projections are based on this loading factor through 2050 for Plants No. 1 and No. 2 (Table 4-1).

CCWQRF Historical Data

The CCWQRF historical BOD_5 loading data begins at Plant start up in March of 2003 and continues somewhat sporadically through November of 2005. This data averages at 0.19 p/c/d.

This amount of historical data (less than three years) is not sufficient to project loadings over an approximately 50 year time period, especially considering the area is still rapidly developing. Before the plant was constructed, the flows in this service area were directed to Plants 1 and 2. Since loading concentrations can generally be considered uniform within a community this report will assume that the BOD_5 loading for CCWQRF are the same as Plant 1 and 2 at 0.27 p/c/d.

Four Mile Creek Historical Data

Four Mile Creek is also limited in the amount of influent loading data available since it was added to the system in 2001 and process upgrades were not complete until March of 2004. The data available (14 months) gives a loading of approximately 0.24 p/c/d which is not a significant difference from the Plant 1 and 2 data. In order to stay consistent and conservative, the loading projections for Four Mile Creek will also be made using 0.27 p/c/d.

Potential Service Areas

All potential service areas are projected using the 0.27 p/c/d value.

Updated BOD_5 Loading Projections

All service areas are projected using a BOD5 loading factor of the 0.27 p/c/d. The projections for each service area are presented in Table 4-1.

Table 4-1. BOD_5 Projections

	2010 BOD_5 (ppd)	*2020 BOD_5 (ppd)*	*2030 BOD_5 (ppd)*	*2040 BOD_5 (ppd)*	*2050 BOD_5 (ppd)*
Plants 1 & 2 (Current Service Area)	93,171	95,409	96,832	97,972	99,035
CCWQRF (Current Service Area)	2,267	2,528	2,566	2,604	2,643
4MC (Current Service Area)	4,468	5,277	5,956	6,163	6,370
City of Wichita Potential Service Areas	7,700	10,878	14,578	18,711	22,844
Surrounding Communities Service Areas	22,620	27,781	29,745	33,836	36,394
Total	130,226	141,872	149,678	159,287	167,285

TOTAL SUSPENDED SOLIDS

TSS are solid particles in water that will not settle under the force of gravity alone. Suspended solids can lead to the development of unsightly conditions as well as a depletion of oxygen in a receiving body of water if a wastewater is discharged without removal of TSS.

TSS data was obtained from the City for all three plants. A TSS loading was calculated for each plant and assumptions were then made to calculate projections through 2050.

Plants 1& 2 Historical Data

The recent data for Plants 1 and 2 span from January 2003 to August of 2005 and can been seen in Appendix E. The data mimics the decline seen in the BOD_5 data, but does not appear to have yet returned to the values reported in the previous Master Plan.

Because the anomaly does not exactly match the one seen in the BOD_5 data, a different approach was used to calculate the estimated TSS loading. Both sets of data (recent historical and historical data from the past report) were used to calculate an average TSS of approximately 81,000 ppd. This value was used in conjunction with the 2002 population data to calculate a loading of 0.24 p/c/d. This value is within the range given in the previous report (0.23 p/c/d – 0.27 p/c/d), but slightly higher than

the 0.23 p/c/d value used for that report's projections. TSS loading projections through 2050 for Plants No. 1 and 2 are seen in Table 4-2.

CCWQRF Historical Data

The recent historical TSS data for the CCWQRF was from 2003 and 2005. The 2003 data was not used out due to inconsistencies. As stated above in the BOD_5 discussion, the plant was not online before March of 2003, and data was not available during 2002 which is the only year with an actual population value. For this reason, the projections for this plant will use the 0.24 p/c/d noted above for Plants No. 1 and 2.

Four Mile Creek Historical Data

There are only 14 months of TSS data available for Four Mile Creek which established a loading of approximately 0.23 p/c/d. Since this is not a significant difference from the Plant 1 and 2 data, the projections for Four Mile Creek will utilize 0.24 p/c/d.

Potential Service Areas

All potential service areas are projected using the 0.24 g/c/d value.

Updated TSS Loading Projections

The forecast TSS contribution for Wichita Treatment Facilities is outlined in Table 4-2.

Table 4-2. TSS Projections

	2010 TSS (ppd)	*2020 TSS (ppd)*	*2030 TSS (ppd)*	*2040 TSS (ppd)*	*2050 TSS (ppd)*
Plants 1 & 2 (Current Service Area)	82,818	84,808	86,073	87,087	88,031
CCWQRF (Current Service Area)	2,016	2,247	2,281	2,315	2,349
FMC (Current Service Area)	3,971	4,691	5,294	5,478	5,662
City of Wichita Potential Service Areas	6,844	9,669	12,959	16,632	20,305
Surrounding Communities Service Areas	20,107	24,694	26,440	30,077	32,350
Total	115,756	126,108	133,047	141,588	148,698

AMMONIA, TOTAL KJELDAHL NITROGEN, TOTAL PHOSPHORUS

Like organic materials and total suspended solids which deplete the dissolved oxygen in the receiving stream, each of these compounds also have a negative impact. Ammonia is toxic to fish and other aquatic invertebrates. Total nitrogen and total phosphorus are essential nutrients in the growth of organisms, especially algae and other photosynthetic autotrophs. Without discharge limits, the receiving waters become impaired, currently, reduction of these compounds in treatment plant discharges are the focus of the EPA.

Ammonia is found in wastewaters in varying concentrations depending upon the origin of the wastewater, time of travel in the collection system, as well as other factors that effect the decomposition of organic nitrogen and the hydrolysis of urea. Organic nitrogen is comprised of proteins, peptides, nucleic acids and urea. These are the building blocks and waste products of most organic materials.

Total nitrogen consists of several stated of nitrogen that occurs in nature; in its most oxidative form it is nitrate, then nitrite, ammonia and organic nitrogen. Wastewater as it arrives at the treatment plant has concentrations of nitrate and nitrite that are almost non-existent. Therefore we measure Total Kjeldahl Nitrogen which is the sum of the organic nitrogen and ammonia. In a wastewater treatment plant where ammonia and organic nitrogen are oxidized then the concentrations of nitrate and nitrite become important.

Total phosphorus in wastewater is generally in the form of orthophosphates which are compounds in cleaning agents, fertilizers, food residues and body waste.

Ammonia

Less than two years of historical influent ammonia data is available for the CCWQRF and the Four Mile Creek Facility. The average ammonia concentration for the CCQWRF and Four Mile Creek Facility is 28.30 mg/L and 19.79 mg/L respectively. No new influent ammonia data was provided for Plants No. 1 and No. 2, but was reported in the 2000 Master Plan as being 21 mg/L. When this information is converted to a loading per capita, the plants ranged from 0.023 p/c/d at Four Mile Creek to 0.019 p/c/d at CCWQRF, with Plants No. 1 and No. 2 falling in the middle at 0.021 p/c/d. For the purpose of projections, 0.021 p/c/d will be used at all facilities. Projections for ammonia can be found in Table 4-3.

Table 4-3. Ammonia Projections

	2010 Ammonia (ppd)	*2020 Ammonia (ppd)*	*2030 Ammonia (ppd)*	*2040 Ammonia (ppd)*	*2050 Ammonia (ppd)*
Plants 1 & 2 (Current Service Area)	7,247	7,421	7,531	7,620	7,703
CCWQRF (Current Service Area)	176	197	200	203	206
4MC (Current Service Area)	347	410	463	479	495
City of Wichita Potential Service Areas	599	846	1,134	1,455	1,777
Surrounding Communities Service Areas	1,759	2,161	2,314	2,632	2,831
Total	10,129	11,034	11,642	12,389	13,011

Total Kjeldahl Nitrogen (TKN)

No historical influent TKN information was available for the City's wastewater treatment facilities. Since TKN represents the total nitrogen in the wastewater, and the ammonia portion typically represents 75%-80% of the combined total, a loading rate of 0.028 p/c/d will be used to project TKN at all facilities. The total ppd are projected in Table 4-4.

Table 4-4. TKN Projections

	2010 TKN (ppd)	*2020 TKN (ppd)*	*2030 TKN (ppd)*	*2040 TKN (ppd)*	*2050 TKN (ppd)*
Plants 1 & 2 (Current Service Area)	9,662	9,894	10,042	10,160	10,270
CCWQRF (Current Service Area)	235	262	266	270	274
FMC (Current Service Area)	463	547	618	639	661
City of Wichita Potential Service Areas	799	1,128	1,512	1,940	2,369
Surrounding Communities Service Areas	2,346	2,881	3,085	3,509	3,774
Total	13,505	14,713	15,522	16,519	17,348

Total Phosphorus

Influent phosphorus data was provided for CCWQR and Plant No. 2. The average concentration at CCWQRF was 7.2 mg/L and at Plant No. 2 was 6.2 mg/L. When converted to a loading per capita, both facilities were at or slightly over 0.005 p/c/d. Due to the limited amount of historical data available 0.006 p/c/d will be used for TP projections at all facilities. Projections can be seen in Table 4-5.

Table 4-5. Total Phosphorus Projections

	2010 TP (ppd)	*2020 TP (ppd)*	*2030 TP (ppd)*	*2040 TP (ppd)*	*2050 TP (ppd)*
Plants 1 & 2 (Current Service Area)	2,070	2,120	2,152	2,177	2,201
CCWQRF (Current Service Area)	99	117	132	137	59
FMC (Current Service Area)	50	56	57	58	142
City of Wichita Potential Service Areas	171	242	324	416	508
Surrounding Communities Potential Service Areas	503	617	661	752	809
Total	2,894	3,153	3,326	3,540	3,717

SECTION 5

Water Quality Requirements and Discharge Standards

INTRODUCTION

A critical goal for the development of any wastewater collection system and treatment facility planning effort is to have an understanding of the existing and anticipated regulations and standards and those agencies which are required to enforce the standards. To this end, representatives from the Kansas Department of Health and Environment (KDHE) who have primacy and represent the Environmental Protection Agency (EPA) have been asked to review and comment on the current and anticipated future regulations presented in this document. A meeting was held in Topeka on March 22, 2006 to discuss the impact of regulations on the City of Wichita as they relate to projecting future conditions at the wastewater treatment facilities.

EXISTING REGULATIONS

Current Water Quality Standards

The discharge of wastewater into the receiving waters of the United States must be managed to protect public health, maintain water quality, and comply with federal and state requirements. The Kansas Water Quality Standards are used by the KDHE in the development of permit conditions for the National Pollutant Discharge Elimination System (NPDES) program. These conditions determine the degree, and often the type, of wastewater treatment necessary. The quality of effluent discharged is controlled by designated stream classification, instream water quality standards, and resultant discharge permit limits.

In the State of Kansas, pollution control of surface waters is governed through Kansas Administrative Regulations (K.A.R.) 28-16-28b through 28-16-28f. The intent of these rules is to protect and improve the quality of surface water for human consumption, wildlife, fish and other aquatic life, industry, recreation, and other pro-

duction and beneficial uses. The KDHE has been designated as the responsible governmental unit for implementing this program.

K.A.R. 28-16-28b through 28-16-28f set standards for instream water quality through designated use classifications. The following classifications for the State of Kansas waters have been established.

Table 5-1. State of Kansas Water Classifications

Classification	*Designated Use*
Agricultural Water Supply	Irrigation
	Livestock watering
Aquatic Life Support	Special - threatened or endangered species
	Expected - habitat type and indigenous biota commonly found or expected in the state
	Restricted - indigenous biota limited in abundance or diversity by the physical quality of the habitat
	Production of potable water
Food Procurement	Aquatic or semi-aquatic life for human consumption
Groundwater Recharge	Replenishing groundwater
Industrial Water Supply	Non-potable uses by industry
Recreational	Primary Contact Recreation - body immersed, probable ingestion
	Secondary Contact Recreation - ingestion not probable

Stream Use Designations

Plant No. 1, located at K-135 and 31st Street South serves central and east Wichita and provides screening, influent pumping, and extraneous flow holding. The flow from Plant No. 1 is then conveyed to Plant No. 2, which is located approximately three miles further south. At this location, flow from the west side of Wichita receives influent pumping and primary treatment, the flow from Plant No. 1 receives

additional primary treatment, and the flow to both facilities is provided secondary treatment, re-aeration, and disinfection. The effluent from Plant No. 2 enters Segment 3 of the Arkansas River located in the Lower Arkansas River Basin. The use designation for this River Segment is all of those classifications noted in Table 5-1 with Aquatic Life Support being labeled as "Special" and Recreational being labeled as "Primary Contact". The river segment is by law or written permission of landowner open to and accessible by public.

The CCWQRF is located east of 135th Street, north of 37th Street, and south of 45th Street. The facility provides primary, secondary, and tertiary treatment for flows generated in northwest portions of Wichita. Treated wastewater effluent from CCWQRF is discharged to Segment 10 of the Cowskin Creek which is part of the Lower Arkansas River Basin. The use designation for this Segment is all of those classifications noted Table 5-1 with Aquatic Life Support being labeled as "Expected" and Recreational being labeled as "Primary Contact". The river segment is by law or written permission of landowner open to and accessible by public.

The Four-Mile Creek Plant is located near 159th and Harry Street. The effluent from this plant enters Segment 16 of the Four Mile Creek located in the Walnut River Basin. The use designation for this Segment is all of those classifications noted above with Aquatic Life Support being labeled as "Expected" and Recreational being labeled as "Primary Contact" The river segment is not open to and accessible by the public under Kansas Law.

Kansas Discharge Permitting System

The NPDES permit is enforced by the State of Kansas through the office of KDHE. The KDHE office requires that effluent discharge permits be obtained for all point sources discharging wastewater into state waters. A point source is defined as "any discernible, confined, and discrete conveyance from which pollutants are or may be discharged" (United States Environmental Protection Agency (U.S. EPA), 1983). Pollutants to be regulated include liquid and solid wastes of chemical, biological, or physical nature, which are discharged into surface waters. The NPDES permit is typically renewed every five years.

An effluent discharge permit issued under NPDES includes two main elements: specific effluent limits for each regulated pollutant being discharged, and effluent monitoring requirements.

Effluent limits in Kansas NPDES permits reflect two levels of treatment requirements. The first level, referred to as technology-based limits, is based on tech-

nological treatment capabilities and provides the minimum degree of treatment required before discharge.

The second level of treatment requirements, termed water-quality-based effluent limits, may be imposed on municipal and industrial dischargers if technology-based limits are insufficient to protect and maintain designated water uses. These water-quality-based limits are defined by total maximum daily loads (TMDLs), which are the maximum quantities of pollutants that can be carried by receiving water without adversely affecting water uses (Federal Water Pollution Control Act, 1972). The TMDLs are proportioned among dischargers on a given river segment through a waste load allocation procedure (U.S. EPA, 1983).

The KDHE has published a document titled "Surface Water Nutrient Reduction Plan" dated December 29, 2004. The document provides a background of goals and challenges associated with implementation of nutrient reduction and development of nutrient criteria. The State of Kansas has selected an approach that strives to achieve 30% reduction for nitrogen and phosphorus with a coordinated effort of both point and non-point source reductions. Point source reduction will affect the City of Wichita Wastewater Treatment Plants. The KDHE proposes that "technology-based nutrient limitations be phased into municipal wastewater treatment facility (WWTF) permits over the next 15 years, or three permit cycles." Technology based biological nutrient removal (BNR) will be expected to meet, on an annual average, limits of 8 mg/L for Total Nitrogen (TN) and 1.5 mg/L for TP. All NPDES permits can be expected to incur on their next permit renewal a requirement to establish a plan for meeting nutrient limits.

For the purpose of this Master Plan Update, anticipated NPDES limits for nutrients at Wichita's wastewater treatment facilities can be determined by multiplying the projected future total flow for all facilities times the maximum concentrations of 8 TN/1.5 TP to obtain a maximum total load (pounds) discharged to receiving streams. All points of discharge ultimately reach the Arkansas River within the state of Kansas. Through the master planning effort, that load can be proportioned between the respective NPDES permits. The forecasted effluent limits in the tables that follow assume that each plant will need to be individually capable of meeting 8 TN/1.5 TP.

Existing and Anticipated NPDES Permit Requirements

Wichita's Wastewater Treatment Plants No. 1 and No. 2. The City of Wichita was issued a NPDES permit, No. M-AR94-IO01 (Federal Permit No. KS 0043036) on November 7, 2003, that identified effluent limitations, monitoring requirements, and

other conditions for wastewater discharge from Plant No. 2 (-001 outfall) or from the Extraneous Flow Basin at Plant No. 1 (-002 outfall). The current permit became effective on January 1, 2004 and will expire on December 31, 2007. This permit is based upon the Plant No. 2 design effluent flow of 54 MGD discharging to the Lower Arkansas River. However, the newer facilities of CCWQRF, Four Mile Creek Wastewater Treatment Facility, and the Mid-Continent Wastewater Treatment Facility currently under design produce an effluent quality with lower concentrations of nutrients. Consequently, Plant No. 2 nutrient upgrade could be completed in phases.

Table 5-2. Plants No. 1 and 2 Current and Forecasted Design Effluent Limits

Limits	*Current Wichita Plants No. 1 and 2 NPDES Limits*		*Forecast and Design Limits for Wichita Plants No. 1 and 2*	
	*-001 Outfall **	*-002 Outfall ***	*-001 Outfall*	*-002 Outfall*
BOD_5 (mg/L), Monthly Average	*20 (June–Aug)* *25 (April, May, Sept. & Oct)* *30 (Nov-March)*	*Monitor* *(daily per occurrence)*	*15*	*Monitor* *(daily per occurrence)*
TSS (mg/L), Monthly Average	*30*	*Monitor* *(daily per occurrence)*	*15*	*Monitor* *(daily per occurrence)*
Ammonia Nitrogen (as N, mg/L), Monthly Average	*7.3 (Jan)* *5.8 (Feb & Dec)* *4.1 (March)* *3.5 (April)* *2.6 (May)* *1.7 (June & July)* *3.1 (Aug)* *3.6 (Sept)* *6.1 (Oct)* *6.8 (Nov)*		*1*	
Dissolved Oxygen (mg/L), Weekly Average	*6.0*		*5.0*	

pH	*6-9*	*Monitor*	*6-9*	*Monitor*
Fecal Coliform (colonies/100 ml), Monthly Geom. Average	*200 (April-Oct)* *2000 (Nov-March)*	*Monitor* *(daily per occurrence)*	*200 discharge/ 20 re-use*	*Monitor* *(daily per occurrence)*
Nitrate & Nitrite (as N, mg/L)	*Monitor Monthly*		*Monitor*	
Total Kjeldahl Nitrogen (as N, mg/L)	*Monitor Monthly*		*Monitor*	
Total Nitrogen (as N, mg/L)	*Calculate Monthly*		*8.0*	
Phosphorus (mg/L)	*Monitor Monthly*		*1.5*	
Temperature (C)	*Monitor Weekly*			
Chlorides (mg/L)	*Monitor Monthly*			
Sulfates (mg/L)	*Monitor Monthly*			
Whole Effluent Toxicity (%)	*66% effluent NOEC (Conduct Quarterly)*			
Priority Pollutant Scan	*128 parameters (once in permit period)*			

*Minimum removal of 85% required for BOD_5 and TSS

**-001 outfall must be discharging at or above 54 MGD prior to allowing any discharge of effluent through the -002 outfall

Wichita's Four Mile Creek Wastewater Treatment Plant. The City of Wichita was issued a NPDES permit, No. M-WA01-OO02 (Federal Permit No. KS0081973) on August 24, 2005, that identified effluent limitations, monitoring requirements, and other conditions for wastewater discharge from the Four Mile Creek facility. The current permit became effective on October 1, 2005 and will expire on September 30, 2010. This permit is based upon the design effluent flow of 3.0 MGD discharging to Four Mile Creek.

Table 5-3. Four Mile Creek Current and Forecasted Design Effluent Limits

Limits	*Current Four Mile Creek WWTF NPDES Limits*	*Forecast and Design Limits for Four Mile Creek WWTF*
	*(1 permitted outfall) **	
BOD_5 (mg/L), Monthly Average	*20 (April-Oct)* *25 (Nov-March)*	*15*
TSS (mg/L), Monthly Average	*30*	*15*
Ammonia Nitrogen (as N, mg/L), Monthly Average	*4.8 (Nov-Feb)* *2.9 (March & Oct)* *2.7 (April)* *2.2 (May)* *1.7 (June)* *1.5 (July)* *1.6 (August)* *2.1 (Sept)*	*1*
Dissolved Oxygen (mg/L), Weekly Average	*6.0*	*5.0*
pH	*6-9*	*6-9*
Fecal Coliform (colonies/100 ml), Monthly Geom. Average	*200 (April-Oct)* *2000 (Nov-March)*	*200 discharge/ 20 re-use*
Nitrate & Nitrite (as N, mg/L)	*Monitor Monthly*	*Monitor*
Total Kjeldahl Nitrogen (as N, mg/L)	*Monitor Monthly*	*Monitor*
Total Nitrogen (as N, mg/L)	*Calculate Monthly*	*8.0*

Phosphorus (mg/L)	*Monitor Monthly*	*1.5*
Total Residual Chlorine (Daily maximum, ug/L)	*13*	
Whole Effluent Toxicity (%)	*82% effluent IC25 (Conduct Annually)*	
Priority Pollutant Scan	*128 parameters (once in permit period)*	

*Minimum removal of 85% required for BOD_5 and TSS

Wichita's Cowskin Creek Water Quality Reclamation Facility. The City of Wichita was issued a NPDES permit, No. M-AR94-OO03 (Federal Permit No. KS0095681) on May 29, 2002, that identified effluent limitations, monitoring requirements, and other conditions for wastewater discharge from the CCWQRF. The current permit became effective on June 1, 2002 and will expire on May 31, 2007. This permit is based upon the design effluent flow of 2.0 MGD discharging to the Cowskin Creek.

Table 5-4. CCWQRF Current and Forecasted Design Effluent Limits

Limits	*Current CCWQRF NPDES Limits*	*Forecast and Design Limits for CCWQRF*
	*-001 Outfall and -002 Outfall have identical effluent parameters**	*-001 Outfall and -002 Outfall have identical effluent parameters**
BOD_5 (mg/L), Monthly Average	*20 (June–Aug)* *25 (May & Sept)* *30 (Oct-April)*	*15*
TSS (mg/L), Monthly Average	*30*	*15*
Ammonia Nitrogen (as N, mg/L), Monthly Average	*5.2 (Nov-Feb)* *3.2 (March & Oct)* *2.8 (April)*	*1*

	2.1 (May) *1.6 (Jun & Aug)* *1.7 (July)* *2.3 (Sept)*	
Dissolved Oxygen (mg/L), Weekly Average	*5.0*	*5.0*
pH	*6-9*	*6-9*
Fecal Coliform (colonies/100 ml), Monthly Geom. Average	*200*	*200 discharge/ 20 re-use*
Nitrate & Nitrite (as N, mg/L)	*Monitor Monthly*	*Monitor*
Total Kjeldahl Nitrogen (as N, mg/L)	*Monitor Monthly*	*Monitor*
Phosphorus (mg/L)	*Monitor Monthly*	*8.0*
Chlorides (mg/L)	*Monitor Monthly*	
Whole Effluent Toxicity (%)	*76% effluent NOEC (Conduct Annually)*	
Priority Pollutant Scan	*128 parameters (once in permit period)*	

*Minimum removal of 85% required for BOD_5 and TSS

Wichita's Future Mid-Continent Treatment Plant (Plant No. 5.) The KDHE provided a letter dated August 16, 2004 proposing anticipated effluent limits based on the water quality standards at that time. KDHE identified the proposed discharge as Kansas Permit No. M-AR94-OO05. The proposed limits were based upon a design effluent flow of 3.0 MGD discharging to the Cowskin Creek. The KDHE letter noted that Cowskin Creek is presently impaired based on nutrients and oxygen demand impact.

Table 5-5. Mid-Continent (Plant No. 5) Forecasted Design Effluent Limits

Limits	Forecast Mid-Continent WWTF NPDES Limits	Design Limits for Mid-Continent WTF
	(assumes 1 permitted outfall) *	15
BOD_5 (mg/L), Monthly Average	25 (Nov-March) 20 (April-Oct)	15
TSS (mg/L), Monthly Average	30	1
Ammonia Nitrogen (as N, mg/L), Monthly Average	4.8 (Dec-Feb) 2.9 (March & Oct) 2.5 (April) 1.9 (May) 1.5 (Jun) 1.4 (Jul & Aug) 2.0 (Sept) 4.4 (Nov)	5.0
Dissolved Oxygen (mg/L), Weekly Average	5.0	6-9
pH	6-9	200 discharge/ 20 re-use
Fecal Coliform (colonies/100 ml), Monthly Geom. Average	200	Monitor
Nitrate & Nitrite (as N, mg/L)	Monitor Monthly	Monitor
Total Kjeldahl Nitrogen (as N, mg/L)	Monitor Monthly	8.0
Phosphorus (mg/L)	Monitor Monthly	1.5

Chlorides (mg/L)	*Monitor Monthly*	
Lead (mg/L)	*Monitor Monthly*	
Copper (mg/L)	*Monitor Monthly*	
Whole Effluent Toxicity (%)	*82% effluent NOEC (Conduct Annually)*	
Priority Pollutant Scan	*128 parameters (once in permit period)*	

*Minimum removal of 85% required for BOD_5 and TSS

Wichita's Potential Future Satellite Facilities (Small Stream Direct-Discharge). It is assumed for this study, that any potential satellite facilities will have direct effluent discharge into small streams. The proposed effluent standards will require that potential satellite facilities be provided the capability to disinfect the wastewater discharged on a year-round basis. This will also be true of the ammonia removal requirement. As discussed previously, technology based biological nutrient removal (BNR) will be expected to meet, on an annual average, limits of 8 mg/L for Total Nitrogen (TN) and 1.5 mg/L for Total Phosphorus (TP). Filtration is not required at this time, but the hydraulic and process scheme should be designed to accommodate this component, as filtration will be a tool which can be used to meet lower phosphorus limits in the future and if regulations result in limits that are below the levels that can be achieved biologically. Metals removal has not been an issue and was not addressed by KDHE staff.

POTENTIAL FUTURE REGULATORY CHANGES

Effluent Re-Use

Clarification of the requirement for providing a chlorine residual at the sprinkler head, when Ultraviolet (UV) was used as the disinfection method at the treatment plant, for golf course irrigation was requested. KDHE indicated that the requirement was currently being investigated, and may be eliminated.

The ability to reduce the load (pounds) discharged to the receiving stream by incorporating effluent re-use was discussed as a tool for dealing with TMDL's as well as TN and TP when the discharge concentration is calculated as an annual average.

KDHE agreed that the reduction in load to the receiving stream could be taken as a credit, provided that the method in which the water was re-used did not result in ultimate discharge to a surface water body at a different location.

Pharmaceuticals

KDHE staff's only comment regarding potential regulations for pharmaceuticals in WWTP discharges was that the construction of a new facility should provide for additional, it would be advisable to leave extra room in the hydraulic grade to allow for future "tail-end treatment add-ons."

Proposed Sanitary Sewer Overflow (SSO) Regulations

The EPA signed a notice of proposed rulemaking on January 4, 2001 concerning overflow occurrences from municipal sewer collection systems (40 CFR Parts 122 and 123.) The fundamental purpose of the proposed rules is to recognize the fact that sanitary sewer overflows present important concerns for public health and the environment. As of January 20, 2001, the document was withdrawn from the Office of the Federal Register and has yet to be implemented for several reasons. What appears certain, however, is that EPA is serious about sanitary sewer overflows and the rule, and associated Capacity, Management, Operation and Maintenance (CMOM) program, will be promulgated eventually. It is imperative that the City prepare for this Program and continue to establish methods to control and prevent sanitary sewer overflows.

In general, the proposed regulations prohibit any sanitary sewer system discharges prior to the headworks of a publicly owned treatment works (POTW) treatment facility, unless it can be proved that the discharge was caused by severe natural conditions or was unavoidable despite proper management, operation and maintenance of the system. Documentation of proper management, operation, and maintenance of the system will require implementation of a CMOM program.

CMOM Overview

The six key components of CMOM are:

1 General Standards
2 Management Program

3 Overflow Response Plan
4 System Evaluation and Capacity Assurance Plan
5 CMOM Program Audits
6 Communications

General Standards

The general standards are that the City properly manage, operate and maintain the Collection and Treatment System. They must provide adequate capacity to handle peak flows. And the City should incorporate all feasible steps to stop and mitigate all sanitary sewer overflows. Included in this effort is also notification of parties affected by sanitary sewer overflows and providing access to the public of a written summary and audit of the program.

Management Program

The City must be empowered to perform the work and should have goals, an organization to perform work, and a way of measuring performance based on established activities. This would include design standards and performance. The management efforts would also include monitoring, measurement, and program modifications.

Overflow Response Plan

Every identified overflow must be reported, investigated by appropriate personnel and a response effort be made. After proper notification of governmental agencies a follow up plan must be activated by trained staff, and if required an emergency response be implemented.

System Evaluation and Capacity Assurance Plan

If peak flows are contributing to the SSO, the City must prepare and implement a Plan. The three components of the plan are 1) evaluation, 2) Capacity enhancement measures, and 3) Plan updates.

Program Audits

Cities will be required to perform an audit. This will require identification of the SSO, evaluation of the City's CMOM Program and compliance with the regulation, identification of any deficiencies and the steps required to correct the problems.

Communications

The holder of the NPDES Permit will need to communicate with all parties on "a regular basis." The communication process should provide for input from all interested parties.

Master Planning and CMOM Implementation

One of the six key components of CMOM listed above is the Capacity Assurance Plan. Essentially this Capacity Assurance Plan is required to certify that the City has the ability to handle all flows (future and satellite systems). If not, the plan must identify those problem areas and develop a plan to provide the needed capacity. This would include identified projects with associated costs and schedules to be completed. Then it is imperative to develop an implementation plan and modify the plan as needed.

Developing this plan is important because all of the criteria set out such as design storm, pipeline capacity determinations, etc. are the guidelines for defense of the CMOM Program. Dynamic Sewer models that are calibrated will likely be required to define the capacity issues and provide the City with the guidelines needed to avert the sanitary sewer overflow. Types of improvements that will need to be considered will be increased pipeline capacity for transportation of flow in the larger mains and increased treatment facilities capacity. Other options are elimination of Infiltration and Inflow and constructed system storage. Storage is a viable option but location is critical and potential odors must taken into consideration.

Master Planning is a tool to meet these fundamental requirements of a CMOM program. These requirements are accomplished by developing a good system map which is field verified, selecting a computer model that is appropriate and utilizing it, performing the I/I evaluations as budget allows, and considering where and how storage can be implemented into the collection system or at the treatment facility. Included in this work would be open discussions with all satellite communities that discharged into the City's collection system.

The proposed regulations would be enforced through the jurisdiction of the NPDES permitting process. Consequently, it is recommended that the City of Wichita be fully aware of the outcome of the SSO regulations and their impacts when they are issued in their final form.

Proposed Policy Regarding NPDES Permit Requirements for Peak Wet Weather Discharges from POTW Treatment Plants Serving Separate Sanitary Sewer Collection Systems

The following is a summary of the draft peak wet weather discharge policy from EPA. Should the City ever be placed in a position of bypassing, it is important to understand what the rules are, how they came about, and how to comply. The EPA provided notice on December 22, 2005 that comments were being invited on a draft policy regarding NPDES permit requirements for peak wet weather discharges from POTW serving separate sanitary sewer collection systems.

History

A previous interpretation on the issue was released for public comment on November 7, 2003. EPA's proposed action was not a rule change. Blending is a longstanding wastewater treatment practice that predates the 1972 Clean Water Act. It involves routing excess primary treated flows around secondary (biological) treatment processes, and combining them with secondary treated flows before discharging it to the environment. Blending is used to keep the microbes in biological processes from being washed away during severe storms. If that happens, treatment plant staff must wait several weeks for a new colony of microbes to mature before wastewater can receive full secondary treatment again.

EPA received significant public comment on the proposed policy, and retracted that document. As a result of this retraction of the proposed guidance document, the Natural Resources Defense Council (NRDC) and the National Association of Clean Water Agencies (NACWA) provided EPA with a joint proposal recommending an approach significantly different than the November 2003 proposal. On December 22, 2005 another draft policy was developed.

December 2005 Draft Policy

The December 2005 Draft Policy provides extensive comment on the Agency's interpretation of 40 CFR 122.41(m), the bypass regulation. This policy: (1) interprets 40 CFR 122(m)(4) as it applies to peak wet weather flow diversion around secondary treatment units at POTW treatment plants serving separate sanitary sewer systems where the flow is recombined with the plant effluent before discharge, (2) interprets

40 CFR 122.41(m)(4)(i)(B) no feasible alternatives, (3) does not apply to overflows prior to the headworks of a POTW, dry weather diversions, diversions around primary or tertiary units, or diverted flow that is not recombined with effluent from secondary units prior to discharge, (4) promotes the use of measures to provide the highest possible treatment to the greatest possible peak wet weather flow and, (5) promotes reporting and public notification of peak wet weather diversion events. A combination of approaches can be used to achieve compliance with this policy: (1) ensure full utilization of available secondary treatment capacity, (2) reduce I/I, (3) maximize the use of the collection system for storage, (4) provide off-line storage and (5) provide sufficient secondary treatment capacity.

In order to avail itself of this policy the POTW treatment plant serving a separate sanitary sewer collection system needs to submit a "No Feasible Alternatives Analysis" to the NPDES permitting authority at the time of the next NPDES permit renewal. For a POTW operator that is applying for a peak wet weather flow diversion at a treatment plant as an anticipated event the analysis must include: (1) documentation of the current treatment plant treatment unit design and maximum flow capacities and the feasibility of increasing the flow through the units, (2) estimates of the frequency, duration, and volume of current wet weather diversions and evaluate alternatives to reduce the frequency, duration and volumes of such occurrences and the related costs, (3) estimates of future diversions based on weather predictions, population growth, and treatment plant changes and evaluate the options for reducing the flow diversions, (4) assess other ways to reduce peak wet weather volumes, (5) evaluate different technologies that are or could be used to provide additional treatment to peak wet weather diversions at the POTW and the costs of implementing these techniques, (6) evaluate the extent to which the permitee is maximizing its ability to reduce I/I in its own collection system but also includes an evaluation of the surrounding satellite municipal collection systems, (7) evaluates the peak flow reductions possible through the implementation of a CMOM program, (8) addresses the ability of the community served to fund the peak wet weather flow improvements discussed in the analysis, proposes a protocol for monitoring the recombined flow at least once daily during all diversions, (9) project the POTW effluent improvements and other improvements in the collection system should the technologies, practices and/or other measures be implemented as discussed in the analysis.

BIOSOLIDS FRAMEWORK

The City of Wichita has a consolidated biosolids handling facility located at Plant No. 2. Biosolids generated at all wastewater treatment facilities operated by the City of Wichita are transported to Plant No. 2 where they receive final processing at this central location. The City of Wichita also currently contracts with some neighboring communities for processing and land application of their wastewater treatment biosolids.

The regulatory requirements most significantly related to the City of Wichita's biosolids program are outlined in the following sections.

Standards for the Use and Disposal of Sewage Sludge, 40 CFR Part 503 Regulations

The final 40 CFR Part 503 regulations were published in February, 1993. The major requirements which affect the City of Wichita are:

- Land application
- Pathogen reduction (Class A and Class B)
- Vector attraction reduction
- Permits

These requirements are briefly outlined below.

Land Application. Biosolids application to agricultural and non-agricultural land, reclamation sites, public contact sites, and home lawns and gardens is limited by the pollutants in the biosolids. Biosolids must be applied at agronomic rates not to exceed the plant nitrogen requirements established by KDHE. Table 5-6 lists the federal pollutant limits. These limits are applied to land application as follows:

- All biosolids for land application must be less than the Pollutant Ceiling Concentration and the Cumulative Pollutant Loading.
- Biosolids applied to lawns and gardens must meet the Alternate Pollutant Concentration.
- Biosolids given away or sold to the public must meet the Alternate Pollutant Concentration, or the Annual Pollutant Loading.

Table 5-6. Land Application Pollutant Limits

Pollutant	*Pollutant Ceiling Concentration, mg/kg*	*Cumulative Pollutant Loading, kg/ha*	*Alternate Pollutant Concentration "EQ sludge", mg/kg*	*Annual Pollutant Loading Rate. Limits for APLR Biosolids kg/ha/yr*
Arsenic	75	41	41	2.0
Cadmium	85	39	39	1.9
Copper	4,300	1,500	1,500	75
Lead	840	300	300	15
Molybdenum	75			
Mercury	57	17	17	0.85
Nickel	420	420	420	21
Selenium	100	100	36	5.0
Zinc	7,500	2,800	2,800	140

NOTES:
1. 1 ton = 900 kg
2. 1 acre = .4047 hectares
3. mg/kg - milligrams per kilogram
4. kg/ha - kilograms per hectare

Pathogen Reduction. Class A and Class B pathogen reduction requirements for land application are established by the Part 503 regulations. Class A pathogen reduction is required for public distribution and for lawns and gardens. All other land application methods require Class B pathogen reduction although significant site restrictions will apply to Class B land application.

Class A: Either 1,000 most probable number (MPN) fecal coliform/gram total dry solids, or 3 MPN salmonella/4 grams total dry solids, and one of the following:

- **Thermally Treated Biosolids** – Biosolids must be subjected to one of four time-temperature regimes.
- **Biosolids Treated in a High pH – High Temperature Process** Biosolids must meet specific pH, temperature, and air drying requirements.
- **Biosolids Treated in Other Processes** – Process must demonstrate reduction of enteric virus and viable helminth ova. Maintain operating conditions used in the demonstration after pathogen reduction demonstration is complete.
- **Biosolids Treated in Unknown Process** – Biosolids must be tested for pathogens – Salmonella sp. Or fecal coliform bacteria, enteric viruses and viable helminth ova at the time the biosolids are used or disposed, or, in certain situations, prepared for use or disposal.

- **Biosolids Treated in a PFRP** – Biosolids must be treated in one of the following Processes to Further Reduce Pathogens (PFRP) which include:

1 Composting
2 Heat treatment
3 Heat drying
4 Thermophilic aerobic digestion
5 Pasteurization
6 Beta Ray Irradiation
7 Gamma Ray Irradiation

- **Biosolids Treated in a Process Equivalent to a PFRP** – Biosolids must be treated in a process equivalent to one of the other PFRP's as determined by the permitting authority.

Class B: 2,000,000 MPN fecal coliform/gram total dry solids and a process to significantly reduce pathogens (PSRP) which includes:

- Anaerobic digestion
- Aerobic digestion
- Air drying
- Composting
- Lime stabilization
- Other PSRP equivalent process

Vector Attraction Reduction (vectors include flies, mosquitoes, fleas, rodents, and birds). This requirement addresses the stabilization of biosolids prior to disposal and requires one of the following processes to achieve this stabilization.

- Reduce the mass of volatile solids by a minimum of 38%
- Demonstrate vector attraction reduction with additional anaerobic digestion in a bench scale unit.
- Demonstrate vector attraction reduction with additional aerobic digestion in a bench scale unit.
- Meet a specific oxygen uptake rate for aerobically treated biosolids.
- Use aerobic processes at greater than 40 degrees C for 14 days or longer (e.g. during composting)
- Add alkaline materials to raise the pH under specific conditions.
- Reduce the moisture content of biosolids that do not contain unstabilized solids from other than primary treatment to at least 75% solids.
- Reduce moisture content of biosolids with unstabilized solids to at least 90%.
- Inject biosolids beneath the soil surface within a specific time, depending on the level of pathogen treatment.

- Incorporate biosolids applied to or placed on the land surface within specified time periods after application to or placement on the land surface.

Permits. The Part 503 regulations require permits for all wastewater plants generating biosolids. The permit application is required six months before the expiration of the existing NPDES permits for the treatment plant. The information required for a permit application includes:

- Biosolids monitoring data and annual volumes.
- Available groundwater monitoring data for landfills or land application sites.
- Description of biosolids use or disposal practices including location of application or disposal sites, contractors who apply biosolids, and distributors who market biosolids.
- A land application plan for each site including:

1 Geographical area covered by plan.
2 Site selection criteria.
3 How the site will be managed.
4 Advance notice to permitting authorities, adjacent landowners and occupants, and to the public (if required by the State).

Additional Applicable Regulations

Wastewater treatment and biosolids handling can also be affected by additional laws and regulations, as described below.

Kansas Department of Health and Environment Minimum Standards of Design

The KDHE provides Minimum Standards of Design for Water Pollution Control Facilities. These documents cover most aspects of the wastewater treatment plant.

The KDHE standards for biosolids are identical to the EPA Part 503 regulations with the following addition relative to land application:

- Biosolids storage sites and drying beds must be lined or paved, and runoff and leachate controlled and treated.

Clean Water Act (CWA)

The federal CWA establishes requirements for all discharges to surface waters through the NPDES permit process. The authority for the Part 503 Sludge regulations is also provided by the CWA.

All point source dischargers are required to have an NPDES permit and to comply with the required effluent conditions. Biosolids management in compliance with the Part 503 regulations is required as part of the NPDES permit.

Industrial waste pretreatment requirements are also part of the CWA requirements. In establishing local limits for pretreatment, biosolids use must be considered.

RCRA Hazardous Waste Regulations, 40 CFR Part 261

RCRA regulations define and control the handling of hazardous waste. Wastewater biosolids are exempt from RCRA requirements unless it is determined to be a hazardous waste through testing of toxicity characteristics (Toxicity Characteristics Leaching Procedure).

Comprehensive Environmental Response Compensation and Liability Act (CERCLA)

The CERCLA may be applied to require corrective actions to remove hazardous substances discharged to the environment. This legislation establishes liability and corrective actions for parties responsible for the discharge. The liability is extensive and comprehensive. While remote, the application of CERCLA liability to wastewater biosolids could be possible if hazardous substances are traced to the biosolids.

City of Wichita and Sedgwick County Requirements

Local regulations which could impact wastewater treatment and biosolids operations include:

- Metropolitan Area Planning Commission/Local Planning Commission – for technical and zoning review and approval
- Sedgwick County Health Department – for review of biosolids use or disposal practices and approval or disapproval of permits
- Equus Beds Groundwater Management District – for review of biosolids use or disposal practices if within District boundaries

SECTION 6

Evaluation of Existing Sanitary Sewer Facilities

INTRODUCTION

This Section describes the evaluation of the existing Wichita sanitary sewer collection system, including:

- Description of the existing sanitary sewer collection system
- Preparation of a map of the existing interceptor system consisting of sewer lines 10 inches and larger
- Review of flow monitoring information
- Evaluation of existing interceptor sewers and lift stations serving the City

Evaluation and comparison of alternative solutions to deficiencies identified in this evaluation will be presented in later Sections.

Appendix F provides a map showing the existing sewer facilities and the boundaries of the 2050 sewer service area, drainage basins and subbasins. The map includes all gravity sewers 10-inches and larger in diameter.

A separate document (Appendix G) describes the process of converting the prior hydraulic model (SewerCAT) to the current software (H20MAP Sewer Pro).

DRAINAGE BASINS

As previously discussed, the study area includes three distinct existing wastewater service areas:

- Plant No. 1 and 2
- CCWQRF
- Four Mile Creek

Surface drainage through Wichita generally follows the Arkansas River which flows through central Wichita from north to south. Nearly the entire City is in the

Arkansas River watershed. Gravity sewers can serve most of the city to Plant No. 1 and No. 2 near the Arkansas River in southern Wichita.

The Cowskin Creek flows through western Wichita (west to east) and joins with the Arkansas River to the south of Wichita. Areas west of a ridge line that runs generally from north to south between Tyler and Ridge Roads are in the Cowskin Creek watershed. Lift stations are used to transfer Cowskin Creek drainage basin wastewater flows to Plants No. 1 and 2. The northern portions of Cowskin Creek watershed located downstream of the CCWQRF are pumped back to this facility for treatment.

The Walnut River lies to the east of Wichita. Areas east of a ridge line that runs generally from north to south between Webb and Greenwich Roads are in the Walnut River watershed. Gravity sewers and the Four Mile Creek wastewater treatment plant serve the Four Mile Creek drainage basin within the Walnut River watershed. Other Walnut River watershed areas within the 2050 service area boundary are undeveloped.

Drainage basins and sub-basins within the 2050 service boundary were defined in Section 1. The drainage basins for the existing sewer system and the designators used in computer modeling include:

- NWI
- CSI
- SS22
- SS1
- SS23
- SWI
- Dry Creek
- WIS
- 4MC

INTERCEPTOR SEWER SYSTEM

Sanitary Sewers

The sanitary sewer system is fully mapped in City of Wichita's sewer GIS computer data bank, comprising approximately 49,000 pipe links. The numbers of sewer pipes in the GIS are listed in Table 6-1. For comparison, the pipe counts in the 2003 SewerCAT hydraulic model are also shown. The hydraulic evaluation includes all pipes that are 12-inches and larger plus the 10-inch and smaller lines that were included in the prior model.

Table 6-1. Number of Sanitary Sewer Pipes

Pipe Diameter	*Total in GIS*	*SewerCAT Model*
10” and smaller	42,506	103
12”	1,335	44
15”	1,103	77
18” and greater	3,906	2,580

Table 6-2 summarizes the length of existing sewers by pipe diameter and material as recorded in the City’s GIS. The most frequent pipe size is 8-inch. The majority (97 percent) of the existing system is composed of either polyvinyl chloride (PVC) or vitrified clay (VCP) pipe.

Table 6-2. Length of Sanitary Sewer by Pipe Material

Diameter (in)	*ABS(1)*	*ACP(2)*	*CIP, CMP, DIP(3)*	*Concrete, RCP, PLRCP(4)*	*HDPE(5)*	*PVC*	*VCP*	*VCP with CIPP Liner*	*blank, N/A*	*Grand Total*
1						551				551
2						4,963				4,963
3						1,627				1,627
4						29,091	3,098			32,189
6			438			27,683	50,052	140	510	78,823
8	82,056	1,726	2,525			3,646,874	4,208,315	322,949	64,129	8,329,145
10	4,197		814			274,702	166,194	15,975	3,337	465,220
12	1,441		1,586			146,280	167,171	10,489	1,244	328,211
14			288			15,920				16,207
15	984		75			109,459	155,068	8,469	1,491	275,546
16			168			8,825	723			9,716
18			1,878	224		90,139	212,336	5,035	4,770	314,383
20			1,057			11,255	22,790			35,102
21			1,764			51,454	35,246	11,266	17,331	117,061
22					238					238
24			3,041	732		83,380	122,321	837	4,390	214,701
27						19,041	13,792		3,003	35,835
30			105	9,095		23,484	99,192	485	1,142	133,503
32							233			233
36			211	1,636		40,707	130,968	4,291	301	178,115

Diameter (in)	*ABS(1)*	*ACP(2)*	*CIP, CMP, DIP(3)*	*Concrete, RCP, PLRCP(4)*	*HDPE(5)*	*PVC*	*VCP*	*VCP with CIPP Liner*	*blank, N/A*	*Grand Total*
42				25,226		17,742	4,926	4,093	1,683	53,669
45				1,100			1,674			2,774
48			160	383		9,198	2,047			11,787
54				44,071			9,488	1,183		54,742
60				23,702		3,449	3,670		1,065	31,886
66				19,204						19,204
78				1,050		4,493	40			5,583
(blank)						1,904			55	1,959
Total	88,678	1,726	14,109	126,994	238	4,622,219	5,409,346	385,211	104,452	10,752,973
Percent of Total	0.8%	0.0%	0.1%	1.2%	0%	43.0%	50.30%	3.6%	1.0%	100.0%

(1) ABS – Acrylonitrile Butadiene Styrene
(2) ACP – Asbestos Cement Pipe
(3) CIP – Cured in Place, CMP – Corrugated Metal Pipe, DIP – Ductile Iron Pipe
(4) RCP – Reinforced Concrete, PLRCP – Plastic Lined Reinforce Concrete Pipe
(5) HDPE – High Density Polyethylene Pipe

The City's GIS does not provide information on the age or condition of each sewer line. The high percentage of VCP pipe in the system indicates that approximately one-half of the pipes are probably over 30 years old. Table 6-3 summarizes the length of pipes that have been rehabilitated by various lining methods. Approximately 4.3 percent of the total system has been relined. Approximately 6.6 percent of the VCP sewer has been provided a cured in place pipe (CIPP) lining.

Table 6-3. Length of Rehabilitated Sanitary Sewer

Diameter (in)	*Not Lined*	*VCP with CIPP Liner*	*Fold & Form Liner*	*Other Liners **	*Total*
1	551				551
2	4,963				4,963
3	1,627				1,627
4	32,189				32,189
6	76,276	140		2,407	78,823
8	7,983,915	322,949	1,457	20,824	8,329,145
10	448,190	15,975		1,055	465,220

Diameter (in)	*Not Lined*	*VCP with CIPP Liner*	*Fold & Form Liner*	*Other Liners **	*Total*
12	315,211	10,489	140	2,371	328,211
14	16,207				16,207
15	266,149	8,469	138	790	275,546
16	9,044			672	9,716
18	308,789	5,035		559	314,383
20	31,394		1,020	2,688	35,102
21	105,373	11,266		422	117,061
22	238				238
24	211,865	837	105	1,894	214,701
27	35,835				35,835
30	119,701	485		13,317	133,503
32	0			233	233
36	173,667	4,291		157	178,115
42	46,848	4,093		2,728	53,669
45	2,774				2,774
48	10,435			1,352	11,787
54	32,684	1,183		20,875	54,742
60	30,013			1,873	31,886
66	19,204				19,204
78	5,583				5,583
(blank)	1,959				1,959
Grand Total	10,290,684	385,211	2,860	74,218	10,752,973
Percent of Total	95.7%	3.6%	0.0%	0.7%	100.0%

* Other liner codes in the GIS include HDPE, IPR CIPP, PVC, Sliplined, VIP and Other. An additional 6,367 feet of pipe coded "N/A" for liners are not included above.

The H20MAP Sewer software automatically determines the flow split at sewers that have more than one downstream pipe according to the geometry of each pipe. Manholes where flow is divided between two pipes are listed in Table 6-4. The City inspected the majority of these locations to confirm the proper arrangement and elevations.

Table 6-4. Flow Split Manhole Locations

Manhole Number	*Manhole Number*
5548-237SP	5744-005a
5548-238	5644-028a
5548-086	5644-028
5548-086a	5644-011a
5548-202Sa	5644-011
5548-202S	1238
5547-950S	5644-420a
5548-535a	5644-420
5548-535	1227
5646-390	5647-013a
5646-046a	6047-030
5646-046	5745-027
5646-046a	175a
5646-046	5745-010
5744-055	5745-010(2)
5744-055a	

Lift Stations

Table 6-5 summarizes information on the existing lift stations as recorded in the City of Wichita's maintenance management system. Most of the stations have two equal capacity pumping units. Lift Station Nos. 6 and 22 have three pumps and Lift Station Nos. 27 and 56 have four pumps. The firm capacity is the capacity with one pump assumed out of service. For Lift Station No. 27, the firm capacity assumes the two larger capacity pumps are out of service. Difficult topography (including the three major drainage areas that divide the City and areas of relatively flat slopes), have contributed to the need for lift stations.

Table 6-5. Existing Lift Stations

Station No.	*Structure*	*Location*	*Year Installed*	*No. Pumps*	*Firm Capacity (gpm)*	*Horsepower*
1	5448-LS01	636 N. Waco	1969	2	1500	15
2	5449-LS02	15th & Ferrell		2	800	10
3	5451-LS03	1008 W. 29th St. N.	1968	2	150	1.5
4	5350-LS04	2556 N. Amidon	1981	2	850	10
5	5450-LS05	1415 W. 23rd St. N.	1976	2	150	1.5
6	5344-LS06	3163 S. Glenn	1956	3	3200	15
7	5444-LS07	614 W. 27th St. S.	1982	2	100	1.5
8	5443-LS08	3360 S. Osage St.	1954	2	200	2
9	4648-LS09	1151 N. Firefly St.		2	920	20
10	4950-S10	2761 N. Ridge Rd.	1991	2	250	10
11	5348-LS11	1717 Sim Park Dr.	1979	2	100	1.5
12	6446-LS12	15800 E. Harry St.	1984	2	100	1.5
13	5351-LS13	1134 W. 34th N.	1984	2	100	1.5
14	5143-LS14	5411 W. York St.	1987	2	190	5
15	5544-LS15	2599 S. St. Francis St.	1984	2	225	2
16	5651-LS16	3602 N. Poplar	1985	2	175	3
17	Not used **					
18	4748-LS18	1099 N. Shefford	1985	2	340	3
19	6150-LS19	Tallgrass East	1993	2	140	2
20	5043-LS20	3901 S. Arapaho St.	1987	2	190	5
21	5349-LS21	2125 N. Amidon Ave.	1980	2	230	2
22	5253-LS22	4601 N. Meridian Ave.		3		
23	5352-LS23	3800 N. Porter St.	1980	2	160	2
24	5042-LS24	4141 S. Boyd St.	1993	2	195	5
25	5346-LS25	1631 W. Harry	1979	2	230	3
26	Not used					
27	4844-LS27	2625 S. Tyler Rd.	1990	4	11,800	150 & 250
28	5050-LS28	2221 N. Lakeway Cir.		2	500	5
29	4649-LS29	12222 W 13th St. N.	1981	2	100	3

Station No.	*Structure*	*Location*	*Year Installed*	*No. Pumps*	*Firm Capacity (gpm)*	*Horsepower*
30	5643-LS30	E. Side of Hydraulic Between Tulsa & I-135		2	200	2
31	5241-LS31	W. 47th St. S. & Mt. Carmel		2		
32	5349-LS32	1949 N. Amidon Ave.		2	100	2
33	5242-LS33	4340 S. West St.	1991	2	275	2
34	5048-LS34	999 N. Lakeland	1991	2	270	2
35	5145-LS35	2199 S. West St.	1983	2	1,400	25
36	4648-LS36	1129 N. Coachhouse Rd.	1984	2	100	2
37	5447-LS37	650 N. Seneca St.	1986	2	110	1.5
38	Not used					
39	Not used					
40	4750-LS40	10766 W. 21st St. N.		2	925	30
41	5051-LS41	Ridgeport		3		
42	5447-LS42	225 W. Douglas Ave. Inside Century II	1984	2	85	5
43	Not used					
44	6239-LS44	6781 S. Greenwich Rd. (111th)	1994	2		
45	6239-LS45	11721 E. 63rd. St. S.		2	98	
46	6449-LS46	1544 N. Freedom Rd.		2	150	7.5
47	4445-LS47	16313 W. Hwy. 54		2	375	5
48	4447-LS48	15510 W. Maple	1995	1	98**	5
49	4347-LS49	17010 W. Maple		2	140	5
50	4445-LS50	16001 W. Hwy. 54	1995	2	135	
51	4445-LS51	15535 W. Hwy. 54	1995	2	130	5

Station No.	*Structure*	*Location*	*Year Installed*	*No. Pumps*	*Firm Capacity (gpm)*	*Horsepower*
52	4546-LS52	1526 S. 151st. St. W.	1995	2	98	5
53	4545-LS53	1810 S. 151st St. W	1995	2	458	5
54	Not used					
55	5448-LS55	739 W. 10th St. N.	1995	2	175	2.4
56	4649-LS56	2114N. 135th St. W, S.E. Cor. 21st St. & 135th	1995	4	1416	50

* gpm – Gallons per Minute

**Blank cells indicate data was not available.

*** Station nos. 17, 26, 38, 39, 43, and 54 are not in use.

**** There is no firm capacity for Lift Station No. 48. The capacity shown is the capacity of the one installed pump

Table 6-5 also includes the year each station was built, if known. Lift Station No. 8 is the oldest facility, installed in 1954 and now 60 years old. Based on age, Lift Stations No. 1, 3, 6, and 8 may be near the end of the typical 30 to 50 year useful life of a pumping station.

Of the 56 lift stations enumerated above, ten have serious problems and another nine have less intensive maintenance issues. It is recommended that a detailed pump station evaluation survey be completed for all the lift stations in the City. This survey would elaborate upon the condition, capability, performance, and maintenance needs for each station. It would also establish a priority ranking system and possible consolidation measures, along with a more detailed budget. This process would ultimately provide the most efficient use of the funds available to the City for capital improvements.

Each lift station discharges to a force main. Table 6-6 shows the total length of force mains in the GIS by pipe diameter, totaling 146,671 feet (27.6 miles). The GIS data does not include the installation year for the force mains, however, they were presumably constructed along with the lift station. The material codes in the GIS indicate that most of the force mains are PVC pipe, with only a few force mains constructed of CIP or DIP pipe. The GIS does not provide information regarding the age or condition of the force mains. The CIP and DIP force mains may also be approaching the end of the typical useful life.

Table 6-6. Force Mains

Diameter (in)	*Length (ft)*
1	551
2	4,814
3	1,627
4	30,023
6	15,632
8	8,571
10	10,418
12	19,878
14	15,820
16	7,850
18	170
24	31,318
Grand Total	146,671

FLOW MONITORING INFORMATION

Previous Flow Monitoring Data

From 1994 through 2001, the City conducted a series of sewer flow monitoring programs covering the entire sanitary sewer system. The flow metering data were summarized in the year 2000 Master Plan and were used in the SewerCAT model. Table 6-7 lists all of the monitor locations that had flow ratios for peak wet weather flow (PWF) vs. peak dry weather flow (PDF) of 3.8 or greater. These monitors represent the critical locations where higher than average I/I entered the sewer system.

Table 6-7. Critical Previous Flow Monitoring Manholes

Site Number	*Manhole*	*PDF (MGD)*	*10 year PWF (MGD)*	*Ratio: PWF:PDF*
1	5549-306	0.826	9.058	11.0
2	6050-009	0.374	3.381	9.0
3	6149-001	0.134	1.099	8.2
4	4746-003	0.232	1.662	7.2

Site Number	*Manhole*	*PDF (MGD)*	*10 year PWF (MGD)*	*Ratio: PWF:PDF*
5	5451-037	0.196	1.344	6.9
6	6046-039S	0.547	3.511	6.4
7	5845-050	0.85	4.94	5.8
8	5647-178	2.12	12.268	5.8
9	5547-693	0.727	4.131	5.7
10	4850-001	0.398	2.22	5.6
11	4950-002	0.25	1.378	5.5
12	6147-005	0.546	3.006	5.5
13	6052-002	0.328	1.803	5.5
14	6048-014	0.573	2.947	5.1
15	5645-195	2.881	14.574	5.1
16	5645-184	4.399	22.121	5.0
17	5049-031	0.199	0.956	4.8
18	5644-256	4.237	19.576	4.6
19	5951-024	0.337	1.527	4.5
20	5549-018	0.722	3.071	4.3
21	5952-001	0.419	1.714	4.1
22	5950-001	0.754	2.875	3.8
23	5245-001	3.34	12.695	3.8

Need for new Flow Monitoring Information

Since 2001, the City of Wichita has completed pipe relief projects and a city-wide sump pump removal project. City Staff reported that wet weather overflows from the current sewer system do not typically occur. Flow monitoring to re-test the critical manholes in Table 6-7 is recommended to determine whether the previous high levels of I/I have been reduced. These manholes include sites in WIS, SS23, SWI, NWI, and CIS drainage basins.

The City has taken ownership of the Four Mile Creek sanitary sewer facilities and wastewater treatment plant. No prior flow and rainfall monitoring data are available for Four Mile Creek. City Staff reports that flow to the wastewater treatment plant suggests the presence of higher levels of I/I. Flow monitoring is recommended to determine the actual flows in Four Mile Creek sewers. A program using nine to 10

flow meter sites should provide sufficient data. Table 6-8 lists the proposed monitoring manholes for Four Mile Creek.

Table 6-8. Recommended Four Mile Creek Monitoring

Site Number	*Manhole*	*Pipe Diameter (in)*
1	6446-224	21
2	6448-006	18
3	6348-148	18
4	6349-031	24
5	6446-001	36
6	6346-059	30
7	6346-002	24
8	6246-147	15
9	6246-017	24

The City of Wichita provided for review the data files for flow monitoring completed since 2001. Most of the sites were on smaller lines and did not include corresponding rainfall data. Therefore, the additional monitoring data could not be used to collaborate reduced I/I.

All previous flow monitoring data is out of date and the I/I in the system has probably been reduced since the prior monitoring. New flow monitoring data should be collected as part of the design phase for any relief sewers recommended in this Master Plan. Flow monitoring needs to be accompanied by rain gages near the centroids of each monitored area for determining the inflow vs. rainfall relationship. Flow monitoring data needs to be evaluated to determine average and peak dry weather flows, infiltration, and inflow as a function of rainfall intensity.

SANITARY SEWER COLLECTION SYSTEM CAPACITY ANALYSIS

Capacity Analysis Criteria

Design criteria used for evaluating Wichita's sanitary sewer system conform to KDHE's 1979 Minimum Standards for Design. Gravity sewers are evaluated for

having adequate hydraulic capacity flowing full to convey peak wet weather flows. Sewer extensions to serve new growth and relief sewers are sized to convey peak wet weather flows $^{2}/_{3}$ full for sewers 18-inches and smaller or ¾ full for larger sewers.

The hydraulic capacity of gravity sewers was determined using Manning's equation for open channel flow. A conservative Manning's "n" value, or friction coefficient, of 0.014 was used for evaluating existing sewers in this report to reflect possible conditions such as deposits, rough joints, settlement, root growth, and other defects that would reduce the sewer's capacity. Where required, relief sewers are sized as replacement sewers. Cost evaluation of replacement vs. parallel relief sewers should be performed during detailed design.

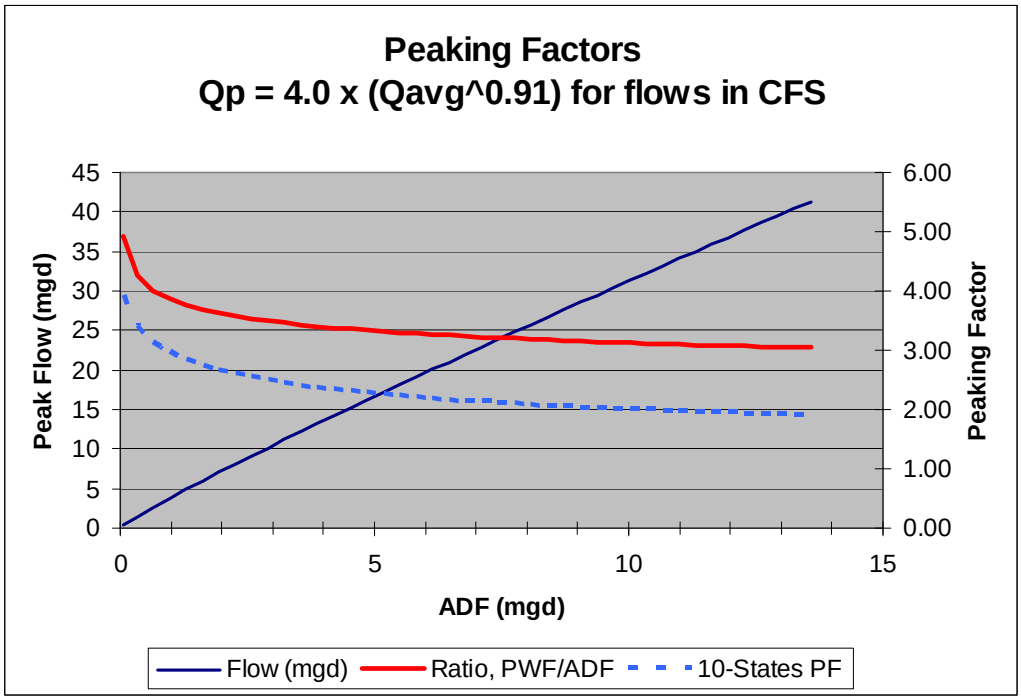
Manning's equation for full pipe flow in circular pipes is as follows:

where $Q = 1/n * 0.4632 * D^{(8/3)} * S^{(1/2)}$
"Q" is the flow in cubic feet per second,
"n" is the Manning's friction coefficient,
"D" is the pipe diameter in feet, and
"S" is the slope in feet per foot.

Lift stations were evaluated for sufficient firm capacity to convey the peak flow rate. The firm capacity is the rated capacity of the pumps with the largest unit(s) out of service. Force mains were evaluated based on a maximum allowable velocity of 12 feet per second (fps).

Average dry weather flows in each subsystem for years 2002, 2010, 2020, 2030, and 2050 as developed previously in this Master Plan Update were used for the capacity evaluation. KDHE guidelines suggest design ratios for peak wet weather flows vs. dry weather flows of 2.0 to 5.0, with a typical minimum of 3.0. Prior master planning and other Wichita design projects have used peaking factors of 3.0 or greater. For the capacity analysis, a peaking factor relationship was developed to range from approximately 5.5 at smaller flows to a minimum of approximately 3.0, as shown on Figure 6-1.

Figure 6-1. Peaking Factors



Capacity Analysis Methodology

The H20MAP Sewer hydraulic model as converted from SewerCAT was expanded to include all lines 12-inches and larger for the capacity analysis. Data for the additional gravity sewers and force mains were extracted from the City's GIS. Data for the lift stations was provided by the City's maintenance management system files. The process added the trunk sewers for the Four Mile Creek basin to the model. Following calibration, the expanded model was determined adequate for the capacity analysis. The expanded model includes 6,360 sewers and 23 lift stations.

The City's GIS was used to determine each modeled manhole's subbasin. The total average daily flows (ADF) in each subbasin for each demand projection year were distributed uniformly to the modeled manholes in the subbasin. The hydraulic model accumulates the ADF flows to each sewer and applies the peaking factor curve to determine the design PWF.

Evaluation of existing Interceptor Sewers with Projected Peak Flows

Hydraulic capacity analyses were performed for design PWF for years 2002, 2010, 2020, 2030 and 2050. Appendix F includes graphical plots from the H20MAP Sewer

model for each year indicating the flow vs. capacity (q/Q) ratio. Ratios greater than 1.0 indicate overloaded line sections. Table 6-9 summarizes the overloaded sewers for each modeled year.

Table 6-9. Pipes with q/Q greater than 1.0

Description	*2002*	*2010*	*2030*	*2050*
Length (ft)	167,543	177,337	186,749	212,955
No. of Sewers	394	433	450	514

* ft - feet

The second map in Appendix F shows the overloaded sewer segments for design year 2050 on the existing sewer map. Each of the overloaded reaches should be evaluated for capacity improvements. Significant sewer overloads, based on existing capacity, projected ADF and the design flow curve, are expected to occur in the Four Mile Creek basin, WIS, SS3, SWI, SS22, and CIS.

Lift Stations

Table 6-10 summarizes modeling results for the 23 lift stations included in the model. For year 2050, projected peak flows exceed the station capacity for 9 lift stations, indicating a need to expand or replace the facilities. The installed firm capacities were not available for five stations.

Table 6-10. Lift Station Adequacy Under 2050 PWF

Lift Station Number	*Total Flow (cfs)*	*Firm Cap (gpm)*	*Firm Cap (cfs)*	*Excess Capacity (cfs)*
1	3.791	1500	3.342	-0.449
4	2.473	850	1.894	-0.579
6	9.47	3200	7.129	-2.341
14	0.34	190	0.423	0.083
18	0.68	340	0.757	0.077
20	0.362	190	0.423	0.061
22	1.68	0	0.000	-1.680
24	0.342	195	0.434	0.092
27	21.191	11800	26.287	5.096

Lift Station Number	*Total Flow (cfs)*	*Firm Cap (gpm)*	*Firm Cap (cfs)*	*Excess Capacity (cfs)*
28	0.46	500	1.114	0.654
29	0.205	100	0.223	0.018
32	0.202	100	0.223	0.021
33	0.827	275	0.613	-0.214
34	0.589	270	0.601	0.012
35	0.82	1400	3.119	2.299
40	3.514	925	2.061	-1.453
41	0.981	0	0.000	-0.981
43	2.267	0	0.000	-2.267
56	10.948	1416	3.154	-7.794
57	2.34	1416	3.154	0.814

* CFS – Cubic Feet per Second

SECTION 7

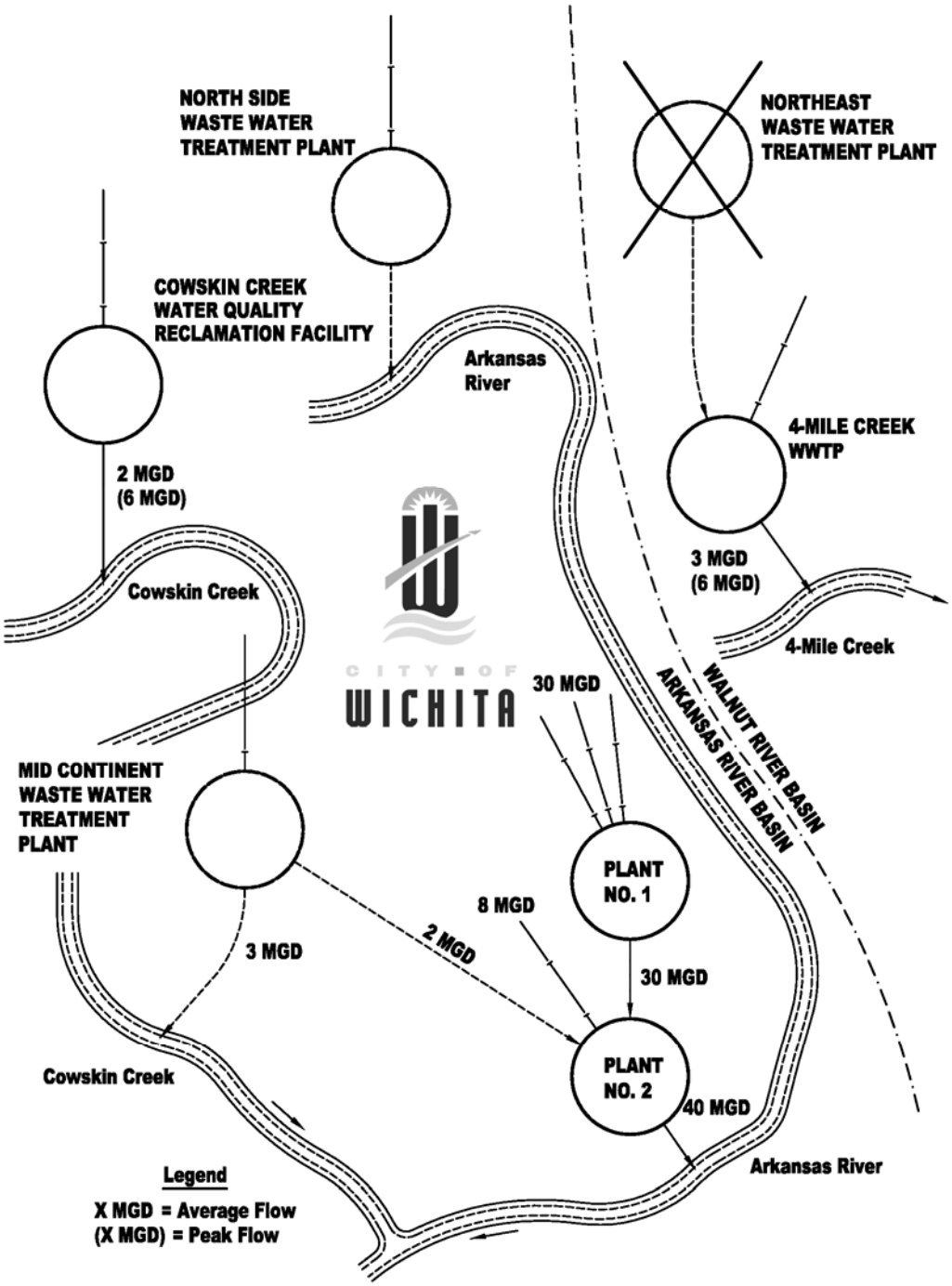
Wastewater Treatment Facility Evaluation Preface

Wastewater treatment for the City of Wichita has changed over the past 10 years from a centralized approach with the responsibility of treatment focused on Treatment Plant No.2, to a distributed concept with satellite plants providing wastewater treatment for the growth areas. Today the City of Wichita operates four treatment plants and is in the process of constructing a fifth. In the long range master plan a North Side Wastewater Treatment Facility to receive wastewater flows from North of K-96 highway is planned and the previously projected Northeast Side Wastewater Treatment Plant has been dropped. These existing and proposed treatment facilities are as follows:

1 Treatment Plant No. 1
2 Treatment Plant No. 2
3 Cowskin Creek Water Quality Reclamation Facility (CCWQRF)
4 Four Mile Creek Wastewater Treatment Facility
5 Mid-Continent Wastewater Treatment Facility (under design/construction)
6 North Side Wastewater Treatment Facility (future)
7 Northeast Side Wastewater Treatment Facility (dropped)

Wastewater treatment for the City of Wichita is the sum performance of the listed facilities working independently to collectively provide service to the whole community. Each portion of the City is sewered with collection systems, that transport wastewater to collector sewers and pump stations, that transport wastewater to interceptor sewers and main pump stations, that transport the flows to the individual treatment plants. As new treatment facilities are constructed, service areas are adjusted to direct flows from either Plant No. 1 or Plant No. 2 to the new facilities thereby reducing the loads on these two centralized treatment facilities and providing the opportunity to better utilize the effluent from the facilities in a beneficial way. Figure 7-1 provides the general overview of wastewater treatment for the City of Wichita.

Figure 7-1 Service Overview



The following is an analysis of the current wastewater treatment systems for the City and a detailed review of each treatment facility. The purpose of the treatment facility evaluations is to discuss the capacity and performance of each plant and its ability meet future capacity needs and regulatory requirements for future effluent quality. Based upon this detailed evaluation, planning for treatment facility expansion can take place.

SECTION 8

Evaluation/Description of Plant No. 1

GENERAL

History

Wastewater Treatment Plant No. 1 has been modified several times over the years and currently functions as a main lift station and extraneous flow holding serving approximately 75% of the City of Wichita. All other components at Plant No. 1 which consisted of primary clarification, biological treatment and biosolids handling, have been abandoned.

Service Area

The service area for Plant No. 1 generally includes the central and eastern half of the City of Wichita, and also provides service to the majority of the City's industrial contribution. Plant No. 1 currently serves approximately 253,000 customers in the Wichita area. The plant service area extends as far north as Kechi and as far south as 47th Street south. Flow projections for this facility are shown in Table 8-1.

Table 8-1. Plant No. 1 Flow Projections

	2002	*2010*	*2020*	*2030*	*2040*	*2050*
Plant No. 1 Average Daily Flow (MGD)	28.00	29.03	29.46	29.81	30.17	30.52
Plant No. 1 Peak Daily Flow (MGD)	51.80	53.71	54.50	55.15	55.81	56.46

This table has been expanded with additional information and is available in Appendix H.

General Process Description and Capacity

Plant No.1 is the main lift station for the City of Wichita. The facility components include influent screening, lift pumps, a flow diversion structure, discharge pipe to Treatment Plant No. 2, extraneous flow holding basins, and odor control equipment. Figure 9-1 located at the end of Section 9 provides a schematic diagram of Plant No. 1 and Plant No. 2. While each unit process is evaluated in detail, the following Table 8-2 summarizes each component's firm and maximum capacity and compares those values against the current and future flows which results in an expected service life.

Table 8-2. Plant No. 1 Process Capacity

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Influent Barscreening					
	Vert. Front Cleaned Barscreens (4) @ 18 MGD				
	Firm Capacity (MGD)	51.81	54	56.46	2010
	Maximum Capacity (MGD)	51.81	72	56.46	N/A
Influent Pumping					
	Horiz. Centrifugal Pumps (8) @ 24.0 MGD each				
	Firm Pumping Capacity (MGD)	51.81	96	56.46	N/A
	Maximum Pumping Capacity (MGD)	51.81	192	56.46	N/A
Extraneous Flow Holding Basins					
	(2) Basins @ 5.0 MG each	*	10	*	
	(1) Lagoon @ 24 MG				
	Average Flow Conditions (MGD)	*	24	*	

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Transmission Line					
	60-inch RCP	51.81	61	56.46	N/A
	66-inch RCP	51.81	79	56.46	N/A
	48-inch Control Valve	51.81	80	56.46	N/A
Primary Clarification					
208 ft Clarifier (1) Located @ Plant No. 2					
	Avg. Flow Conditions (MGD)	28.00	34	30.52	N/A

* - Determined by the City thru future collection system flow monitoring activities, the basin has not been used since the I/I reduction program has been completed.

INFLUENT SCREENING

Description

The influent screens are located between the main collection system outfall and the influent pump station wet well. The purpose of the screens is to protect downstream process and the influent pumps from clogging with rags, solids, debris and other non-treatable material. The material captured on the face of the screen, larger than ¾-inch, is removed utilizing a mechanical rake which discharges the debris into a channel sluicing system. The existing sluicing system was recently modified to dispose of the removed screenings in lieu of grinding them and returning them to the process. The screenings are transported by a water sluicing system to a washer, fine screen and compactor where they are removed and disposed of in a dumpster. The sluicing system uses plant water, a collection channel, and a transport pipe to carry the material. The screenings, when finally discharged into the dumpster, are relatively free of organic material and can be removed to the City/County solid waste facility.

Inventory

Plant No. 1 has four (4) influent screens (two for each section of the influent wetwell) combined with a sluicing system for disposal of the screenings removed from the wastewater. Each screen is a front cleaned barscreen, four feet wide with ¾-inch spacing between the bars. The screens can be isolated with sluice gates and operate independently based upon time and headloss.

Capacity

The capacity of each screen is 18 MGD. This results in a firm capacity of 54 MGD and a maximum capacity of 72 MGD. The sluicing system is sized to handle the maximum capacity of each influent screen.

Current Conditions

Each screen can be isolated using a sluice gate and each unit appears to be in good condition. Each unit has been well maintained but there is evidence of corrosion on the frames of each unit. The bar spacing for each screen is approximately 3/4 inches clear which is sufficient for pump protection, but is no longer considered adequate for protection of the treatment process. The process is in good condition and should only require routine maintenance for the next several years. The firm capacity of the screening system is reached in 2025 but since the peak daily flows do not increase dramatically in the study period it is unlikely that problems would be experienced with this system due to flow. However, beyond ten years, the units will still require replacement resulting from wear and corrosion.

INFLUENT WETWELL/PUMPING

Description

The flow which passes through the influent screening enters the wetwell. The wetwell is divided into two compartments that can be completely isolated from each other, North Side and South Side. Both wetwells are equipped with four (4) horizontal sewage pumps which operate independently based upon wetwell levels for a total of eight (8) pumps. Two pumps on each side are equipped with a variable frequency drives (VFD) that adjust the speed of the pump to match the gravity flows entering the wetwell while the balance of the pumps are constant speed and operate at only

one condition. The City is in the process of adding a third drive to each side of the wetwell which will leave one constant speed pump per side. The collected flows are pumped from the gravity wetwell to the diversion structure.

Inventory

Equipment for the influent pumping process includes four (4) horizontal 20 MGD sewage pumps on each side of the wetwell for a total of eight (8) pumps. Two pumps (one on each side) are equipped with variable frequency drives and the remaining are constant speed pumps. Controls and level indicators are also included in both wetwells. The pumps and piping system are provided with isolation valves, and pump check valves.

Capacity

This dual wetwell arrangement allows full redundancy of 80 MGD. Based upon number of pumps utilizing both wetwells the firm capacity of the facility is 140 MGD, with a maximum capacity of 160 MGD. While these flows exceed the rated capacity of the barscreens, it is possible under surcharged conditions for this condition to exist.

Current Conditions

The design of the facility hydraulics was reviewed utilizing the Hydraulic Institute criteria, and found to be more than adequate, and the facility has performed well to date. The electrical system and controls have been recently upgraded. The pumps are currently performing well, and should only require routine maintenance for the next several years. Since this equipment is operational 24 hours a day with rotating elements subject to wear, replacement bearings, seals and impellers should be provided for in the maintenance budget.

BELL MOUTH AND FLOW DIVERSION STRUCTURE

Description

The flow from the pumping system discharges vertically through a flared pipe section (bell mouth), and cascades into a concrete structure. Flow discharged vertically allows the pumps to operate under a nearly constant discharge pressure. The screened

raw wastewater in the diversion structure can be directed to either the extraneous flow holding basins or to Plant No. 2 for processing. This process has been modified by plant operating staff to reconfigure one of the diversion gates so that it can be operated through the use of a chain hoist.

Current Conditions

Hydraulically, and in terms of process control, this process is working well and allows the flexibility to divert wastewater to Plant No. 2 or to the extraneous flow holding basin as conditions arise. Odor has been a significant concern at Plant No. 1 and this structure allows some odors to escape. Because of the cascade created by the bell mouth, gasses entrained in the influent wastewater are released. For the odor control system to function properly these gasses must be captured and then transported to the treatment vessel. If gasses escape the system odors are released. Currently there are several segments of this structure open to the atmosphere and could contribute to the escape of odors. The control of the gates is a second area of concern. While the chain hoist used to open the extraneous flow gate is functional, it is difficult to operate and can not be operated remotely which impedes process control and requires on-site operation.

ODOR CONTROL UNIT

Description

Odor control facilities were installed in 1992 to reduce odors from Plant No. 1. The process consists of two reaction vessels ducting, fans, and chemical feed all sized to transport foul air from the head spacing above the individual treatment processes to the reaction vessels for treatment and discharge. There have been some modifications to the ducts and collection systems during recent modifications at Plant No. 1.

Current Conditions

While the process has greatly reduced the odor emitted from this location, additional work is needed. There have been significant changes from the odor control industry in the capture and treatment of odors since this process was constructed. Because of the impacts that odor has concerning the performance of wastewater treatment facilities and because of less tolerance of odors in general by the community, consideration

should be given to continued study of this issue and possible additional construction of improvements.

66-INCH TRANSMISSION LINE TO PLANT NO. 2

Description

The transmission line to Plant No. 2 directs the flows from Plant No. 1 pump station to a primary clarifier located at Plant No. 2. This pipeline is constructed of reinforced concrete and consists of a section on site at Plant No. 1, a river crossing, a crossing of the Turnpike, and the balance generally extending north to south following the river and terminating in the influent control valve structure of Plant No. 2. The flow from the diversion structure provides enough static head on the transmission line to transport 80 MGD. The pipeline is maintained in a full pipe condition to prevent corrosion by utilizing an actuated butterfly valve located in the influent control valve structure at Plant No. 2.

Current Conditions

In general the pipe line is in fair condition. A relatively small portion of the pipe line was recently replaced with the Plant No. 1 upgrade, which had suffered from corrosion. The balance of the pipe where possible, was inspected for additional corrosion. In general the pipe line has experienced minor corrosion through out but does not appear to be in imminent danger of failure. The actuated butterfly valve at Plant No. 2 can be somewhat difficult to modulate to match pipeline flow to pump discharge; however, new control modifications have solved most of the problem. The transmission line is serviceable for the next several years, but depending upon the future direction for this facility the replacement or paralleling of this pipe line may need to be considered.

EXTRANEOUS FLOW BASIN (EFB)

Description

Extraneous flow holding consists of two five million gallon basins providing a combined capacity of 10 million gallons and one lagoon with a 24 million gallon capacity. The first two basins are constructed of concrete and perform like primary clarifi-

ers and the lagoon is a large concrete lined basin. In general, during an extraneous flow event the flows that are diverted into the EFB from the interceptor sewer are those flows arriving at Plant No. 1 that cannot be transported to Plant No. 2. The design is based on the premise that initial flows with heavy solid materials and heavy organic materials are processed through the plant and that the more dilute wastewater that follows are the flows that are diverted to the holding basins. This is important since these basins are not covered and do not have supplemental aeration to keep the waters from becoming septic. Operationally, when the rate of incoming flow exceeds 80 MGD, the excess flows are diverted to the clarifier sections of the EFB's and then overflow into the concrete lined lagoon. Following the extraneous flow event the stored wastewaters are returned to the Plant No. 1 pump station wetwell to be transported to Plant No. 2 for treatment.

Current Conditions

There are some operational difficulties associated with the return of these wastewaters to the pump station that may require some construction and control improvements. It should be noted that the extraneous flow holding basins can discharge when they become filled to capacity and continue to receive additional flow; however, no discharges have occurred in the past 10 years.

OVERALL SITE EVALUATION

Description

Plant No. 1 has several structures that have been abandoned in place causing some unsightly conditions, ongoing maintenance problems and odor generation. Consideration should be given to demolishing these structures to improve the public image of the facility, eliminate safety issues and maintenance problems.

This site will always be the location of a main pump station that will process the flow from central and east Wichita. The area once reclaimed through demolition is large enough that other options for the site could be considered.

Evaluation of Overall Treatment Facility Capacity

In general Plant No. 1 would have a rated capacity of 80 MGD and should be able to transport flows to this level without much difficulty. Problems arise if operational difficulties are encountered with either the transmission line or the Plant No. 2 influent control valve. The balance of the facility is served with redundant equipment or processes. In addition to the ability to transport the flows there is a combined capacity of 34 million gallons of extraneous flow storage that can be utilized. As a point of comparison this storage volume is equal to 1.2 days of Plant No. 1 Average Daily Flow.

Conclusions

Plant No. 1 is performing well and has many years of useful service life left. Flows attributed to growth in Wichita are being process by the satellite plants and Plant No. 1 future flows are not dramatically changed. Planning issues for Plant No. 1 should change from growth and capacity, to long term goals for operations, maintenance, regulatory requirements, environmental concerns, public image, and reduced operational costs. At a minimum a pump station will always be located on this site. There is land available to accommodate alternate uses provided that demolition of the abandon structures is completed.

SECTION 9

Evaluation/Description of Plant No. 2

GENERAL

History

Wastewater Treatment Plant No. 2 is the main wastewater treatment facility for the City of Wichita and processes the majority of the total flow from the City and discharges treated effluent into the Arkansas River. Plant No. 2 operated under the authority of the NPDES Permit issued by KDHE. The plant has been modified many times and utilizes several different processes to treat wastewater to keep up with permitting regulations, and to meet the changing discharge standards imposed by the NPDES permit. While the future direction of the City is to construct satellite treatment facilities to process the wastewater from the growth areas on the perimeter of the City, Treatment Plant No. 2 will still provide wastewater treatment for the majority of the community. Since the facility has been modified several times to comply with different regulations attributed to each modification, the capacities of each unit process will vary. Some of the equipment and process is new and in good condition and other portions have served a useful life and should be replaced.

Service Area

The service area flow evaluation for Plant No. 2 includes flows that are pumped from Plant No. 1 and those that flow by gravity from West Wichita. A portion of the current flow from West Wichita will be diverted to a new Mid Continent Treatment Plant located near the airport. This plant is to be designed as a skimming facility taking all daily flows from the Cowskin Creek Interceptor up to and including 3.0 million gallons per day with the capability during peak flow conditions of taking 6.0 MGD. It is also planned that the residual solids generated through the treatment of the wastewater would be returned to the interceptor and transported to Plant No. 2 for continued processing. The Mid-Continent Treatment Facility is expected to be constructed and operational in 2008.

Table 9-1 lists the Average Daily Flow projections for Plants No. 2 and the Mid-Continent facilities.

Table 9-1. Plant No. 2 Flow Projections

	2002	*2010*	*2020*	*2030*	*2040*	*2050*
Plant No. 1 ADF (MGD)	28.00	29.03	29.46	29.81	30.17	30.52
Plant No. 2 ADF (Excluding CIS and F-SW -05,06, and 09) (MGD)	7.12	7.49	7.9	8.23	8.58	8.93
CIS Flow (MGD)	4.72	5.02	5.32	5.56	5.72	5.87
Mid-Continent Facility ADF (MGD)	0.00	3.00	3.00	3.00	3.00	3.00
* CIS and F-SW-05, 06, and 09 flow to Plant No. 2 (MGD)	4.72	2.02	2.32	2.56	2.72	2.87
Plant No. 2 ADF (MGD)	39.84	38.54	39.68	40.6	41.47	42.32

* Equals Cowskin Creek Interceptor Flow plus F-SW-05, 06, and 09 minus ADF treated at the Mid-Continent Facility. Balance of the flow plus the residual solids from the Mid-Continent Facility are transported to Plant No. 2

Table 9-2 lists the Peak Daily Flow projections for Plants No. 2 and the Mid-Continent facilities.

Table 9-2. Plant No. 2 Peak Daily Flow Projections

	2002	*2010*	*2020*	*2030*	*2040*	*2050*
PDF Plant No. 1 (MGD)	51.80	53.71	54.50	55.15	55.81	56.46
Plant No. 2 ADF (Excluding CIS and F-SW -05,06, and 09) (MGD)	12.53	13.18	13.90	14.48	15.10	15.72
CIS Flow (MGD)	8.31	8.83	9.36	9.79	10.06	10.33
Mid-Continent Facility PDF (MGD)	0.00	6.00	6.00	6.00	6.00	6.00
* CIS and F-SW-05, 06, and 09 flow to Plant No. 2 (MGD)	8.31	2.83	3.36	3.79	4.06	4.33
Plant No. 2 PDF (MGD)	72.64	69.72	71.77	73.42	74.98	76.51

** Equals Cowskin Creek Interceptor Flow plus F-SW-05, 06, and 09 minus PDF treated at the Mid-Continent Facility. Balance of the flow plus the residual solids from the Mid-Continent Facility are transported to Plant No. 2

More detailed tables for Plant No. 1 and the proposed Mid-Continent service areas are available in Appendix H including current and projected population and flow data listed by sub-basin. When construction of the Mid-Continent Satellite Treatment Facility is complete, the Cowskin Creek Interceptor will direct a portion of the flows

from basins CIS and F-SW to the Mid-Continent Treatment Facility. Flows from these basins are currently treated by Plant No. 2.

General Process Description and Capacity

The review of the Plant No. 2 process is based upon the ability of the whole facility to meet new regulations requiring the removal of nutrients from the wastewater prior to discharge into the Arkansas River at the projected flows and loadings. This anticipated level of treatment is much more advanced than the design of the current facility.

As stated previously Plant No. 2 is the main wastewater treatment plant for the City of Wichita. The facility components include influent screening, lift pumps, grit removal, primary clarification, intermediate lift pumps, trickling filter biological treatment, intermediate settling basins, screw lift pumps, nitrification using activated sludge, final clarifiers, ultraviolet light disinfection, re-aeration and lastly discharge to the Arkansas River. In addition to these unit processes that provide the treatment of the liquid portion of the wastewater there are residual solids that are processed at Plant No. 2 and are made up of primary sludge, and waste activated sludge. These solids are pumped to the sludge distribution box, thickened in a dissolved air floatation units, pumped to the anaerobic digestion units, followed by dewatering with belt filter presses. These solids are then stored in a covered storage facility for ultimate disposal agriculturally through application on crop land. Figure 9-1 located at the end of this section is schematic of Plant No. 1 and Plant No. 2 treatment processes. While each unit process is evaluated in detail, the following Table 9-3 provides a summary of each component's, firm and maximum capacity and compares those values against the current and future flows which result in an expected service life.

Table 9-3. Plant No. 2 Process Capacity

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Influent Barscreening					
	Vert. Front Cleaned Barscreens (2) @ 30 MGD				
	Firm Capacity (MGD)	20.84	30	20.03	N/A
	Max Capacity (MGD)	20.84	60	20.03	N/A
Influent Pumping					
	Horiz. Centrifugal Pumps (4) @ 10.0 MGD each				
	Firm Pumping Capacity (MGD)	20.84	30	20.03	N/A
	Maximum Pumping Capacity (MGD)	20.84	60	20.03	N/A
Grit Removal					
	Grit Removal Unit (1) @ 30.0 MGD				
	Firm Capacity (MGD)	11.84	30.0	11.88	N/A
	Maximum Capacity (MGD)	20.84	60.0	20.05	N/A
Primary Clarification					
	180 ft Primary Clarifier				
	Firm Capacity (MGD)	11.84	25	11.88	N/A
	Max Capacity (MGD)	20.84	41	20.05	N/A
	205 ft Primary Clarifier				
	Firm Capacity (MGD)	28.00	34	30.52	Exceeds Capacity
	Max Capacity (MGD)	51.81	54	56.46	2020

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Intermediate Pump Station					
	Axial Flow Pumps (4) @25.2, (2) per Trickling Filter Train				
	Firm Capacity (one train)	39.84	25.2	42.32	Exceeds Capacity
	Maximum Capacity (two trains)	39.84	50.4	42.32	N/A
Trickling Filtration					
	Filters (2 trains of 4) @ 6.3 MGD per Filter				
	Firm Capacity MGD (one train)	39.84	25.2	42.32	Exceeds Capacity
	Maximum Capacity MGD (two trains)	39.84	50.4	42.32	N/A
Intermediate Clarification					
	205 ft Clarifiers (2–1 per Trickling Filter Train)				
	Firm Capacity MGD (one train)	39.84	25.2	42.32	Exceeds Capacity
	Maximum Capacity MGD (two trains)	39.84	50.4	42.32	N/A
Screw Pump Station					
	84-inch Screw Pumps (4) @ 18 MGD each				
	Firm Pumping Capacity (MGD)	39.84	54	42.32	N/A
	Maximum Pumping Capacity (MGD)	72.64	72	76.51	Exceeds Capacity
Aeration					
	3 Trains of 2 Basins (6 total)				
	Original Design (MGD)	39.84	54	42.32	N/A
	Partial Treatment (MGD)	39.84	35.4	42.32	Exceeds Capacity

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
	No Preliminary Treatment (MGD)	39.84	18.6	42.32	Exceeds Capacity
Final Clarification					
	160 ft Clarifiers (6) 1 per Aeration Basin				
	Average Flow Conditions (5 Clarifiers)	39.84	40	42.32	2042
Disinfection					
	Open Channel Ultraviolet (2)@ 38 MGD each				
	Firm Capacity MGD (one train)	72.64	40	76.51	Exceeds Capacity
	Maximum Capacity MGD (two trains)	72.64	80	76.51	N/A

INFLUENT SCREENING

Description

Flows received at Plant No. 2 come from Plant No. 1 and west Wichita. Flows from Plant No. 1 are discharged into a primary clarifier as discussed below and do not pass through the influent screens while the flows from west Wichita are processed through the influent screens. Flows from west Wichita arrive through a 60-inch diameter interceptor that is connected to the influent barscreen structure. There are two 5.0 feet wide vertical front cleaned barscreens with ½-inch bar spacing. The purpose of the screens is to protect downstream processes and the influent pumps from clogging with rags, solids, and other debris. The material captured on the face of the screen, larger than 1/2 inch, is removed utilizing a mechanical rake which discharges the debris into a screw conveyor.

The removed screenings are conveyed into a grinder/washer and compactor to remove the excess organics and excess water. The manipulated screenings are then discharged into a dumpster where they are transported to solid waste disposal.

The barscreens can be isolated for major maintenance by two sluice gates. Flows that pass through the barscreen are discharged into the Plant No. 2 main pump station.

Inventory

The equipment in this process includes two 5.0 feet wide vertical front cleaned barscreens with ½ -inch bar spacing, a shaftless screw conveyor, and a grinder/washer and compactor. The screens are operated through a control system based upon time and headloss through the unit. System cleaning activation and deactivation, control of the wash water system, start/stop of the conveyer and grinder are all completed automatically by the control system.

Capacity

Each barscreen is rated at 30 MGD and the waste disposal equipment is sized to handle maximum load from each of the screens. Each screen is adequately sized for the influent flows that are expected at this facility.

Current Conditions

These units are approximately 6 years old and are in good physical condition. There have been some operational problems with the equipment, most recently with two system failures resulting in the motor and gear box being submerged in the influent wastewater. These conditions required special and extreme measures to reinstate the units into operation.

The screening removal equipment is producing a good product, but is showing signs of wear, especially the screenings washer/grinder unit. Consideration should be given to refurbishing this equipment.

The sluice gates associated with this process have been damaged. In efforts to close the gates in the past the actuating stems have been bent causing the gates to operate with difficulty making them unreliable.

INFLUENT PUMPING

Description

The Plant No. 2 main pump station lifts the screened wastewater from the wet well and discharges the flow into the grit removal process. The lift station is a dry-well/wetwell unit using horizontal centrifugal sewage pumps. These pumps are operated based on wetwell levels and are equipped with variable frequency drives. These VFDs allow the pumping rate to adjust to match the incoming flows which produces a more uniform flow to the treatment process.

These pumps discharge into a common force main that discharges into the grit removal process.

Inventory

There are four horizontal centrifugal sewage pumps each with a rated capacity of 10 MGD and are equipped with 100 horsepower motors and variable frequency drives.
The motor control center, including all fuses, disconnects, variable frequency drives and process controls are housed in an air-conditioned electrical room and appear to be in very good condition. Process control and monitoring equipment are used to automatically the control pumps based upon wetwell level.

Capacity

Each pump has a rated capacity of 10 MGD for a total firm capacity of 30 MGD and maximum capacity of 40 MGD. Based upon the peak daily flow conditions there is adequate capacity in this pump station to fulfill future conditions.

Current Conditions

The pumps' electrical systems and controls were upgraded with the installation of the barscreens in year 2000 and are in good condition. It is not anticipated that work other than routine maintenance will be required within the next ten years. It is important to note that these pumps have rotating elements that operate nearly continuously, consequently consideration should be given to budgeting for replacement of bearings, seals and impellers when the maintenance becomes more demanding and if pump capacity declines.

GRIT REMOVAL

Description

The grit removal system consists of several individual processes. The influent passes through a mechanical vortex grit removal unit where the flows are stirred with a paddle driven by a motor and gear box mounted on top of the each unit. This stirring action causes the grit in suspension to move to the center of the unit and drop into a holding chamber. Grit is pumped periodically from the holding chambers into grit classifiers which separates the grit from the liquid. The liquid portion is returned to the process and the dewatered grit is discharged into a hydraulically actuated push off box along with the materials discharged from the sludge screener. This push off box is then emptied on a regular basis into a dump truck that transports the material to disposal.

This system is covered and is ventilated through an odor control system that also supports the grit unit pump station, wetwell and the screenings facility. Foul air is pulled from these units and is discharged into a biofilter (bed of wood chips).

Process flows leaving the grit removal unit discharge into a flow control structure where they are routed to a primary clarifier for continued processing.

Inventory

Grit removal is achieved by one of two mechanical vortex grit removal units manufactured by Smith and Loveless. The capture grit is removed from the vortex units via a Wemco recessed impeller grit pump (one for each unit), two grit classifiers (one for each unit), and a shaftless screw conveyor. Odors are removed by the headworks odor control system.

Capacity

Each grit unit is 20 feet in diameter and has a rated capacity of 30 million gallons per day. While it is possible to move more water through the units hydraulically, process performance deteriorates. This provides a firm capacity of 30 MGD and maximum capacity of 60 MGD.

Current Conditions

Overall the grit system works well and should require only routine maintenance over the next ten years. Grit systems encounter a significant amount of wear resulting from the abrasive nature of the material being concentrated and removed, which results in the need for scheduled maintenance. In addition to the scheduled maintenance, the hydraulic power unit for the push off box should be examined. It has been plagued with leaks. Consideration should be given to having a hydraulic power unit specialist repair and or modify the unit to minimize this maintenance.

Another item associated with the odor control system is the wood chip media which has been in place long enough for compaction in the bed to occur and for the media to begin to break down into compost like material. The media is approaching its useful life and should be scheduled to be removed and replaced.

PRIMARY CLARIFIER

Description

Primary clarification is the first step in the biological treatment process. Its purpose is to remove settleable solids from the waste stream, thereby, reducing the organic loads on the balance of the process. These settled solids are then processed as primary sludge discussed later in this evaluation. The primary clarification process for all flows collected at both Plants No. 1 and No. 2 is provided at the Plant No. 2 site.

Plant No. 1 Primary Clarifier

The Plant No. 1 primary clarifier, located on the Plant No. 2 site, is a modified intermediate clarifier which originally served the south bank of trickling filters. It should be noted that when the intermediate clarifier was converted the south bank of four trickling filters was permanently removed from service. Plant No. 1 primary clarifier is 205 feet in diameter with an eighteen foot side water depth. Included in the clarifier conversion were the addition of a scum removal system modification of the launders and weirs and the replacement of the sludge pump. The original sludge scraping mechanism was retained. The design capacity of this unit is 34 MGD average and 54 MGD peak. This process currently is not equipped with odor control measures. As the neighborhood develops and odor issues become more important, odor control measures for this process should be considered. Flows leaving the primary clarifiers are discharged into the intermediate pump station for transport to the trickling filter process. Solids removed in this process are returned to the primary headworks.

Plant No. 2 Primary Clarifier

Influent flows arriving at Plant No. 2 main pump station are processed through the primary clarifier located on the west side of the treatment plant. This clarifier is 180 feet in diameter with an eighteen foot side water depth. It is also equipped with an inboard weir, scum removal system and sludge scrappers. The design capacity is 25 MGD average and 41 MGD peak. This process currently is not equipped with odor control measures. As the neighborhood develops and odor issues become more important, odor control measures for this process should be considered. Flows leaving the primary clarifiers are discharged into the intermediate pump station for transport to the trickling filter process.

Backup Primary Clarifier

The backup primary clarifier for either Plant No. 1 or Plant No. 2 is the northwest intermediate clarifier. While the normal function of this unit is that of an intermediate clarifier, its use as a primary clarifier would be more important to the process if one of the first line primary clarifiers was out of service. This clarifier is also 205 feet in diameter with an 18 feet side water depth. Therefore, the capacity of the unit is the same as the Plant No. 1 primary.

Inventory and Capacity

Plant No. 1 Primary is 205 feet in diameter with an 18 foot sidewall depth and a capacity of 34 MGD average and 54 MGD peak.

Plant No. 2 Primary is 180 feet in diameter with an 18 foot sidewall depth and a capacity of 25 MGD average and 41 MGD peak.

Backup Primary is 205 feet in diameter with an 18 foot sidewall depth and a capacity of 34 MGD average and 54 MGD peak but causes a reduction in the performance of four trickling filters when it is used as a primary clarifier.

All units are equipped with mechanical sludge scrappers, weirs and launders and sludge pumps for the removal of the settled solids. The Plant No.1 and Plant No. 2 primary clarifiers are equipped with scum removal systems; however, the backup clarifier is not.

Current Conditions

Plant No. 1 Primary Clarifier

Overall the performance of the unit is good. However, the support equipment is not working well. There are problems with the sludge pumping systems transferring the

sludge to the solids handling and digestions systems. Scum is being successfully removed from the clarifier, but discharges into a scum box that must be periodically pumped out by a contractor to remove the material. This effort is a maintenance problem and should be addressed. The sludge pumping system installed under the 2005 construction contract was found to be inadequate and the system is being upgraded with a properly sized Vaughan Chopper pump.

Plant No. 2 Primary Clarifier

Overall the unit is in good mechanical condition and is performing well. The scum pumping system and the sludge pumping systems are in good working condition and transport their respective products to the solids treatment and handling process.

INTERMEDIATE PUMPING

Description

Intermediate pumping provides the necessary energy to lift the partially treated wastewaters to drive the trickling filter rotating distributors. The process water being pumped includes the effluent from the primary clarifiers, return flows from most the other components in the treatment plant and the trickling filter recycle flows. The intermediate pumping station discharges and recycles the flow into two sets of four rock media trickling filters.

Inventory

There are four axial flow pumps installed in a single basin. The configuration is based upon one pump operating per bank of four trickling filters. Originally three of the pumps were dedicated to the three banks of trickling filters with one pump that could be discharged to any of the three banks of filters. However, with the current modifications the North and South pumps are each dedicated to a bank of trickling filters and the two interior pumps offer flexibility and can pump in either direction.

This process is the hub for the trickling filter process and receives and pumps all flows that pass through the trickling filters. This includes the recycle flows necessary to keep the trickling filters rotating even during low influent flow conditions. The recycle flows are established by a weir in the screw pump station. Effluent from the intermediate clarifiers is maintained at a minimum elevation by this weir, so that when influent flows are low flow is returned to the intermediate pump station.

Capacity

Each pump has a capacity of 25.2 MGD, and has a fully redundant backup pump. This provides firm and maximum capacity of the intermediate pumping station of 50.4 MGD.

Current Conditions

While of older manufacture, these pumps have been routinely maintained over their life and are performing well. As with any steel material in wastewater application, corrosion can be an issue. While not apparent from visual inspection the wall thickness of the discharge manifold should be tested for internal corrosion damage and loss of structural integrity.

TRICKLING FILTERS

Description

The rock media trickling filters provide secondary wastewater treatment and are physically located between primary clarification and intermediate clarification. They provide the pretreatment prior to nitrification in the activated sludge process. Although trickling filters are an old technology, they continue to perform very well in reducing BOD_5 levels.

Inventory

Secondary treatment consists of two sets of four rock media trickling filters. Each trickling filter is 200 feet in diameter with 6 feet 9 inches of rock media. The trickling filter is doused with wastewater through a rotating distributor that turns based upon the hydraulic energy imparted by the discharge nozzles. Each distributor has a center column and four arms. Along each arm is an array of nozzles to evenly distribute the flow over the surface of the filter media. On the back side of each arm are a few braking nozzles that discharge the flow in the opposite direction to prevent the arms from rotating too fast during high flow events.

Capacity

Each tricking filter would have a capacity of approximate 6.3 MGD to remove organic materials (BOD_5) from the wastewater. This provides 25.2 MGD of capacity

per bank of four units. With two banks on line the total capacity of the process is 50.4 MGD. Because of the nature of operation and recycle flows from the intermediate pump station each filter sees nearly identical hydraulic flow through out the day with only the strength of the process water changing depending upon the relationship between influent flow and recycled flow. It is possible to operate the system with one or multiple units out of service but in general the treatment process is based upon utilizing a full bank of four trickling filters at a time.

Current Conditions

The trickling filters were constructed in 1960, and have been in service for approximately 46 years. The rotating elements have been replaced and maintained through normal maintenance over the years and are generally in good condition.

The existing rock media is original to the 1960 filter construction. The filter is protected by the upstream screening equipment which is designed to remove solids and debris. The debris which is not caught in the influent screens can become trapped in the filter's rock media. This creates obstructions in the media which restricts flow and reduces the filters BOD_5 removal efficiency. The previous influent screen technology was less efficient at debris removal than the existing screens which were installed in 2000. As a result a significant amount of debris has accumulated in the media creating obstructions. .

By nature, trickling filters are open, cascading devices which will release entrained gasses, as well as, provide habitat for snails and filter flies. The existing trickling filters are contributors to odor, nuisance insects and have the maintenance issues associated with snails in the balance of the process.

While these units have served well to this point, effluent water quality requirements as well as, the environmental issues associated with these same units will likely result in their discontinued use at Plant No. 2 in the long term.

INTERMEDIATE CLARIFIERS

Description

The purpose of intermediate clarifiers is to remove the slough material discharged by the trickling filters. The slough is then processed with balance of the residual solids in the solids treatment and handling portions of the plant. The original construction included three intermediate clarifiers. During the 2005 construction project Interme-

diate Clarifier No. 3 was converted to a primary clarifier to process flows from Sewage Treatment Plant No. 1 as was stated above. Intermediate Clarifier No. 2 was also configured so it can serve as a standby unit for both the Plant No. 2 Primary Clarifier and intermediate Clarifier No. 3. This reconfiguration included a piping option which allows the continued use of the west bank of trickling filters in the event that Intermediate Clarifier No. 2 was in service as a primary clarifier. Under this operational scenario "West Bank" trickling filter effluent would be sent directly to the screw lift pump station without having been through the intermediate settling process.

Settled solids from the intermediate clarifiers are returned to the headworks where they are pumped through the grit unit and co-settled in the primary clarifier for processing along with the primary sludge.

Inventory

Two intermediate clarifiers each 205 feet in diameter with 18 feet sidewall depths. Solids are pumped or returned to the intermediate solids collection box for return to the headworks for de-gritting and co-settling in the primary clarifier.

Capacity

Each 205 feet diameter clarifier would have a rated capacity of approximately 33 MGD. This capacity would consist of both the influent flows and the recycle flows processed through the trickling filters.

Current Conditions

Overall the units are in good mechanical condition and are performing well.

Screw Lift Pump Station and Distribution Box

Description

The screw lift pump station lifts the partially treated wastewaters from the trickling filter secondary treatment process to the nitrification process in the activated sludge process basins. Flows arriving at this pump station have been received from the intermediate clarifiers and are discharged to the flow distribution box at the head of the

activated sludge process. This box divides the flow into the three activated sludge treatment trains.

Inventory

There are four enclosed screw pumps installed in a single structure. Each pump operates independently at a set rate of RPM. By their design screw pumps are variable flow rate pumps. The rate of flow is established by the depth of the water in the influent well, as the depth increases so does the pumping rate until the depth reaches the centerline of the screw pump cylinder at which time the maximum pump capacity is realized. By controlling the number of pumps in operation the maximum capacity of the station is established, and minimum flows result in the level in the influent well just enters the screw pump cylinder. This feature allows variable pumping without sophisticated controls. These pumps are driven by a motor and gearbox and the support bearings are lubricated with an automatic oiler system.

Capacity

Each screw pump has cylinders 84-inches in diameter with a full capacity of 18 MGD. This provides firm capacity of 54 MGD and maximum capacity of 72 MGD.

Current Conditions

These pumps have been routinely maintained over their life and are performing well and to date have not been a maintenance issue.

AERATION BASIN

Description

There are three trains of two aeration basins for a total of six aeration basins. These basins have recently been upgraded from a Biolac Aeration System to a fixed grid system using disc style, fine bubble, and ceramic diffusers. This modification has resulted in less maintenance and less operator attention while providing a very well balanced aeration pattern and high efficiency oxygen transfer. Each basin also received a stainless steel curtain approximately $^{1}/_{3}$ of the distance to the effluent weir, mounted across the basin, to provide two distinct zones within the aeration basin. The function of the stainless steel curtain is to increase the efficiency of the oxygen

transfer thereby using less energy. Influent flow is received from the main distribution box following the screw lift pump station. Each of the three trains from the main flow distribution box flow to a second flow control box that divides the flow into two streams one to each aeration basin in that train. The influent flows are mixed with the return activated sludge from the final clarifiers. This mixture is introduced into one end of the aeration basin through an influent header. Each aeration basin has a dedicated final clarifier. There are three blower buildings, each one dedicated to a set of two aeration basins.

Inventory

There are three trains of two aeration basins for a total of six basins each with a volume of 2.27 MG. Each train of two basins is supported by three 300 horsepower centrifugal blowers with a rated capacity of 6400 standard cubic feet per minute (SCFM) each. One blower is dedicated to each basin with a center blower that provides a backup to the other two units. Air rates to the basin are controlled by throttling the inlet valve to the blower. Air rates are adjusted based upon the measured dissolved oxygen concentration in each basin.

Flows leaving the aeration overflow a weir to a dedicated final clarifier. Solids from the bottom of the clarifier are discharged into a wetwell equipped with two 15 horsepower axial flow return activated sludge (RAS) pumps each rated at 3500 gpm and one 15 horsepower progressing cavity waste activated sludge (WAS) pump rated at 275 gpm.

The WAS pumps, blowers and controls are located in the blower building with the RAS pumps located adjacent to the building outside. There is one building dedicated to each activated sludge train. The electrical room is separate from the blowers and pumps and is an air conditioned space.

Capacity

The capacity of the aeration process is contingent upon the performance of the trickling filter process and the concentration of the ammonia in the supernatant and filtrate flows from the solids treatment process. The capacity limitations are based upon detention time in the aeration basins and the amount of air that can be supplied by the blowers. The following Table 9-4 depicts the sensitivity of the current process to the levels of treatment that precedes it.

Table 9-4. Aeration Process Capacity Based on Organic Loading Entering the Process

	BOD_5 (mg/l)	*Ammonia (mg/l)*	*Basin Capacity (MGD)*	*Maximum Capacity (MGD)*
Original Design	50	20	9	54
Partial Treatment	100	25	5.9	35.4
No Preliminary Treatment	280	25	3.1	18.6

Current Conditions

This process is working well and producing a quality effluent. The equipment supporting this process is also working well and allows for operational flexibility. As can be seen in the capacity evaluation (Table 9-4) depending upon the preliminary treatment process, the capacity of the aeration process can be limited.

FINAL CLARIFIERS

Description

Each of the six aeration basins has a dedicated final clarifier. Solids are drawn from the clarifiers utilizing a series of draft tubes after being collected by plows on the sweep arms. These settled solids are piped to the return activated sludge wetwell and are then pumped to the distribution box to maintain the active microbial mass in the aeration basin. Periodically settled sludge is wasted from the process to maintain the desired level of biomass in the aeration basin. The flow from the final clarifiers passes on to the UV disinfection process.

Inventory

The six aeration system final clarifiers are each 160 feet in diameter with a 14 foot sidewall depth. Each final clarifier is equipped with scum sweeps with launder brushes for weir, scum baffle and launder algae control. RAS pumps and WAS pumps are housed in the blower buildings adjacent to the clarifiers.

Capacity

The hydraulic capacity of each clarifier based upon average daily flow conditions would be approximately 8.0 MGD using a surface overflow rate as the limiting fac-

tor. However, the most important factor is solids loading rate. Depending upon the performance of the aeration basins, the capacity of the clarifiers could either be reduced or increased. If there is a problem with the clarifier then the corresponding aeration basin is also taken out of service.

Current Conditions

The clarifiers have been routinely maintained after being placed in service in 1989. There have been issues with the reliability of the draft tubes which have been subject to plugging and/or reduced flows. Staff indicates they are pursuing the abandonment of algae sweeps for algae control in favor of launder covers. One significant problem that should be address is the method of scum control. Scum from the basins is discharged into a scum box adjacent to the clarifier. Periodically a submersible pump discharges flows back into the clarifier causing a significant increase in total suspended solids being discharged from the plant, additionally, a truck must come by on a regular basin and remove the scum from the scum box. The truck then transports the scum across the plant site and discharges it into the solids handling system. This is a cumbersome method to handle a routine operation and it contributes to odor problems.

UV DISINFECTION

Description

Flow from the aeration basin final clarifiers passes to the UV disinfection unit. Disinfection is accomplished with an open channel, medium pressure, high intensity UV system consisting of two channels and four reactors equipped with 56 lamps per reactor. The final effluent flow is exposed to UV light produced at a wavelength of between 240 to 260 Angstroms which disrupts the bacteria reproduction by breaking the chromosomes within the cells. Process efficiency is measured by the reduction in the coliform count per 100 ml from more than 20,000,000 to less than 200. The flow from this process is directed to the reaeration unit.

Inventory

The two UV channels are each equipped with two reactors. Each reactor has 56 lamps for a total number of 224 UV lamps. Minimum UV transmittance is 65%. The lamp system is automatically self-cleaned.

Capacity

The rated capacity of the UV system is 40 MGD design flow per unit for maximum flow of 80 MGD.

Current Conditions

The disinfection system is meeting the disinfection requirements of the permit. The performance of the UV units is effected by two primary conditions; the first being the transmissivity of effluent, and the second is the rate of flow. The most critical component is the transmissivity which is governed by the performance of the preceding processes.

DISCHARGE/STATIC FLOW REAERATION

Description

Effluent from the UV disinfection is channeled to Oxycharger static mixers to raise dissolved oxygen levels from between 0 and 2 mg/l to above 4 mg/l. These are static reaeration devices that are used to increase the dissolved oxygen level. Dissolved oxygen concentration is required for maintenance of water quality in the river.

Inventory

There are three reaeration units that are hydraulically staged to maximize the efficiency of the units. They are fabricated from stainless steel and have screens and drop sections to provide oxygen entrainment.

Capacity

The rated capacity of the reaeration units is approximately 30 MGD each for a combined maximum capacity of 90 MGD. The units work based on the availability of sufficient hydraulic head. If the river level is elevated and backs water from the River into the process, the performance will be reduced. The amount of dissolved oxygen is also dependent upon the efficiency of the aeration system process. If performance is low in the aeration process then the performance will be low in the reaeration process.

Current Conditions

These units were placed in service in 1989 and are in good operating condition. It was noted by the operational staff that the units require periodic cleaning to remove algae and debris from the screen sections.

Evaluation of Overall Treatment Facility Capacity

Based on the current regulations, Plant No. 2 treatment capacity is limited between 40 and 50 million gallons per day. The limiting process is the activated sludge units. In addition to being the limiting process for current permit standards, activated sludge treatment is Plant No. 2's only process which can meet proposed regulations requiring an effluent containing no more than 8.0 mg/l total nitrogen and 1.5 mg/l total phosphorus. The current activated sludge does not have the capacity to meet these future limits.

If the trickling filter process is abandoned, and the wastewater organic loadings remain the same, the activated sludge process would be limited to approximately 18.6 MGD of treatment and still not meet the proposed nutrient removal requirements.

Conclusions

Wastewater Treatment Plant No. 2 has served a long and useful life. It has undergone several modifications over the years to maintain compliance with changing regulations. Treatment utilizing the trickling filter process has been the City's "work horse". The proposed nutrient removal regulations and other future regulations will essentially render the trickling filter system obsolete. The WWSD will need to begin to phase them out of service.

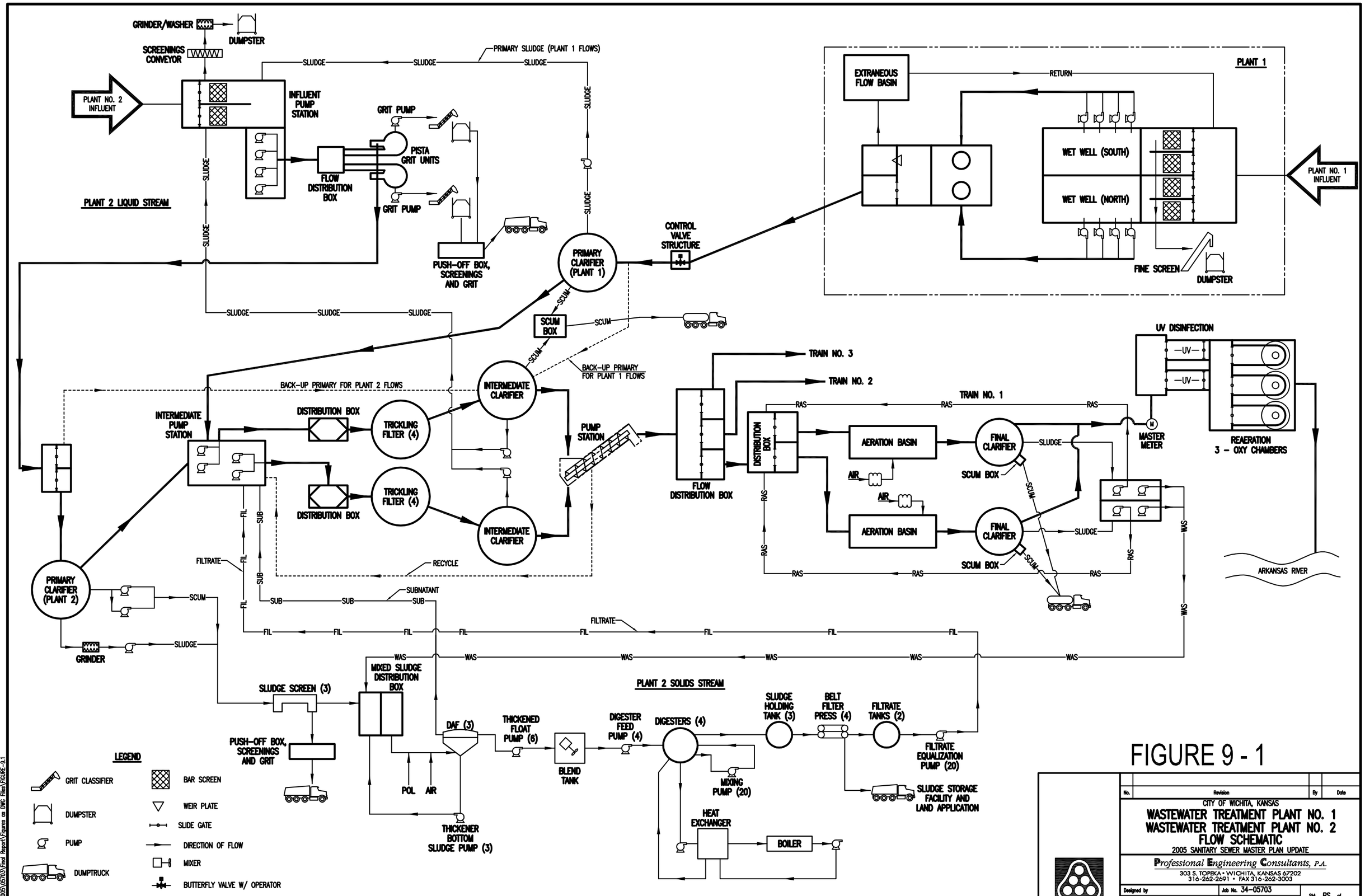


FIGURE 9 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

WASTEWATER TREATMENT PLANT NO. 1
WASTEWATER TREATMENT PLANT NO. 2
FLOW SCHEMATIC

2005 SANITARY SEWER MASTER PLAN UPDATE

Professional Engineering Consultants, P.A.
303 S. TOPEKA • WICHITA, KANSAS 67202
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F:\2005\05703\Final Report\Figures as DWG Files\FIGURE-9.1

SECTION 10

Existing CCWQRF Evaluation

GENERAL

History

The Cowskin Creek Water Quality Reclamation Facility (CCWQRF) services the northwest part of the City. Construction of this plant was completed in the Spring of 2003 following the previous Master Plan update. The overall design for the facility is based on an average capacity of 2.0 MGD and a peak of 6.0 MGD. The treatment facility was constructed with the ability to parallel components and expand the plant in the future to 4.0 MGD with a peak capacity of 12.0 MGD.

Service Area

The service area for this satellite treatment plant includes approximately 3,523 acres of the North West Interceptor basin (NWI) with a 2002 population estimate of 5,492.

The NWI basins are served by both the CCWQRF and Plant No. 2, but all flows from this basin are expected to be redirected to CCWQRF before 2010. Additional basins anticipated to be served by the CCWQRF before 2050 are as follows:

1 All of the Future Northwest basin(F-NW)
2 One of the Future Southwest basins (F-SW-07)

The City has not established specific dates for the incorporation of these basins into the service area. The connection of these basins will be dependant upon the actual growth in the area. The facility must be prepared to process the anticipated flows from the service area and recommendations for capacity increases will be based on future basin flow projections. The flow projections for all the service area is listed in Table 10-1.

Table 10-1. CCWQRF Average Daily Flow Projections

	2002	2010	2020	2030	2040	2050
CCWQRF Total Flow (MGD)	0.65	1.15	1.64	2.21	2.68	3.16

Projections for the CCWQRF's future service are less predictable than projections for the City's other treatment facility service areas. The northwest passageway is anticipated to be constructed just north of the CCWQRF which could produce rapid growth within the CCWQRF service area. At this time it is indeterminable whether these resultant flows would be directed to the City of Colwich, or the CCWQRF. In addition, the City of Colwich could elect to abandon their treatment facility and request that their flow be directed to the CCWQRF. Since the City can not make a determination as to the outcome of these issues, the situation will need to be closely monitored in future Master Plan Updates.

A more detailed table for the CCWQRF service area is available in Appendix H including current and projected population and flow data listed by sub-basin.

Table 10-2 lists the projected peak flow to the facility.

Table 10-2. CCWQRF Peak Daily Flow Projections

	2002	2010	2020	2030	2040	2050
CCWQRF Total Flow (MGD)	1.95	3.45	4.92	6.63	8.04	9.48

General Process Description and Capacity

The CCWQRF was constructed to alleviate flows into Plants No. 1 and No. 2 from the northwest section of the City. The treatment facility provides Biological Nutrient Removal. The overall treatment process includes screening, grit removal, biological treatment, clarification, tertiary treatment, disinfection, and reaeration after which it discharges into Cowskin Creek. A flow schematic of the treatment process is included at the end of this section.

Table 10-3 is a process capacity table that summarizes the current process capacity and compares that to projected flows to the facility.

Table 10-3. CCWQRF Process Capacity Summary Table

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Off-Site Influent Pumping					
	Submersible Pumps (4) @ 472 gpm each				
	Firm Pumping Capacity (MGD)	1.80	2.00	5.79	2042
	Maximum Pumping Capacity (MGD)	1.80	2.72	5.79	N/A
On-Site Influent Pumping					
	Submersible Pumps (2) @ 0.72 MGD each				
	Firm Pumping Capacity (MGD)	*	0.72	3.69	2014
	Maximum Pumping Capacity (MGD)	*	1.44	3.69	2022
Headworks					
	Spiral Barscreen/Press (2)				
	Firm Screening Capacity (MGD)	0.65	6.00	3.16	N/A
	Maximum Screening Capacity (MGD)	1.95	12.00	9.48	N/A
	Manual Bar Rack (MGD)		6.00		
	Grit Removal Unit (1) @ 6.0 MGD				
	Average Flow Conditions (MGD)	0.65	2.00	3.16	2028
	Peak Flow Conditions (MGD)	1.95	6.00	9.48	2028
Biological Treatment					
	Biological Treatment Trains (2)				
	SOR per Basin (Lbs O_2/day)	5,444	12,600	26,542	2018
Final Clarifiers					
	60 ft Circular Clarifiers (2)				
	Avg. Flow Conditions (MGD)	0.65	2.00	3.16	2028

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
RAS Pumping					
RAS Centrifugal Pumps (3) @ 1.58 MGD each					
	Firm Pumping Capacity (MGD) to one Clarifier	0.23	1.58	1.14	N/A
Tertiary Treatment					
	Disk Filter (1) @ 6.0 MGD				
	Average Daily Flow Capacity (MGD)	0.65	2.00	3.16	2028
	Peak Flow Capacity (MGD)	1.95	6.00	9.48	2028
Disinfection					
	Open Channel Ultraviolet (2)				
	Average Daily Flow Capacity (MGD)	0.65	4.00	3.16	N/A
	Peak Flow Capacity (MGD)	1.95	8.00	9.48	2041

* - current need controlled by plant internal flows

INFLUENT PUMPING (OFF SITE)

Description

The main pumping station for the CCWQRF is located on the southeast corner of 21st Street North and 135 Street West. The main pump station was sited at this location to provide the maximum gravity service to the contributing service area. The station pumps the collected wastewater three miles to the north to the treatment facility headworks. In addition to pumping, odor control and emergency power generation is also provided at the site.

Inventory

There are four 50 horsepower (HP), variable speed submersible pumps with effluent flow monitoring. In addition there is a diesel powered standby generator and a deep bed, granular activated carbon absorption system for foul air treatment.

Capacity

The pumps are rated at 472 gpm with 116 feet of total dynamic head (TDH) in the existing 14-inch force main, but have a rated capacity of 875 gpm with 102 feet of TDH in the future 20-inch force main.

Current Conditions

This is recent construction and is in good condition. The existing odor control system is a Carbon Absorber.

INFLUENT PUMPING (ON SITE)

Description

In anticipation of development west and north of the CCWQRF plant site an "On-Site" pump station was constructed. This pump station was constructed at a depth which will provide gravity sewer service to a substantial part of the service area. The pump station also receives flow from on-site processes.

Inventory

The pump station is equipped with two 20 HP, variable speed submersible pumps.

Capacity

The pumps are rated at 500 gpm at 60 feet of discharge head.

Current Conditions

The pump station was constructed in 2003 and is in good condition.

HEADWORKS

Description

The Headworks building houses the preliminary treatment process, the maintenance shop and the plant's main electrical center. The influent flow is delivered to this structure from the on site and off-site pumping stations to the headworks. The flow is

directed through the preliminary treatment process which consists of screening and grit removal. From the headworks, the flow is discharged by gravity into the aeration basin.

Inventory

The Headworks Building equipment includes two-2 HP spiral barscreens, each rated at 6.0 MGD and one manual bar rack rated at 6.0 MGD. The two-6.0 MGD spiral screens will provide sufficient screening for the anticipated ultimate plant capacity of 12.0 MGD. There is one grit removal unit rated at 2.0 MGD average and 6.0 MGD peak. The grit removal unit is a non mechanical vortex grit unit. The grit is removed from the bottom of the grit unit by a 0.32 MGD, 7.5 HP grit pump and sent to a Dewatering Screw Grit Conveyor powered by a 1 HP electric motor. Space is available for a second grit removal unit and associated dewatering conveyor.

Capacity

The headworks is designed for a wet weather peak flow of 6.0 MGD which is adequate for current flows. It is expandable to 12.0 MGD.

Current Conditions

The headworks is of recent construction and is in good condition.

BIOLOGICAL TREATMENT PROCESS

Description

The biological treatment process is extended aeration equipment with anoxic and anaerobic treatment zones for nutrient removal. After preliminary treatment, the flow is fed by gravity into one of two racetrack configured biological treatment basins for extended processing. This process achieves biological nutrient removal and includes anaerobic, anoxic, and aeration zones within each of the two process trains.

The aeration basin is designed for nearly complete oxidation of ammonia and BOD_5, as well as phosphorus uptake following anaerobic conditioning. The remaining tankage is designed to condition the bacteria for phosphorus release (anaerobic basin) and for denitrification (anoxic basin). The basin design maintains a low DO

mixed liquor recycle to the anoxic basin which affords maximum denitrification efficiency.

The basins are constructed with a common wall separating the two aeration basins and anoxic zones. The anaerobic selectors may also be isolated with the use of slidegates which allows processing 100% of the influent flow with one half of the basin volume if necessary under low flow conditions.

Inventory

Under normal conditions, basin influent flow is directed into the anaerobic splitter-box which contains a 7.5 MGD submersible mixer. The flow can be split to either treatment train over weirs controlled by slidegates. Each biological treatment train includes one anaerobic basin with a 3 HP submersible mixer. From the anaerobic portion of the treatment process, the flow is directed through ports into the anoxic section of the basin. Each anoxic basin contains one 15 HP submersible mixer. The flow then moves to the extended aeration process where a 150 HP surface aerator is mounted at the end of the racetrack basin. The aeration basin originally contained rotating scum troughs. One has been removed and the second will be removed in the future. Monitoring equipment for the aeration basins include two suspended solids analyzers (one in each basin), and four dissolved oxygen meters (two in each basin).

Capacity

The two anaerobic treatment basins each have a volume of 0.3 MG and a 3.6 hour hydraulic detention time (HDT). The two anoxic basins are 0.3 MG each with a 7 hour HDT. The aeration basins are 0.75 MG each with a HDT of 18 hours at average daily flows (2.0 MGD). The aerators can each transfer up to 12,600 lbs of O_2 each at 3.5 lbs O2 per HP per hr. The two treatment trains are fully redundant at 1.0 MGD average daily flow. The biological treatment process is adequately sized until 2018.

Current Conditions

The basins and equipment are new construction and are in good condition.

FINAL CLARIFIERS

Description

The two final clarifiers are 60 ft diameter with outboard launders and provide separation and settling of the mixed liquor suspended solids. The effluent from each biological treatment train discharges into 24-inch effluent pipes located at the bottom of the basins. The pipes are combined into one 36-inch pipe that discharges into a mixing structure which allows for an equal flow split between the two final clarifiers.

The solids are settled, moved along the bottom with a spiral blade rake, and discharged through the sludge blowdown. The sludge is either returned to the aeration basin or wasted to aerated holding. The scum accumulated on the clarifier surface is skimmed and discharged into a scum box. The effluent from the clarifiers flows over the v-notched weirs for discharge to the tertiary treatment process.

Inventory

The sludge collection consists of a spiral blade rake with a ¾ HP drive motor. The waste activated sludge is pumped to the aerated holding basin, or the aeration basin using two parallel submersible pumps rated at 0.14 MGD each. These pumps were also designed to transfer scum from the aeration basins to the aerated holding basin.

Capacity

The two 60 foot diameter clarifiers are 12 ft deep and have a weir length of 188 foot each. The surface area for each clarifier is 2,827 ft^2 with a design surface loading rate of 21 $lbs/day/ft^2$. The HDT is three hours each at average daily flow. The maximum RAS pump capacity is 1.44 MGD.

Current Conditions

The final clarifiers are new construction and in good condition.

TERTIARY TREATMENT

Description

A filter is used for tertiary treatment and to produce reuse water. The filter media is a cloth-membrane and provides consistent removal of very fine particulate matter which increases the effectiveness of the UV disinfection downstream. The water flows from the final clarifiers by gravity into the filter where it passes through the cloth membrane prior to being disinfected. Chlorine can be fed into the filter high pressure spray water to control bacteriological growth on the media. Staff can also add an aluminum sulfate feed upstream of the final clarifiers if needed to enhance phosphorus removal both in the clarifiers and in the filters.

The unit is designed to backwash automatically based on water level differential. The unit is also designed to maintain continuous filtration during backwash.

Inventory

The filter operates on a rotating axis with a ¾ HP motor. The cleaning system has a suction backwash pump and a high pressure spray pump rated per the manufacturer's requirements. Monitoring equipment for this process includes a 14" influent magnetic meter.

Capacity

The capacity of the filtration system is 2.0 MGD average and 6.0 MGD peak with a total filter surface area of 645.6 ft^2. The building is constructed to house a redundant system to be installed in a later phase.

Current Conditions

The filter is new construction and in good condition.

UV DISINFECTION/REUSE WATER STATION

Description

Following filtration the flow enters the UV disinfection channel located in the covered deck structure attached to the filter/disinfection building. The water passes

through two banks of UV lights which inactivates bacteria and pathogens present and discharges to the effluent control structure.

A reuse pump station is located adjacent to the disinfection unit. The reuse pumps can divert treated effluent from the discharge of the disinfection channel. The facility has multiple applications for reuse water for process or irrigation.

Inventory

The UV disinfection system is medium pressure, high intensity with four modules, and 16 lamps. There are three vertical turbine reuse pumps that provide water to one of two pressure tanks. Two of the pumps are 0.37 MGD (260 gpm) and 25 HP. The third pump is 0.10 MGD (70 gpm) and 10 HP.

Capacity

The UV system is designed to treat 2.0 MGD average daily flow and 4.0 MGD peak daily flow. They can be expanded to 6.0 MGD average daily flow and 12.0 MGD peak capacity by installing additional lamps.

Current Conditions

The UV and reuse water systems are new construction and are in good condition.

RAS PUMPS

Description

RAS pumps are located in the basement of the sludge handling building. Control of the pumps consists of setpoint adjustments of the Programmable Logic Controller (PLC). The RAS discharge is metered and the RAS rate is a setpoint adjustment of pump speed to match the desired flow rate. One pump is dedicated to a specific clarifier with the third pump acting as a redundant pump for both. The pumps are capable of returning 75% of the flow at design.

Inventory

RAS pumping consists of three 15 HP, variable speed pumps. Flow is metered and sample taps are provided on both the clarifier sludge lines and the RAS discharge piping

Capacity

The RAS pumps are rated at 1100 gpm each and 20 ft. TDH.

Current Conditions

This is recent construction and in good condition.

WAS Pumps

Description

WAS pumps are located in the basement of the sludge handling building. WAS pump suction is connected directly to the RAS pump suction lines. Each pump is dedicated to a specific clarifier, alternating with each wasting cycle. Piping allows either pump to obtain suction from either clarifier with the adjustment of manual valves. Pump operation consists of timed setpoints for pump duration and sludge wasting frequency. Flows are metered.

Inventory

WAS pumping consists of two 3 HP constant speed centrifugal pumps

Capacity

The WAS pumps are rated at 200 gpm at 20 ft. of TDH.

Current Conditions

This is recent construction and in good condition

Sludge Handling

Description

WAS is pumped to the aerated holding tank for storage. The operational staff can then dewater the sludge using a gravity belt thickener (GBT). The GBT feed solids concentration is between 0.5 – 1.0%. Discharge solids are maintained < 4-6% solids to facilitate optimum digester operations. Sludge loadout pumps are used to transfer

the thickened solids from the aerobic digester to a tank trailer for transportation to Sewage Treatment Plant No. 2.

Inventory

- Two variable speed GBT feed pumps with metered flow.
- Two variable speed GBT discharge pumps. The pumps adjust speed to match a setpoint in the discharge hopper of the GBT. One polymer feed unit provides polymer to condition solids prior to dewatering on the GBT.
- One 2 meter GBT.

Capacity

The GBT has a hydraulic capacity of 500 gpm and a maximum solids loading of 2,500 pounds per hour. The capacity of the feed pumps, discharge pumps and the polymer unit are controlled by the capacity of the GBT.

Current Conditions

This is recent construction and in good condition. The GBT was equipment previously utilized at Plant No. 2 that was factory rehabilitated and is in good operating condition.

AERATED HOLDING

Description

The aerated holding tank receives WAS and the contents of the basin are aerated. When staff elects to transport WAS the contents of the basin are then dewatered using the gravity belt thickener. The aerated holding tank allows wasting to occur as long as one week without operating the gravity belt thickener and removing the thickened WAS to Plant No. 2.

Inventory

There are two 75 HP, 1400 SCFM positive displacement blowers to provide mixing and aeration in the aerated holding tank. Dissolved oxygen and level indication is also provided.

Capacity

The capacity of the aerated holding tank is 512,000 gallons. The liquid detention time is calculated to be eight days.

Current Conditions

This is recent construction and is in good condition.

AEROBIC DIGESTER

Description

The aerobic digester receives thickened solids from the GBT operation and maintains mixing under aerobic conditions until the contents are trucked to Sewage Treatment Plant No. 2.

Inventory

There are two 100 HP, 2000 SCFM blowers to provide mixing and aeration in the aerated holding tank. Dissolved oxygen and level indication is also provided. Mixing is enhanced by two 15 HP submersible mixers.

Capacity

The capacity of the aerobic digester is 328,000. The design SRT is 40 days.

Current Conditions

This is recent construction and is in good condition.

SLUDGE HAULING

Description

Thickened sludge is pumped from the aerobic digester to the loadout station into a tank trailer. Solids are then transported to Sewage Treatment Plant No. 2 and anaerobically digested with solids generated in the Plant No. 2 operation, dewatered and land applied.

Inventory

The City of Wichita owns and operates two semi-tank trailers which are currently adequate to service all facilities operated and contracted.

Capacity

The sludge loadout pump has a capacity of 500 gpm at 25 ft. TDH with feed solids concentrations ranging between 4-10%

Current Conditions

Current equipment is adequate to perform all necessary operations. The City of Wichita has an equipment replacement program in place.

Evaluation of Overall Treatment Facility Capacity

The CCWQRF is designed for the following flows shown in Table 10-4.

Table 10-4. Design Capacity

Flow	*Influent*
Average Daily (MGD)	2.0
Peak Daily (MGD)	4.0
Wet Weather Peak Flow (MGD)	6.0

The facility is also designed for future improvements that would double the existing capacities. The evaluation of the process illustrates capacity limitations in processes that will dictate the timing of the next planned expansion phase. The facility is now capable of biological nutrient removal and filtration which is expected to be sufficient to meet permit requirements though 2050 with little or no changes to the actual process.

Conclusion

The treatment facility is in good working condition and is meeting all regulatory requirements at this time. Plant operation is primarily through an advanced SCADA

system which allows the facility to be operated remotely with a minimum of operator attention, which allows for efficiency in plant operations. The process is not expected to need any major improvements to meet future requirements. Anticipated improvements will be process capacity related. The need for a Phase No. 2 expansion was anticipated in the original design of the facility and is reiterated by the flow projections in this document.

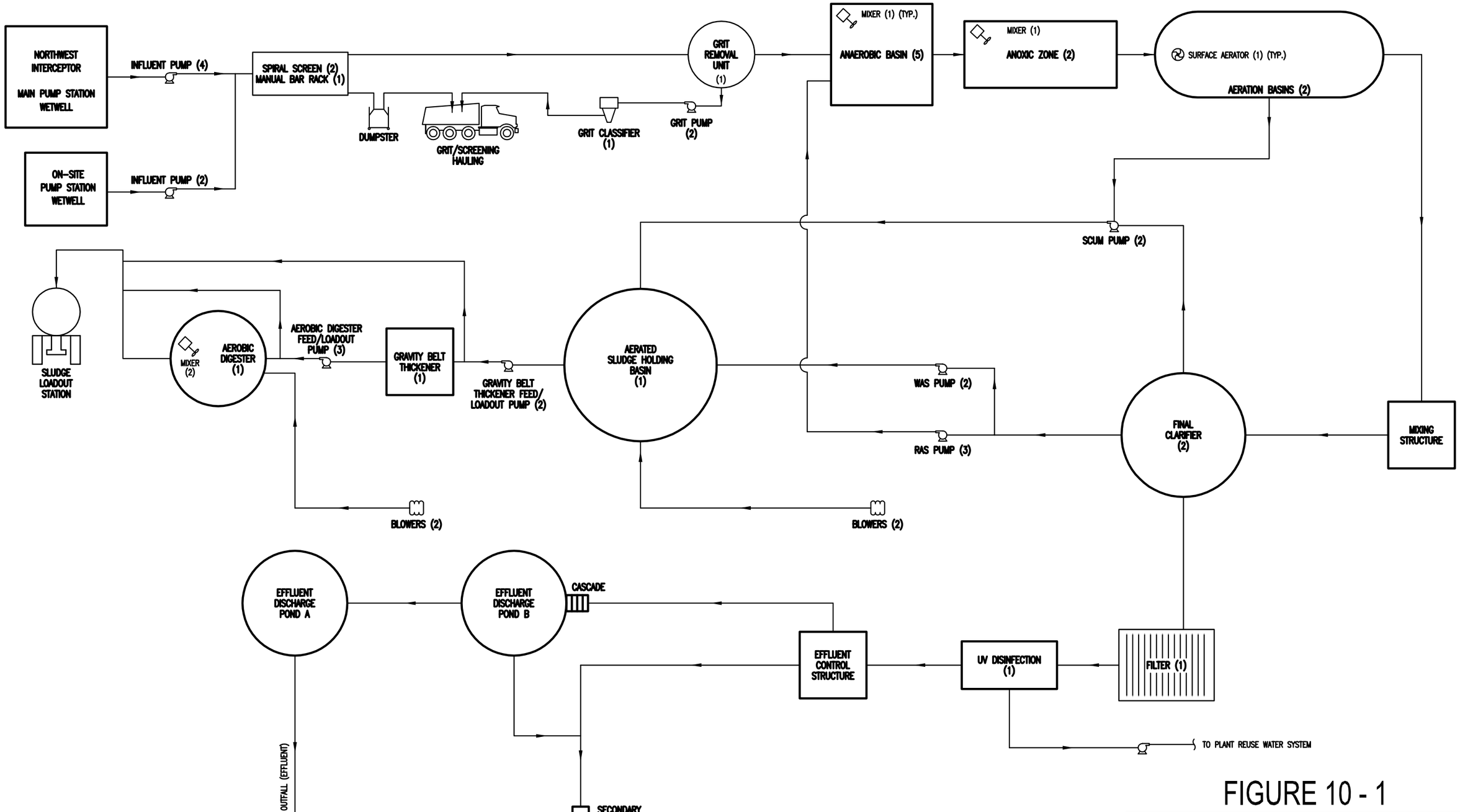

FIGURE 10 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

COWSKIN CREEK WATER QUALITY RECLAIMATION FACILITY – SCHEMATIC

2005 SANITARY SEWER MASTER PLAN UPDATE

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F:\2005\05703\Final Report\Figures as DWG Files\FIGURE-10.1

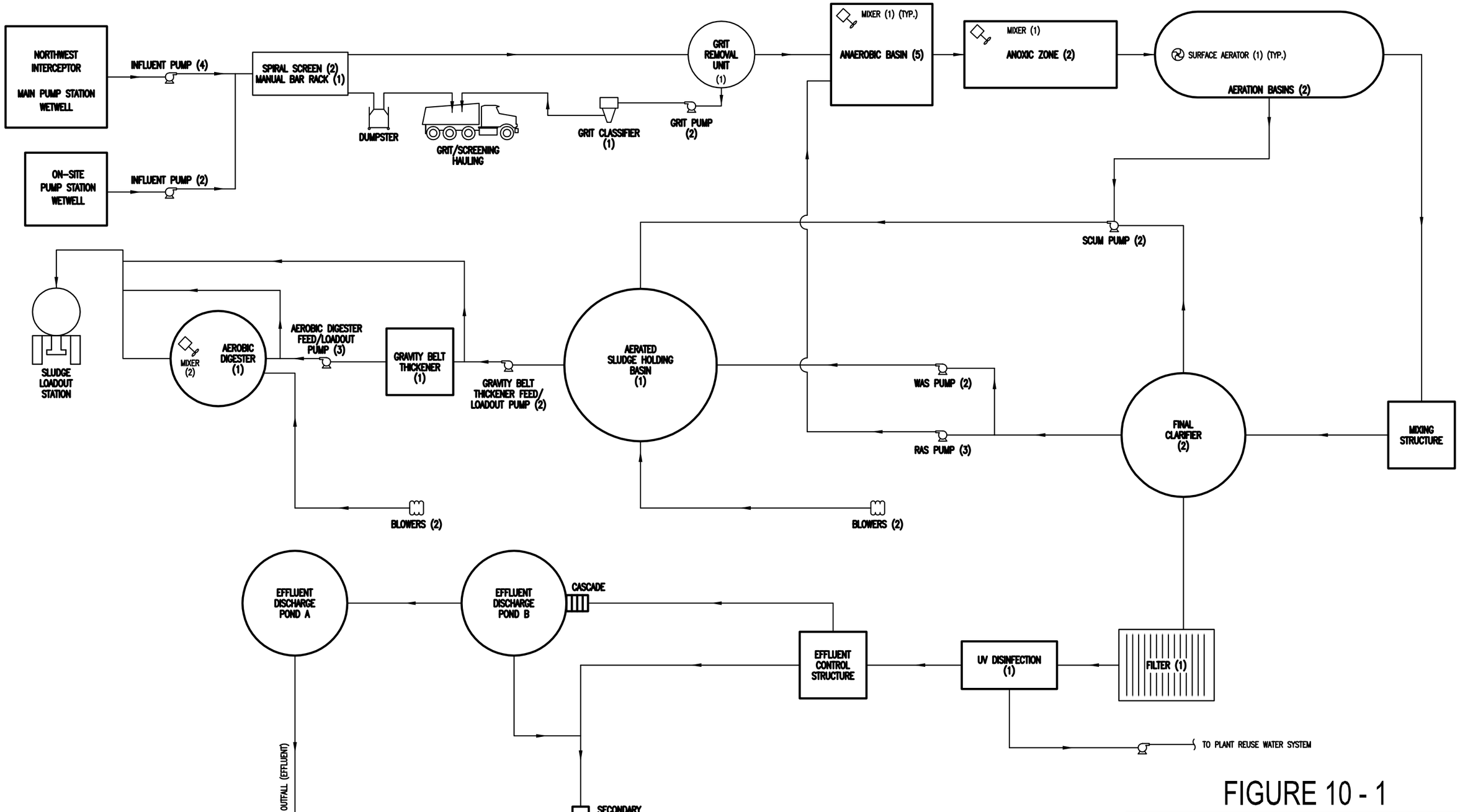

FIGURE 10 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

COWSKIN CREEK WATER QUALITY RECLAIMATION FACILITY – SCHEMATIC

2005 SANITARY SEWER MASTER PLAN UPDATE

Professional Engineering Consultants, P.A.
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SECTION 11

Existing Four Mile Creek Facility Evaluation

GENERAL

History

The City of Wichita Water and Sewer Department purchased the Four Mile Creek Wastewater System from Sedgwick County and took over operations on April 1, 2001. The City immediately saw the need for expansion and rehabilitation as outlined in the 2000 Master Plan Update. As a result, the Four Mile Creek Treatment Facility underwent Phase No. 1 of the City's expansion plans. The expansion and rehabilitation was completed in March of 2004. This facility currently serves the six Four Mile Creek sub-basins. Based on MAPD projections, it is expected to receive flows from an additional six basins before 2050. The plant was designed to accommodate a future increase in capacity to 6.0 MGD average daily flow and 12.0 MGD peak wet weather flow.

The original Four Mile Creek Treatment Facility was named the Timber Lakes/Springdale Sewage Treatment Plant and consisted of two lagoons which are now used as extraneous flow holding ponds. A mechanical extended aeration activated sludge process designed for BOD_5 and ammonia removal was then built adjacent to the lagoons and was designed for an average daily flow of 1.5 MGD, peak flow of 4.5 MGD, and a maximum hydraulic flow of 6.9 MGD. The WWSD purchased the Four Mile Creek Wastewater System from Sedgwick County and took over operations on April 1, 2001. The system, also known as the Eastern Sedgwick County Sewage Disposal District, includes both collection and treatment facilities. As discussed above, the City implemented Phase No. 1 of their two phase expansion plan. Phase No. 1 construction was completed in March of 2004. The improvements included addition of biological nutrient removal (BNR), redundancy in headworks, clarification, provisions for sludge digestion and dewatering, upgrades to electrical and controls systems, and a 1.5 MGD capacity expansion which increases the average daily design flow to 3.0 MGD with a peak wet weather flow of 6.0 MGD.

Service Area

The Four Mile Creek Treatment Facility currently serves approximately 9,541 acres and 13,800 people on the east side of Wichita. The service area currently includes sub-basins within the Four Mile Creek Basin (4MC).

The Four Mile Treatment Facility will serve the following basins before 2050.

1 One of the WIS Basin (WIS-07)

2 All of the Walnut Basins

The City has not established specific dates for the incorporation of these basins into the service area. The connection of these basins will be dependant upon the actual growth in each basin. The facility must be prepared to process the anticipated flows from of these basins at any given time, therefore recommendations for capacity increases will be based on both existing and future basin flow projections. The population and flow projections for all the basins are listed in Table 11-1.

Table 11-1. Four Mile Creek Average Daily Flow Projections

	2002	*2010*	*2020*	*2030*	*2040*	*2050*
4MC Treatment Facility Total Flow (MGD)	1.79	2.63	3.2	3.72	4.02	4.63

Current and projected flow and population data (by sub-basin) for the Four Mile Creek Treatment Facility is located in Appendix H.

Table 11-2 lists the projected peak flows anticipated at Four Mile Creek.

Table 11-2. Four Mile Creek Peak Daily Flow Projections

	2002	*2010*	*2020*	*2030*	*2040*	*2050*
4MC Treatment Facility Total Flow (MGD)	3.58	5.26	6.4	7.44	8.04	9.26

General Process Description and Capacity

The Four Mile Creek Treatment Plant was purchased and incorporated into the City's wastewater system to alleviate flows into Plants No. 1 and No. 2 from the eastern section of the City. The treatment facility was rehabilitated from its original treat-

ment process and now provides biological nutrient removal. The overall treatment process includes screening, grit removal, biological treatment, clarification, disinfection, and reaeration after which it discharges into Four Mile Creek. A flow schematic of the treatment process is included at the end of this section.

Table 11-3 is a process capacity table that lists process capacity and compares that to projected flows to the facility.

Table 11-3. Four Mile Process Capacity Summary Table

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Extraneous Flow Holding					
	Holding Volume (MG)	*	20.70	*	
	Pumping to Extraneous Flow (MGD)	*	2.88	*	
Influent Pumping					
	Self Priming Pumps (3) @ 2.52 MGD each				
	Firm Pumping Capacity (MGD)	3.58	5.04	9.26	2014
	Maximum Pumping Capacity (MGD)	3.58	6.19	9.26	2024
Screenings Removal					
	Spiral Barscreen/Press (2) @ 6.0 MGD each				
	Firm Screening Capacity (MGD)	1.79	6.00	4.63	N/A
	Maximum Screening Capacity (MGD)	3.58	12.00	9.26	N/A
Grit Removal					
	Grit Removal Unit (1) @ 6.0 MGD each				
	Average Flow Conditions (MGD)	1.79	6.00	4.63	N/A
	Peak Flow Conditions (MGD)	3.58	6.00	9.26	2022
Biological Treatment					
	Biological Treatment Train (1)				
	Oxygen for BOD_5 and Ammonia (SOR, lbs/Day)	10,421	16,800	34,949	2014

Process	*Component*	*Current (2002) Process Need*	*Current Process Capacity*	*Future (2050) Process Need*	*Approximate Date No Longer Adequate*
Clarification					
	80 ft Clarifier (1) + 60 ft Clarifier (1)				
	Average Flow Conditions (MGD)	1.79	3.02	4.63	2023
Anoxic Recycle Pumping					
	Centrifugal Anoxic Recycle Pumps (2)				
	Firm Capacity (MGD)	5.37	6.00	13.89	2010
	Maximum Capacity (MGD)	7.16	12.00	18.52	2022
RAS Pumping**					
	Centrifugal RAS Pumps (4)				
	RAS Pumps Dedicated to 80 ft Clarifier (2)				
	Firm Capacity (MGD)	0.69	1.50	1.78	2038
	Maximum Capacity (MGD)	0.69	3.00	1.78	N/A
	RAS Pumps Dedicated to 60 ft Clarifier (2)				
	Firm Capacity (MGD)	0.39	0.84	1.00	2037
	Maximum Capacity (MGD)	0.39	1.68	1.00	N/A
Disinfection					
	Chlorine Contact Basin (1)				
	Volume for 30 Min. of Contact Time at ADF	37,291	50,000	96,458	2012
	Volume for 15 Min. of Contact Time at PDF	37,291	50,000	96,458	2012

* - Determined by the City thru future collection system flow monitoring activities

** - Assumed both Clarifiers are in service and a surface overflow rate of 385

EXTRANEOUS FLOW HOLDING BASIN (EFB)

Description

The two extraneous flow basins are located just west of the treatment plant. The lagoons have a total water storage volume of 20.7 million gallons (MG) at 5 feet of water depth in each cell. A water depth of 5 feet provides a minimum freeboard of 3 feet between the water surface and the top of the dike. Any water depth maintained in the lagoons between events reduces the volume available for wet weather storage. The water is drained by gravity back into the facility through a manual sluice gate that is normally closed.

Inventory

When flows at the Main Influent Pump Station exceed 6.0 MGD, they are diverted to the EFB through a 10 in force main by two 20 HP, vacuum primed pumps with a combined capacity of 2000 gpm or 2.88 MGD. The discharge from the EFB contains a manual sluice gate, V-notch adjustable discharge weir, and an ultrasonic level transmitter that is not presently functioning. A project is planned to install a force main between the influent pumping station and EFB that will facilitate pumping directly from the wet well to EFB using Influent Pump No. 3.

Capacity

As discussed above the capacity of the EFB is dependant on the level of water maintained in the lagoons prior to a rain event. An analysis was preformed on the storage volumes at various operating depths. The results are shown in Table 11-4.

Table 11-4. Analysis of Wet Weather Flow Filling Time

Water Depth Operating Range (ft)	*0-5*	*1-5*	*2-5*	*3-5*	*4-5*
Approximate Dynamic Volume (MG)	20.7	16.5	12.4	8.2	4.1
Filling Time at 2.88 MGD (days)	7.19	5.73	4.31	2.84	1.42

The volume of the EFB and pumping capacity is adequate to meet the City's needs at this time. Future capacity needs are discussed below in the evaluation of overall treatment facility capacity.

Current Conditions

The high water level is maintained primarily for aesthetic reasons, and also to minimize erosion on the internal slopes of the dike. Concrete erosion protection for the interior slopes was designed for the facility, but never constructed. The current slope conditions are in reasonable condition with an average water depth of 3-4 ft. If the average water depth is maintained at 2 ft as recommended above for storage purposes, an increase in slope maintenance will most likely occur. The pumps have been in service since approximately 1972 and are in reasonable condition.

MAIN INFLUENT PUMPING

Description

The main influent pump station is located in the southwest part of the plant site. The wetwell is approximately 32 ft below surface level which receives flow from the collection system. The upper floor houses the electrical equipment, controls, and monorail. The basement floor houses the pumps.

Inventory

There are three 1750 gpm (2.52 MGD) self-priming pumps with a 40 ft TDH. There is also one influent combustible gas detector, a one ton motor driven hoist and trolley, and one 12-inch magnetic flow meter located in the basement on the combined force main discharge which expands to a 16-inch pipe.

Capacity

The firm pumping capacity with two of the three pumps running is a minimum of 4.6 MGD. The construction of the pump station will accommodate a fourth pump when necessary. There is an additional blind flange on the existing discharge line to accommodate a parallel discharge when capacity expansion is necessary.

Current Conditions

The main pump station is in good condition and the pumps received new belts and sheaves during the 2003 rehabilitation.

HEADWORKS

Description

The headworks building is located on the west side of the property and receives flow from the influent pump station through a 16-inch force main. The water is then screened in one of two open channels prior to grit removal. Following grit removal, flow from the headworks is discharged through a 36-inch line into the anaerobic/anoxic basins. The building also houses a separate electrical room.

Inventory

The headworks building has two influent open channels. Each channel has a 6.0 MGD, 2 HP spiral screen for fine screening with screening press. After screening, the water flows by gravity to a 6.0 MGD vortex grit removal unit. The grit is pumped to the grit classifier unit by a 250 gpm, 7.5 HP grit pump and the grit is screened with a screw grit conveyor.

The building monitoring equipment includes a combustible gas leak detector and five float switches.

Capacity

The headworks building is physically designed for twice the capacity of the existing capacity of the plant. The screening is redundant at 6.0 MGD with an ultimate capacity of 12.0 MGD. The building houses two grit removal basins each designed for 6.0 MGD, but only one is equipped with the mechanical equipment required. The next phase of construction will include the installation of the redundant equipment bringing the grit capacity to 6.0 MGD average day and 12.0 MGD ultimate.

Current Conditions

The building and equipment are in good condition. The equipment can be expected to last 18 years more based on an average mechanical equipment life of 20 years. The roof of the original building cannot provide the structural requirements to install hoists to lift the screens out of the channels for maintenance. A monorail beam with supports separate from the roof structure could be added to allow installation of hoists to assist in operation and maintenance.

ANAEROBIC/ANOXIC BASINS

Description

Three anaerobic basins and one anoxic basin are located within on structure north of the headworks building on the northwest side of the property. They receive flow from the headworks. The headworks discharges through a 36-inch pipe into a manhole where sludge from the RAS pumps is mixed with it the combined volume flows by gravity through a 30-inch pipe into the first of three anaerobic mixing chambers. The wastewater then passes over a weir into the anoxic basin where it is mixed with sludge from the anoxic recycle pumps and then discharged over another weir into a splitter box.

Inventory

Each of the three anaerobic basins has a 5 HP submersible mixer. The anoxic basin has two 7.5 HP submersible mixers. The anoxic basin also includes an oxidation reduction potential meter.

Capacity

The anaerobic basins have a combined volume of 0.325 MG with a HDT of 2.6 hours at an average daily flow of 3.0 MGD. The anoxic basin has a volume of 0.675 MG with a HDT of 5.4 hours. The mixers were sized to provide adequate mixing at 6.0 MGD. The next phase of construction will include identical anaerobic/anoxic basins located just north of the existing basins which will bring the capacity to 6.0 MGD average day and 12.0 MGD peak wet weather.

Current Conditions

The basins are in good condition. The equipment can be expected to last 18 years more based on an average mechanical equipment life of 20 years.

AERATION BASIN

Description

The aeration basin was retro fitted in the recent phase of construction with surface aerators on the ends of the basin to provide the aeration and mixing for the process. The basin is an oxidation ditch configuration located just east of the anaerobic/anoxic basins. During normal operation the flow discharges from the anoxic basin and flows by gravity though a 48-inch pipe into the west end of the aeration basins. It is aerated and then discharged over a weir on the northeast side of the basin. Flow from the aeration basin is discharged into the clarifiers.

Inventory

The aerators are slow speed, open vane using VFD motors and are 200 HP each. Monitoring equipment for the basin includes a mixed liquor suspended solids meter and a dissolved oxygen meter.

Capacity

The basin has a volume of 1.67 MG for a total HDT of 13.4 hours at average daily flows of 3.0 MGD. The aerators are each capable of providing 3.5 lbs O_2/HP*hr, or 16,800 lbs/day of Standard Oxygen.

Current Conditions

The structure itself was inspected before the retro-fit and was found to be in good condition. The mechanical equipment can be expected to last 18 years more based on an average mechanical equipment life of 20 years.

FINAL CLARIFIERS

Description

After aeration, the flow is directed into a 48-inch pipe from the aeration basin effluent box. The 48-inch pipe discharges into a wetwell for the anoxic basin recycle pumps. The remaining water flows under a baffle into a separate wet well section that is designed to accommodate a mixer should the City decided to add a chemical injec-

tion point to aid in coagulation. After that, the flow is discharged by gravity into one of the two final clarifiers where the solids are settled out, the scum is removed from the water surface, and the clear supernatant is discharged over the outboard launders.

Inventory

The smaller of the two final clarifiers is 60 ft diameter and is original to the plant. This clarifier was fitted with new mechanical equipment during the most recent facility improvements. The larger of the two final clarifiers is 80 ft diameter and was constructed in 2004 during the most recent construction phase. Each clarifier is equipped with a spiral rake blade sludge collection, full radius skimming, and launder brushes to prevent algae buildup. Each clarifier is equipped with a sludge blanket monitor.

Capacity

The clarifiers' influent flow rates are controlled by the height and length of the discharge weirs. The smaller clarifier has 188 ft of weir length, a surface area of 2,827 ft^2. The 80 ft clarifier has a weir length of 251 ft and a surface area of 5,027 ft^2. At an average daily flow of 3.0 MGD they have a solids loading rate of 19 lbs/day/ft^2, combined surface overflow rate of 382 gpd/ ft^2, and each has a HDT of 6.0 hours.

The piping was installed to accommodate two future clarifiers identical to the 80 ft clarifier. This would bring the clarifier capacity to an average day flow of 6.0 MGD and a peak of 12.0 MGD.

Current Conditions

The clarifier structures and equipment are in good condition. However the protective surface coating of the 80 ft Clarifier equipment painting has failed. The magnitudes of the flows arriving at the Facility have not allowed the City to take the 80 ft clarifier out of service. Coating repairs for the existing 80 ft clarifier will be required when a new 80 ft clarifier is added in the next phase of construction.

DISINFECTION/REAERATION AND OUTFALL STRUCTURE

Description

Flow from the final clarifiers is combined and fed through a Parshall flume for flow measurement. A chlorine induction unit is mounted in the chlorine mixing chamber.

After chlorine injection, the flow serpentines through a series of five open channels. Sulfur dioxide is injected directly before the final chamber for dechlorination. The final open channel is fitted with coarse bubble diffusers to facilitate reaeration before discharge.

Inventory

The existing disinfection and reaeration basin has a 50,000 gallon capacity. This provides 24 minutes of hydraulic detention time at average daily flow and 12 minutes at peak daily flow.

Capacity

Chlorine can be fed at a maximum rate of 500 lbs/day from two, one-ton gas cylinders. The maximum feed rate of the sulfur dioxide system for dechlorination is 500 lbs/day which is supplied by two, one-ton gas cylinders. The chlorination/dechlorination system is capable of loop control with flow pacing from the Parshall flume and a chlorine residual analyzer.

Current Conditions

The disinfection and reaeration basin and equipment was installed with original plant construction in 1985 and is at the end of its 20 year useful life. The City is committed to transitioning all treatment facilities to UV disinfection to eliminate handling and storage of hazardous gasses.

SLUDGE PUMP STATION

Description

The sludge pumping station is located north of the 80 ft diameter clarifier. It houses the anoxic recycle wet well and pumps, scum wetwell and pumping, RAS pumping, WAS pumping, sludge digesters, and the digester blowers. After aeration the flow is directed into the anoxic recycle wetwell where approximately three to five times the influent flow rate is pumped back to the anoxic basin.

The sludge from the final clarifier sludge blow down is pumped through the RAS pumps back into Manhole No. 1 directly before the anaerobic basins. The process pulls WAS from the RAS discharge line through a three way valve and pumps it

into the sludge digesters. The three way valve also enables the WAS pumps to pump scum from a scum pit into the digester. The blowers provide air to the sludge digesters where the sludge is thickened by decanting before it is pumped to the sludge loadout. The floating decanters, located in the digesters, drain the supernatant to a manhole to be reintroduced at the beginning of the process.

Inventory

The sludge pump station has two screw centrifugal anoxic recycle pumps rated at 6.0 MGD and 30 HP each. There are four RAS screw centrifugal pumps, two dedicated to the 60 ft clarifier rated at 0.84 MGD (5 HP), and two dedicated to the 80 ft clarifier rated at 1.5 MGD and 7.5 HP. There are two progressive cavity WAS/scum pumps rated at 0.29 MGD and 15 HP each. The two progressive cavity sludge loadout pumps are rated at 0.36 MGD and 15 HP. In addition to the pumps there are three positive displacements blowers rated at 1300 SCFM and 75 HP which provide aeration to the digesters which also contain decanters. Monitoring equipment includes one bubbler level element in the scum box and one in each digester, a float switch, five flow meters, two smoke alarms, and two dissolved oxygen meters located in the digesters.

Capacity

The building itself has adequate room to accommodate the equipment needed to expand to the ultimate 6.0 MGD average day, 12.0 peak day capacity. The anoxic recycle pumps rated at 6.0 MGD are adequate for the needs of the plant at this time. The WAS pumps are sized such that the future increase in plant capacity will not require more pumping capacity, instead the pumps will operate with increased run times.

The two anaerobic sludge digesters are sized to provide 40 days of SRT with 2% solids after decant. The blowers are sized to service the anticipated ultimate capacity of the plant with three digesters.

Current Conditions

All of the structures and equipment mentioned above were constructed or installed new in the most recent expansion and are in good condition.

Sludge Processing

Description

The solids are pumped off the bottom of the aerobic digesters to the sludge loadout station directly into a tank trailer at approximately 2% solids and then hauled to Plant No. 2 for further processing.

Inventory

Two 250 gpm progressive cavity loadout pumps are housed in the sludge pump station. The monitoring equipment includes a magnetic flow meter.

Capacity

At the 3.0 MGD average daily design flow approximately 132,300 gallons per week of 2% sludge will be produced. Currently the sludge pumps are rated at 0.360 MGD. The sludge is hauled five days a week taking approximately 9.0 hours per week to pump the liquid to the tank trailer. When phase two of the expansion is completed the amount of solids will essentially double. This increase in capacity will require the City to either increase hauling capability or install a dewatering/thickening process.

Current Conditions

The sludge processing equipment is in good condition.

Evaluation of Overall Treatment Facility Capacity

The Four Mile Treatment Facility is designed for the following flows shown in Table 11-5.

Table 11-5. Design Capacity

Flow	*Influent*
Average Daily (MGD)	3.0
Peak Daily (MGD)	6.0

Future projected plant expansions will double the existing capacity to accommodate for population growth and the inclusion of additional basins into the Four Mile service area. The facility is capable of biological nutrient removal and is expected to meet or exceed regulatory requirements thru the year 2050.

CONCLUSION

The treatment facility is in good working condition with the majority of equipment installed with the most recent improvements in 2003-2004. The facility currently meets or exceeds all regulations. The treatment processes will not require significant improvements to maintain effluent water quality regulations.

In keeping with the City's goal of creating a chemical free treatment process at all of its treatment facilities, it is anticipated that the City will replace the current chlorine disinfection process with a UV treatment process when necessary.

The facility will require expansion due to process capacity limitations in the existing basins and equipment.

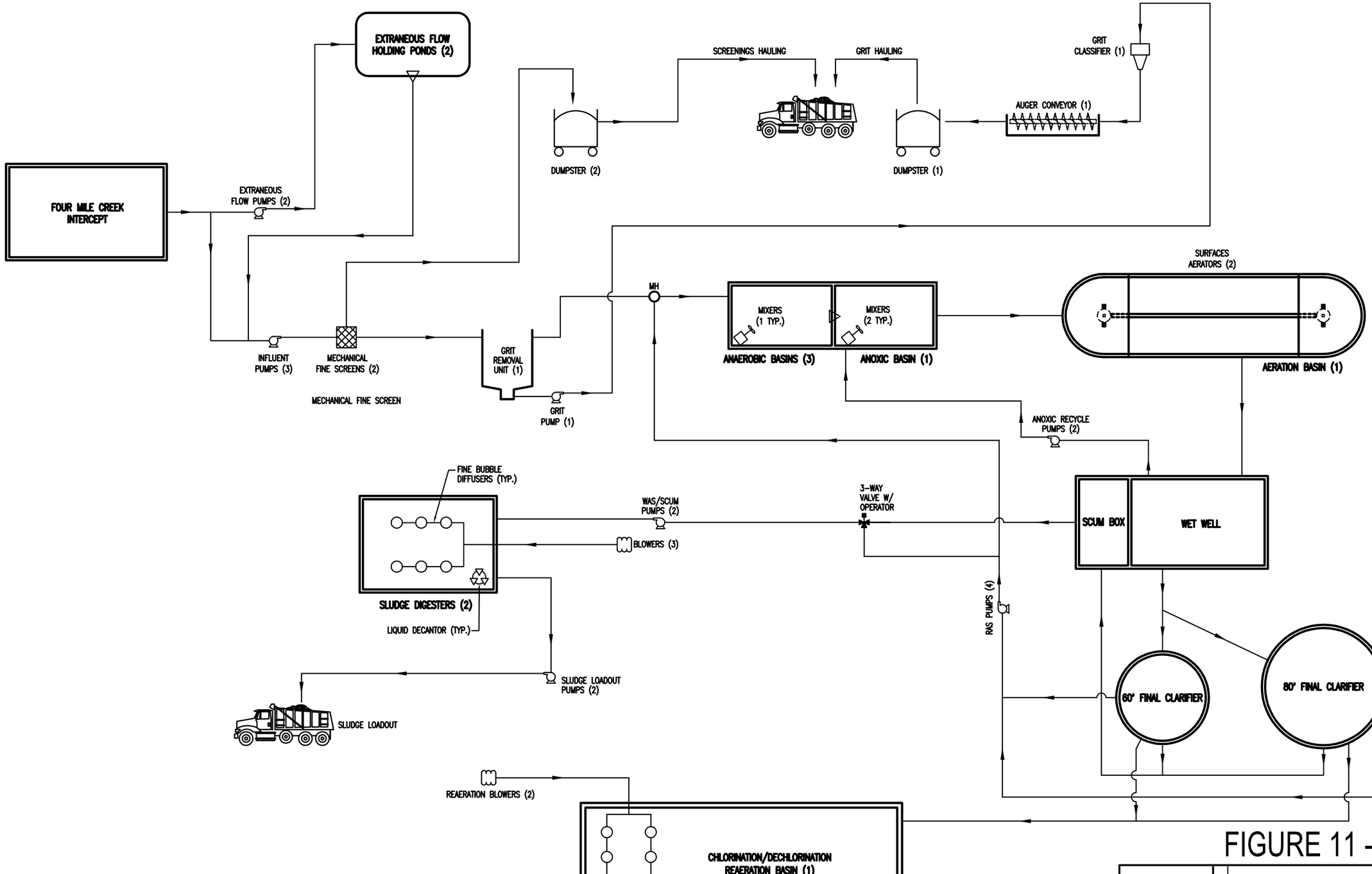

FIGURE 11 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

FOUR MILE CREEK SCHEMATIC

2005 SANITARY SEWER MASTER PLAN UPDATE

Professional Engineering Consultants, P.A.
303 S. TOPEKA • WICHITA, KANSAS 67202
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F:\2005\05703\Final Report\Figures as DWG Files\FIGURE-11.1

SECTION 12

Collection System Improvements and Alternatives

INTRODUCTION

Section 12 describes the sanitary sewer collection system alternatives to service currently unsewered future growth areas within the study area and to provide capacity assurance to areas currently served by City of Wichita.

Alternatives were developed to a planning level to indicate general locations and sizes of major interceptor sewers, lift stations, and force mains. Interceptor layout alternatives considered:

- New gravity interceptors and upgrade of existing interceptor lines to Wastewater Treatment Plant 1 or 2, or to other major interceptors within the Service Area.
- Interceptors for Four Mile Creek Treatment Facility, Cowskin Creek Water Quality Reclamation Facility, Mid-Continent Wastewater Treatment Facility, North Wastewater Treatment Facility, and the Northeast area.
- Upgrade of existing interceptor sewers where overloading exists or is projected.
- New or upgraded lift stations and force mains.

A map of the recommended sanitary sewer collection system improvements is located in Appendix F. The sizing of all pipelines, lift stations, and force mains in this Master Plan are based on design flows developed in Section 3 and the peaking factors developed in Section 6. It has also been stated that the existing flow metering data is out of date and was not useful for this Master Plan Update. New flow monitoring data should be collected to determine actual flow characteristics before design of improvements to existing facilities. A detailed flow monitoring program is described in Appendix J. All final designs should include adequate capacity to handle flows that would be associated with a 10-year rain event.

The proposed alignments of extension sewers and relief sewers on the map of recommended sanitary sewer collection system improvements are conceptual and must also be confirmed during detail design.

The layout and sizing of extension sewers to serve projected growth in currently unsewered areas utilized spreadsheet calculations, as shown in Appendix I. The following describes the hydraulic capacity evaluation of the Wichita collection system through the planning year 2050.

- The capacity evaluation of the existing trunk sewer system utilized the hydraulic model as described in Section 6.
- The model determined the peak flows in each trunk sewer, lift station and force main for years 2010 through 2050.
- Trunk sewers were considered for relief if the peak flow exceeded the full-pipe gravity flow capacity.
- Relief sewers were sized to flow no more than 2/3 full for pipe sizes up to 18-inch diameter, and no more than 3/4 full for larger sewers.
- Per "Kutter's Formula" for the determination of the capacities of circular sewers flowing partially full, the capacity at 2/3 depth is 79 percent of full capacity and the capacity at 3/4 depth is 92 percent of full capacity. Lift stations were required to have firm pumping capacity adequate for the projected peak flow.
- Force mains were evaluated based on a maximum velocity of 8 fps and limiting head losses within the rated pump head.

The need for constructing sewer extensions or relief sewer facilities will depend on actual development.

Basis for Cost Opinions

The opinions of probable cost provided in this report were based primarily on experience and judgment, vendors, and published sources. For gravity sewer costs, an average bury depth of 10-feet to 15-feet with minimal rock excavation was assumed. Geotechnical validation of this assumption is beyond the scope of this report. Soil characteristics, groundwater, and excavation techniques can vary significantly and therefore can have a significant impact on final cost. The impact of weather, cost, and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's methods of determining prices, economic conditions, government regulations and laws (including the interpretation thereof), competitive bidding or market conditions and other factors affecting such opinions or projections are difficult to control; consequently, the final project costs will vary from the opinion of costs provided in this

report, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

The opinion of costs for all items of equipment and hardware included in the improvements and upgrades typically include equipment, installation, electrical and mechanical systems, and instrumentation. For the purpose of this report it was assumed three phase power will be available at the sites for future pumping facilities. Cost opinions do not include sales taxes, wastewater characterization, treatability testing, pilot testing, special construction requirements, acquisition of easements, removal and disposal of hazardous materials and waste, extraordinary legal expenses, or other non-construction costs.

Improvement cost opinions for sanitary sewers were based on the unit construction costs presented in Table 12-1. Capital costs were developed by adding 30 percent for contingencies to obtain total construction cost and 25 percent for engineering, legal, and administrative costs to obtain total project cost. The costs are indexed to the October 2006 ENR – Construction Cost Index value of 8,500.

Table 12-1 Unit Costs for Sanitary Sewers

Pipe Diameter (in)	*Construction Cost ($/ft)*
8	80
10	93
12	97
15	113
18	131
21	155
24	170
27	190
30	213
36	255
39	277
42	284
48	324
54	365
60	405
66	446

Pipe Diameter (in)	*Construction Cost ($/ft)*
72	632
96	975

SEWER EXTENSIONS TO SERVE PROJECTED GROWTH

The following describe the layout and capacity evaluation of extension trunk sewers for each currently unsewered growth area. Extension trunk sewers were developed to extend service throughout the growth areas within the 2050 boundary, as defined Section 6. Future sewer extensions to serve projected growth were aligned to follow natural drainage courses, and where possible to follow alignments along existing or potential streets. The alignments considered the available aerial photography, topographic mapping and parcel mapping. The extension sewers were assigned pipe elevations and slopes based on the existing ground slope, the pipe invert elevation at the connection to existing sewers, and a typical sewer depth of 10-feet. Sizing for all future extension and relief sewers assumed a design Manning's "n" value of 0.014, a minimum diameter of 8-inches, and the City of Wichita's flow depth criteria. Extension sewer layouts are schematic in nature and the actual alignments, depths of sewer and slopes must be confirmed during final design.

Future North Area Analysis

The future North Area sub-basins comprise areas located between existing City development and the northern 2050 service area boundary, which borders Valley Center, Park City, Bel Aire and Kechi. Sub-basin F-N-04 is small; it will not require a trunk sewer greater than 8-inch diameter and can be sewered by gravity to existing sub-basin SS23-06. Sub-basin F-N-03A surrounds the intersection of Interstates 135 and 235; areas south of Interstate 235 could be sewered by gravity flow south into existing sub-basin SS23-08, and areas north of the Interstate would require a highway crossing to provide sewer service. Sub-basin F-N-03B will not require a trunk sewer greater than 8-inches, and can be sewered by gravity into existing sub-basin SS23-03.

Sub-basins F-N-01 and F-N-02 lie between the Arkansas River and the flood control channel; this area is very flat and sanitary sewer service will require pumping. Currently, the City is constructing a new lift station on Meridian along with a force main connecting to the existing force main at lift station LS22, which pumps to sub-basin SS23-08. LS22 will be retired when the improvement is completed. Trunk

sewer extensions to serve sub-basins F-N-01 and F-N-02 will convey flows to the new lift station. In the future, a new force main will be built on 53rd Street and Hoover to convey flows from this lift station to the future North Plant. At that time, all of F-N-01, F-N-02 and existing sub-basin SS23-09 will be served by the North Plant.

The North Area sewer extensions are summarized in Table 12-2. The upstream and downstream manhole numbers are shown on the map of the recommended sanitary sewer collection system improvements located in Appendix F. Sewers are sized for the design year 2050 peak wet weather flows.

Table 12-2. Future North Area Sewer Extensions

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Diameter (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-N-02	F-N-02-06	F-N-02-05	2,013	10	$243,400	$304,300
F-N-02	F-N-02-05	F-N-02-04	2,661	10	$321,700	$402,100
F-N-02	F-N-02-04	F-N-02-03	1,961	10	$237,100	$296,400
F-N-02	F-N-02-03	PLS-005	3,710	15	$545,000	$681,300
F-N-02	F-N-02-01	F-N-02-02	1,641	10	$198,400	$248,000
F-N-02	F-N-02-02	F-N-02-03	2,577	10	$311,600	$389,500
F-N-01	F-N-01-01	F-N-01-02	1,185	10	$143,300	$179,100
F-N-01	F-N-01-02	PLS-005	1,945	15	$285,700	$357,100
F-N-02	F-N-02-07	F-N-02-08	2,087	10	$252,300	$315,400
F-N-02	F-N-02-08	F-N-02-09	2,435	10	$294,400	$368,000
F-N-02	F-N-02-09	5451-039	1,598	10	$193,200	$241,500
F-N-03B	F-N-03B-01	5753-001	3,652	15	$536,500	$670,600
F-N-04	F-N-04-01	6052-012	1,000	8	$104,000	$130,000
F-N-04	F-N-04-02	5953-028	4,387	8	$456,200	$570,300
Total			32,852		$4,122,800	$5,094,200

Future West Area Analysis

The future West Area sub-basins are bounded by the City limits, the 2050 service area boundary, and the Arkansas River. The areas in sub-basins F-W-01 and F-W-02 that are north of Highway 96 will be sewered by gravity flow to the future North Plant, which will be located within sub-basin F-W-02. The remaining areas in sub-basins F-

W-01 and F-W-02 are south of Highway 96 and will be sewered by gravity flow to existing sewers in sub-basin SWI-11.

Modeling results for the future West Area sewer extensions are given in Table 2. The upstream and downstream manhole numbers shown on the map of the recommended sanitary sewer collection system improvements located in Appendix F identifies the extensions. Sewers are sized for the design year 2050 peak wet weather flows.

Table 12-3 lists the interceptor sewer information for the future West Area.

Table 12-3. Future West Area Sewer Extensions

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia. (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-W-02	F-W-02-11	F-W-02-10	1,846	8	$192,000	$240,000
F-W-02	F-W-02-10	F-W-02-13	1,846	8	$192,000	$240,000
F-W-02	F-W-02-09	F-W-02-10	2,768	8	$287,900	$359,900
F-W-02	F-W-02-08	F-W-02-09	2,678	10	$323,800	$404,800
F-W-02	F-W-02-05	F-W-02-06	2,614	12	$329,600	$412,000
F-W-02	F-W-02-06	F-W-02-07	1,266	12	$159,600	$199,500
F-W-02	F-W-02-07	F-W-02-08	2,678	10	$323,800	$404,800
F-W-02	F-W-02-13	F-W-02-12	1,846	12	$232,800	$291,000
F-W-02	F-W-02-02	F-W-02-03	2,590	8	$269,400	$336,800
F-W-01	F-W-02-03	F-W-02-01	2,098	18	$357,300	$446,600
F-W-02	F-W-02-01	WWTP - NP	1,000	18	$170,300	$212,900
Total Future West Area					$2,838,500	$3,548,300

Future Northwest Area

The future Northwest Area flows will be treated at CCWQRF. Pumping will be required to convey flows to CCWQRF for all sub-basins except F-NW-01. Extension sewers will convey flows from sub-basins F-NW-03, F-NW-04A, F-NW-04B, and F-SW-07 to lift station LS56, which discharges to CCWQRF. The interceptor sewers were generally laid out to follow the natural drainage.

Several sub-basins are small and do not require extension sewers larger than 8-inch. Collector sewers for sub-basin F-NW-02 will drain to existing sub-basin NWI-

03, to be pumped to CCWQRF at LS56. Collector sewers for sub-basins F-NW-05A and F-NW-05B drain to sub-basin NWI-01, to be pumped via both LS40 and LS56 to CCWQRF.

A new force main is currently under construction to redirect lift station LS-09 flows generated in existing sub-basin NWI-04 from Plant No. 2 to CCWQRF.

Table 12-4 lists the interceptor sewer information for the future Northwest Area.

Table 12-4. Future Northwest Area Extensions

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia/ (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-NW-01	F-NW-01-20	F-NW-01-18	2,561	8	$266,300	$332,900
F-NW-01	F-NW-01-18	F-NW-01-15	2,594	10	$313,600	$392,000
F-NW-01	F-NW-01-17	F-NW-01-15	2,401	8	$249,700	$312,100
F-NW-01	F-NW-01-15	F-NW-01-14	2,784	15	$409,000	$511,300
F-NW-01	F-NW-01-13	F-NW-01-12	1,130	8	$117,500	$146,900
F-NW-01	F-NW-01-12	F-NW-01-16	869	10	$105,100	$131,400
F-NW-01	F-NW-01-16	F-NW-01-14	2,425	12	$305,800	$382,300
F-NW-01	F-NW-01-14	F-NW-01-11	2,579	18	$439,200	$549,000
F-NW-01	F-NW-01-19	F-NW-01-11	1,149	8	$119,500	$149,400
F-NW-01	F-NW-01-11	F-NW-01-07	1,340	21	$270,000	$337,500
F-NW-01	F-NW-01-01	F-NW-01-02	1,392	8	$144,800	$181,000
F-NW-01	F-NW-01-02	F-NW-01-03	1,290	10	$156,000	$195,000
F-NW-01	F-NW-01-03	F-NW-01-04	2,593	12	$327,000	$408,800
F-NW-01	F-NW-01-04	F-NW-01-05	1,341	15	$197,000	$246,300
F-NW-01	F-NW-01-05	F-NW-01-06	2,668	15	$391,900	$489,900
F-NW-01	F-NW-01-06	F-NW-01-10	2,657	18	$452,500	$565,600
F-NW-01	F-NW-01-10	F-NW-01-09	2,605	21	$524,900	$656,100
F-NW-01	F-NW-01-09	F-NW-01-07	1,264	21	$254,700	$318,400
F-NW-01	F-NW-01-07	F-NW-01-08	2,683	27	$662,700	$828,400
F-NW-01	F-NW-01-08	4652-TP3	2,884	27	$712,300	$890,400
F-NW-03	F-NW-03-01	F-NW-03-02	2,619	8	$272,400	$340,500
F-NW-03	F-NW-03-02	F-NW-03-03	2,734	10	$330,500	$413,100
F-NW-03	F-NW-03-03	F-NW-03-04	2,504	12	$315,800	$394,800

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia/ (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-NW-03	F-NW-03-04	F-NW-03-05	2,734	15	$401,600	$502,000
F-NW-03	F-NW-03-05	F-NW-03-06	2,525	15	$370,900	$463,600
F-NW-03	F-NW-03-06	F-NW-03-07	2,515	18	$428,300	$535,400
F-NW-03	F-NW-03-07	F-NW-03-08	1,317	18	$224,300	$280,400
F-NW-04A	F-NW-04A-01	F-NW-04A-02	1,233	8	$128,200	$160,300
F-NW-04A	F-NW-04A-02	F-NW-04A-03	1,807	8	$187,900	$234,900
F-NW-04A	F-NW-04A-03	F-NW-04A-04	1,305	8	$135,700	$169,600
F-NW-04A	F-NW-04A-04	F-NW-04A-05	2,685	8	$279,200	$349,000
F-NW-04A	F-NW-04A-05	F-NW-04A-13	3,060	10	$370,000	$462,500
F-NW-04A	F-NW-04A-12	F-NW-04A-13	2,501	8	$260,100	$325,100
F-NW-04A	F-NW-04A-06	F-NW-04A-08	1,044	8	$108,600	$135,800
F-NW-04A	F-NW-04A-08	F-NW-04A-09	2,107	8	$219,100	$273,900
F-NW-04A	F-NW-04A-09	F-NW-04A-10	2,209	8	$229,700	$287,100
F-NW-04A	F-NW-04A-10	F-NW-04A-18	1,175	8	$122,200	$152,800
F-SW-07	F-NW-04A-11	F-NW-04A-18	2,571	10	$310,800	$388,500
F-NW-04A	F-NW-04A-13	F-NW-04A-14	1,739	10	$210,200	$262,800
F-NW-04A	F-NW-04A-14	F-NW-04A-15	2,695	10	$325,800	$407,300
F-NW-04A	F-NW-04A-15	F-NW-04A-17	2,770	12	$349,300	$436,600
F-NW-04A	F-NW-04A-17	F-NW-04A-16	1,288	18	$219,300	$274,100
F-NW-04A	F-NW-04A-16	F-NW-04A-21	7,614	10	$920,500	$1,150,600
F-NW-04A	F-NW-04A-18	F-NW-04A-19	123	12	$15,500	$19,400
F-NW-04A	F-NW-04A-19	F-NW-04A-20	2,726	12	$343,700	$429,600
F-NW-04A	F-NW-04A-20	F-NW-04A-17	1,313	12	$165,600	$207,000
Total Future Northwest Area					$13,664,700	$17,081,400

Future Southwest Area Analysis

The future Southwest Area flows will be treated at Plant No. 2 and at the Mid-Continent Wastewater Treatment Facility. The interceptor sewers were generally laid out to follow the natural drainage.

Sub-basin F-SW-01 surface drainage flows south and east away from the existing trunk sewers. However, like the existing sewers in this area, the extension sewers would be laid at depths less than 10-feet to convey flows north into the existing trunk sewer on 55th Street. The alternative for F-SW-01 would be to construct approximately 3-miles of new trunk sewer flowing east along 63rd Street to a new lift station and force main discharging to Plant No. 2.

Sub-basin F-SW-08 is on the west bank of the Arkansas River downstream of Plant No. 2. This sub-basin will be served by a new extension sewer, a new lift station (PLS-006) at the River near 71st Street, and a force main extending to Plant No. 2.

Sub-basin F-SW-02 can be served by a gravity extension sewer on 55th Street connecting to the existing 54-inch trunk sewer at Meridian.

Sub-basin F-SW-03 and F-SW-04 can be sewered by gravity into existing sub-basin SWI-03 terminating at existing lift station LS57. The additional flows would require expanding LS57 if the gravity sewer is built. The Wichita Municipal Airport Authority owns land in sub-basin F-SW-04. The City of Wichita considers development unlikely and sewer construction potentially difficult in the area south of the Airport. To allow initial development of upstream portions of F-SW-03, the City has planned for a temporary lift station (PLS-008) between Maize and Tyler Roads, with a force main to convey flows north to sub-basin CIS-11. This lift station will be retired if and when the downstream trunk sewers are built.

Sub-basins F-SW-05 and F-SW-06 can be sewered by gravity into existing City sewers in CIS-11. Flows delivered to CIS-11 are either pumped by LS-27 before reaching Plant 2 or are diverted to the new Mid-Continent WWTP.

One sub-basin (F-SW-07) can be sewered by gravity into sub-basin F-NW-04A for ultimate treatment at CCWQRF. This will allow retiring existing lift station LS-48.

Table 12-5 lists the interceptor sewer information for the future Southwest Area.

Table 12-5. Future Southwest Area Extensions

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia. (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-SW-01	F-SW-01-01	5640-005	2,648	12	$333,900	$417,400
F-SW-01	F-SW-01-02	5441-009	2,676	12	$337,400	$421,800
F-SW-01	F-SW-01-03	5441-010	2,709	12	$341,600	$427,000
F-SW-02	F-SW-02-04	F-SW-02-03	5,304	10	$641,300	$801,600

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia. (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-SW-02	F-SW-02-03	F-SW-02-02	5,342	10	$645,800	$807,300
F-SW-02	F-SW-02-02	F-SW-02-01	5,317	12	$670,500	$838,100
F-SW-02	F-SW-02-01	5341-008	5,235	12	$660,100	$825,100
F-SW-03	F-SW-03-01	F-SW-03-02	2,724	8	$283,300	$354,100
F-SW-03	F-SW-03-02	F-SW-03-03	2,796	8	$290,800	$363,500
F-SW-03	F-SW-03-03	F-SW-03-04	2,673	10	$323,200	$404,000
F-SW-03	F-SW-03-04	F-SW-03-05	2,517	10	$304,300	$380,400
F-SW-03	F-SW-03-05	F-SW-03-06	2,517	10	$304,300	$380,400
F-SW-03	F-SW-03-06	F-SW-03-07	2,609	10	$315,400	$394,300
F-SW-03	F-SW-03-07	F-SW-03-08	2,606	10	$315,100	$393,900
F-SW-03	F-SW-03-08	F-SW-03-09	2,657	10	$321,200	$401,500
F-SW-03	F-SW-03-09	F-SW-03-10	2,626	10	$317,500	$396,900
F-SW-03	F-SW-03-10	F-SW-03-11	2,461	12	$310,300	$387,900
F-SW-03	F-SW-03-11	F-SW-03-13	2,690	12	$339,200	$424,000
F-SW-03	F-SW-03-13	F-SW-03-12	2,513	12	$316,900	$396,100
F-SW-03	F-SW-03-12	F-SW-03-14	2,549	12	$321,400	$401,800
F-SW-03	F-SW-03-14	F-SW-03-20	2,613	12	$329,500	$411,900
F-SW-03	F-SW-03-14	PLS-008	358	12	$45,100	$56,400
F-SW-03	F-SW-03-15	F-SW-03-16	2,703	10	$326,800	$408,500
F-SW-03	F-SW-03-16	F-SW-03-17	2,612	10	$315,800	$394,800
F-SW-03	F-SW-03-17	F-SW-03-18	2,597	10	$314,000	$392,500
F-SW-03	F-SW-03-18	F-SW-03-19	2,716	10	$328,400	$410,500
F-SW-03	F-SW-03-19	F-SW-03-20	2,631	10	$318,100	$397,600
F-SW-03	F-SW-03-20	F-SW-03-21	2,586	15	$379,900	$474,900
F-SW-03	F-SW-03-21	F-SW-03-22	2,872	15	$421,900	$527,400
F-SW-04	F-SW-03-22	F-SW-03-23	4,111	15	$603,900	$754,900
F-SW-03	F-SW-03-23	F-SW-03-24	2,021	15	$296,900	$371,100
F-SW-03	F-SW-03-24	F-SW-03-25	1,944	15	$285,600	$357,000
F-SW-03	F-SW-03-25	LS 57	1,999	15	$293,700	$367,100
F-SW-06	F-SW-06-01	F-SW-06-02	945	8	$98,300	$122,900
F-SW-06	F-SW-06-02	F-SW-06-04	2,123	8	$220,800	$276,000

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia. (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-SW-06	F-SW-06-04	F-SW-06-03	661	10	$79,900	$99,900
F-SW-06	F-SW-06-03	F-SW-06-05	2,705	10	$327,000	$408,800
F-SW-06	F-SW-06-05	F-SW-06-06	2,502	10	$302,500	$378,100
F-SW-06	F-SW-06-06	F-SW-06-07	3,193	12	$402,600	$503,300
F-SW-06	F-SW-06-07	F-SW-06-08	962	12	$121,300	$151,600
F-SW-06	F-SW-06-08	F-SW-06-09	1,486	15	$218,300	$272,900
F-SW-06	F-SW-06-09	F-SW-06-10	1,343	15	$197,300	$246,600
F-SW-06	F-SW-06-10	F-SW-06-16	1,299	15	$190,800	$238,500
F-SW-06	F-SW-06-13	F-SW-06-14	3,046	10	$368,300	$460,400
F-SW-06	F-SW-06-14	F-SW-06-15	3,342	10	$404,000	$505,000
F-SW-06	F-SW-06-15	F-SW-06-16	2,707	10	$327,300	$409,100
F-SW-06	F-SW-06-16	F-SW-06-17	208	18	$35,400	$44,300
F-SW-06	F-SW-06-17	F-SW-06-18	2,585	18	$440,200	$550,300
F-SW-06	F-SW-06-18	F-SW-06-20	2,670	18	$454,700	$568,400
F-SW-06	F-SW-06-20	F-SW-06-21	2,775	18	$472,600	$590,800
F-SW-06	F-SW-06-21	F-SW-06-22	3,729	18	$635,000	$793,800
F-SW-06	F-SW-06-22	4844-001	2,293	18	$390,500	488100
F-SW-08	F-SW-08-10	PLS-006	8,813	8	$916,600	$1,145,800
Total Future Southwest Area					$14,274,400	$18,556,500

Future Southeast Area Analysis

The Future Southeast Area interceptor sewers were laid out to follow the natural drainage. Sub-basin F-SE-01 is a narrow and elongated sub-basin that follows the south and east boundary of sub-basin WIS-06 (McConnell Air Force Base). The City of Wichita does not anticipate significant new development south and east of the Air Force Base. Extension sewers were defined for the western portions of F-SE-01. Extension sewers for the areas north of 53rd Street would connect at Manhole 5740-003 to an existing 30-inch sewer that flows to Plant No. 2. Extension sewers for areas south of 53rd street would terminate at a new lift station (PLS-007). A new force main would convey flows from PLS-007 to Manhole 5740-003. If development occurs in the northeast portions of F-SE-01, it may require a small lift station and force main to convey flows to either sub-basin F-SE-02 or WIS-05.

Sub-basin F-SE-02 natural drainage flows south beyond the 2050 service area boundary into Derby. Gravity sewerage is not possible from F-SE-02 to either Plant 2 or to the Four Mile Creek WWTP. Interceptor sewers for F-SE-02 will flow to a planned lift station (PLS-002) at the 2050 boundary on 55th Street east of Webb Road. The required force main will extend east along 55th Street to connect to existing sewers for flow to Plant No. 2.

No significant development is anticipated for the Southeast Area in the next 10 years. The Southeast Area is currently characterized by slow development and large lot sizes. When development needs are better defined, a small satellite treatment facility should be considered in lieu of constructing lift station PLS-002 and its force main.

Table 12-6 lists the interceptor sewer information for the future Southeast Area.

Table 12-6. Future Southeast Area Extensions

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Dia. (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-SE-01	F-SE-01-06	F-SE-01-09	2,812	10	$340,000	$425,000
F-SE-01	F-SE-01-09	5740-003	1,369	21	$275,900	$344,900
F-SE-01	F-SE-01-11	F-SE-01-10	1,986	8	$206,500	$258,100
F-SE-01	F-SE-01-10	PLS-007	2,058	8	$214,000	$267,500
F-SE-02	F-SE-02-01	F-SE-02-02	2,812	8	$292,400	$365,500
F-SE-02	F-SE-02-02	F-SE-02-03	3,212	8	$334,000	$417,500
F-SE-02	F-SE-02-03	F-SE-02-04	1,860	10	$224,900	$281,100
F-SE-02	F-SE-02-05	F-SE-02-06	2,592	8	$269,600	$337,000
F-SE-02	F-SE-02-06	F-SE-02-04	2,913	8	$303,000	$378,800
F-SE-02	F-SE-02-07	F-SE-02-08	1,500	8	$156,000	$195,000
F-SE-02	F-SE-02-08	F-SE-02-09	2,702	8	$281,000	$351,300
F-SE-02	F-SE-02-09	F-SE-02-10	3,512	10	$424,600	$530,800
F-SE-02	F-SE-02-10	F-SE-02-04	1,318	10	$159,300	$199,100
F-SE-02	F-SE-02-04	F-SE-02-11	3,153	15	$463,200	$579,000
F-SE-02	F-SE-02-11	PLS-002	2,954	15	$433,900	$542,400
F-SE-02	F-SE-02-12	F-SE-02-13	5,340	8	$555,400	$694,300
F-SE-02	F-SE-02-13	F-SE-02-14	3,330	8	$346,300	$432,900
Total Future Southeast Area					$5,280,000	$6,600,200

Future Walnut / Four Mile Creek Area Analysis

The future Walnut Creek / Four Mile Creek area interceptor sewers were aligned to follow the natural drainage. The natural drainage for two sub-basins (Walnut-3A and Walnut-3B) flows south into the existing Four Mile Creek WWTP collection system. Development in Walnut-3A and Walnut-3B is occurring rapidly. There is no current or expected near-term development activity in the rest of Walnut Creek / Four Mile Creek area.

The Walnut-1 sub-basin and the northwest portion of Walnut-2 are in Bel Aire's corporate limits and are expected to be served by Bel-Aire. Extension sewers for this area were sized to handle potential Bel-Aire flows if needed. Walnut-1 drains to the northeast away from the City of Wichita sewers; a new lift station and force main would be required to deliver flows to future City extension sewers in Walnut-2. The portion of sub-basin Walnut-2 in Bel-Aire would drain by gravity to the same future City of Wichita extension sewers.

Sub-basin Walnut-2's natural drainage flows east towards Walnut Creek. A lift station (PLS-003) is planned at the 2050 service area boundary on 159th Street, with a force main extending south along the County line to the Four Mile Creek WWTP. A satellite treatment facility could be considered in lieu of lift station PLS-003 and the associated force main.

Sub-basin Walnut-3A drainage is to the south and extension sewers would connect to existing Four Mile Creek area sewers. Extension sewers greater than 8-inch will not be required.

Sub-basin Walnut-3B drainage is also southward; the City of Wichita has planned an extension sewer for this area that will connect to an existing 20-inch Four Mile Creek area sewer. This sewer will extend service into sub-basin Walnut-2 to allow development south of approximately 29th Street.

Sub-basin Walnut-4 sewers would connect to an existing 18-inch sewer at manhole 6445-057. This sub-basin's wastewater flows would be pumped by Lift Station No. 12 to Four Mile Creek WWTP.

Table 12-7 lists the interceptor sewer information for the future Walnut Creek Area.

Table 12-7. Future Walnut Creek / Four Mile Creek Area

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Diameter (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
WALNUT-2	WALNU-2-02	WALNU-2-03	1,336	8	$138,900	$173,600
WALNUT-2	WALNU-2-03	WALNU-2-04	2,594	12	$327,100	$408,900
WALNUT-2	WALNU-2-04	WALNU-2-05	1,330	15	$195,400	$244,300
WALNUT-2	WALNU-2-05	WALNU-2-06	2,597	15	$381,500	$476,900
WALNUT-2	WALNU-2-06	WALNU-2-07	746	18	$127,000	$158,800
WALNUT-2	WALNU-2-07	WALNU-2-13	3,237	18	$551,300	$689,100
WALNUT-2	WALNU-2-09	WALNU-2-10	770	8	$80,100	$100,100
WALNUT-2	WALNU-2-10	WALNU-2-11	2,584	10	$312,400	$390,500
WALNUT-2	WALNU-2-11	WALNU-2-12	2,539	12	$320,200	$400,300
WALNUT-2	WALNU-2-12	WALNU-2-07	3,629	18	$618,000	$772,500
WALNUT-2	WALNU-2-13	WALNU-2-14	2,875	18	$489,600	$612,000
WALNUT-2	WALNU-2-14	WALNU-2-15	2,903	21	$585,000	$731,300
WALNUT-2	WALNU-2-15	PLS-003	2,563	21	$516,400	$645,500
WALNUT-2	WALNU-2-17	WALNU-2-18	2,954	10	$357,100	$446,400
WALNUT-2	WALNU-2-18	WALNU-3B-01	2,972	10	$359,300	$449,100
WALNUT-3B	WALNU-3B-01	4MC-CV-01	2,668	12	$336,400	$420,500
WALNUT-3B	4MC-CV-01	4MC-CV-02	2,351	12	$296,500	$370,600
WALNUT-3B	4MC-CV-02	WALNU-3B-02	1,336	15	$196,300	$245,400
WALNUT-3B	WALNU-3B-02	WALNU-3B-03	4,229	15	$621,200	$776,500
WALNUT-3B	WALNU-3B-03	6448-001	3,191	15	$468,800	$586,000
WALNUT-4	WALNU-4-01	WALNU-4-02	1,839	8	$191,300	$239,100
WALNUT-4	WALNU-4-02	WALNU-4-03	2,452	8	$255,000	$318,800
WALNUT-4	WALNU-4-03	WALNU-4-04	1,584	8	$164,700	$205,900
WALNUT-4	WALNU-4-04	WALNU-4-05	1,399	12	$176,400	$220,500
WALNUT-4	WALNU-4-05	WALNU-4-10	2,530	12	$319,000	$398,800
WALNUT-4	WALNU-4-07	WALNU-4-08	2,661	8	$276,700	$345,900
WALNUT-4	WALNU-4-08	WALNU-4-09	2,600	8	$270,400	$338,000
WALNUT-4	WALNU-4-09	WALNU-4-10	865	10	$104,600	$130,800
WALNUT-4	WALNU-4-10	WALNU-4-11	213	12	$26,900	$33,600
WALNUT-4	WALNU-4-06	WALNU-4-11	2,338	8	$243,200	$304,000

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Diameter (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
WALNUT-4	WALNU-4-11	WALNU-4-12	3,028	18	$515,700	$644,600
WALNUT-4	WALNU-4-13	WALNU-4-12	3,144	10	$380,100	$475,100
WALNUT-4	WALNU-4-12	6445-057	2,102	18	$358,000	$447,500
Total Future Walnut Creek / 4-Mile Creek Area			76,159		$8,123,500	$12,591,500

Future Growth Area Lift Station and Force Main Requirements

Proposed new lift stations associated with the expansion sewers described in the preceding paragraphs are listed in Table 12-8.

Table 12-8. Proposed Growth Area Lift Stations

Subbasin	*Lift Station Model Designation*	*2050 PWF (MGD)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-N-01	PLS-005	1.540	$444,900	$556,100
F-SE-01	PLS-007	0.572	$165,300	$206,600
F-SE-02	PLS-002	1.501	$433,500	$541,900
F-SW-03	PLS-008	0.783	$226,100	$282,600
F-SW-08	PLS-006	0.217	$62,700	$78,400
F-N-02	PLS-005	0.215	$62,000	$77,500
WALNU-2	PLS-003	2.655	$766,800	$958,500
Total Lift Stations			$2,161,300	$2,706,600

Proposed new force mains associated with the expansion area lift stations are listed in Table 12-9.

Table 12-9. Proposed Growth Area Force Mains

Subbasin	*Upstream Manhole*	*Downstream Manhole*	*Length (ft)*	*Proposed Diameter (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
F-N-01	PLS-005	WWTP - NP	12213	8	$1,270,200	$1,587,800
F-SE-01	PLS-007	5740-003	5538	6	$504,000	$630,000
F-SE-02	PLS-002	5740-003	21355	8	$2,220,900	$2,776,100
F-SW-03	PLS-008	4843-046	3336	6	$303,600	$379,500
F-SW-08	PLS-006	OUTLET-001	10277	6	$935,200	$1,169,000
F-N-02	PLS-005	WWTP - NP	12213	6	$1,111,400	$1,389,300
WALNUT-2	PLS-003	4MC-WWTP	27677	16	$4,065,800	$5,082,300
Total Force Mains			52,719		$10,411,100	$13,014,000

Existing Service Area Analysis to Serve Projected Growth

The performance of the existing sewer system was simulated using the hydraulic model and projected flows for 2010, 2020, 2030 and 2050 as described in Section 6. The flows from future growth areas were input to the existing system as shown on the Existing Interceptor Analysis 2050 figure in Appendix F. The flows from currently served sub-basins for each year were assigned to existing manholes. The existing service area analysis identified sewer system components that will require additional capacity to convey future flows. The analysis used the peaking factor formula described in Section 6.

Flow monitoring is recommended to confirm the current average flows and wet weather (5-year storm) flows for each overloaded sewer, lift station or force main before any of the existing system improvements are included in the City of Wichita capital improvements program.

Potential relief sewer projects were identified for sewer sections that had peak flows greater than the sewer capacity. The relief sewers were sized to flow in parallel to the existing sewer and with both the existing and relief sewer flowing at or below the City design depth vs. diameter criteria.

Existing lift stations were analyzed to convey projected flows with firm capacity. Existing force mains were analyzed based on conveying projected flows with a design velocity of 8 fps or less and with a head-loss within the available pumping head from the existing lift station.

Sewer overloads predicted by the model along the War Industries Sewers were evaluated to better distribute flows. It was determined that the total capacity of the three parallel sewers is sufficient for the total future peak flows. The flows were distributed by providing either flow control structures or by interconnecting the sewers at the locations designated on the map of Collection System Improvements in Appendix F.

Prioritization of potential improvements was evaluated by comparing the peak flows for each design year. Most of the overloaded facilities are indicated to be required for year 2010 flows.

Relief Sewers

Relief sewer projects are designated on map of Collection System Improvements in Appendix F. For existing conditions, the PWF analysis showed several sewers with peak flows greater than their design hydraulic capacity. None of the overloaded sewers, or below minimum slope sewers, resulted in either sewer bypasses or over 1 foot of surcharging above the pipe crown. Therefore, no relief sewers are required to correct any current bottlenecks.

Additional sewers will become overloaded as the sewer system is expanded to meet development. Recommended relief sewers, shown on the Collection System Improvements map located in Appendix F and listed in Table 12-10, were identified based on year 2010 and 2050 model analyses. For planning purposes, relief sewers are sized to parallel and follow average slopes of existing sewers. The preliminary alignments and pipe diameters indicated in this report should be used as a guide in planning. More precise alignments and sizes should be determined during design.

Table 12-10. Relief Sewers

Project	*Upstream Manhole*	*Down-stream Manhole*	*Proposed Parallel Relief Diameter (in)*	*Average Slope (ft/ft)*	*Length (ft)*	*Probable Construction Cost*	*Probable Total Project Cost*	*Phase*
R1	4748-001	4847-009	12	0.004	2,800	$353,100	$441,400	2010
R2	4847-024	4847-009	15	0.0038	3,000	$440,700	$550,900	2010
R3	4847-001	4846-011	24	0.00076	4,500	$994,500	$1,243,100	2010
R4	4743-005	4843-038	15	0.00178	3,000	$440,700	$550,900	2010
R5	4843-038	4844-001	18	0.00275	7,200	$1,226,200	$1,532,800	2010

Project	*Upstream Manhole*	*Down-stream Manhole*	*Proposed Parallel Relief Diameter (in)*	*Average Slope (ft/ft)*	*Length (ft)*	*Probable Construction Cost*	*Probable Total Project Cost*	*Phase*
R6	5246-010	5245-014	24	0.00045	4,600	$1,016,600	$1,270,800	2010
R7	5245-006	5244-013	30	0.00046	7,500	$2,076,800	$2,596,000	2010
R8	5243-011	5342-001	42	0.00057	13,100	$4,836,500	$6,045,600	2010
R9	5342-001	5441-009	48	0.00068	10,600	$4,464,700	$5,580,900	2010
R10	5441-009	5541-006	36	0.00085	7,200	$3,032,600	$3,790,800	2010
R11	6349-144	6248-070	18	0.00237	5,100	$868,500	$1,085,600	2010
R12	6448	4756	18	0.00166	1,745	$297,200	$371,500	2050
R13	6448-162	6446-215	21	0.00266	16,000	$3,224,000	$4,030,000	2020
Total					86,345	$23,272,100	$29,090,300	

Lift Stations and Force Mains

The model peak flows delivered to Lift Station No. 27 next to Mid Continent Airport were 19.14 cfs (13.2 MGD) for year 2010 and 21.19 cfs (13.7 MGD) for year 2050, after diverting up to 6 MGD (9.3 cfs) of the peak flow to the new Mid Continent Wastewater Treatment Facility from a location immediately upstream of Lift Station No. 27. This station has two large pumps each rated at 7,000 gpm with 70 feet of total dynamic head (TDH), and two small pumps each rated 5,900 gpm with a TDH of 55 feet. The pumps have variable speed control to match the pumping rate to the influent flows. Although the modeled peak flows are within the available rated capacity, the pumping head will exceed the rated heads. Flow in the existing 31,300 foot long 24-inch diameter force main would have a velocity of 6.75 fps at a flow of 13.7 MGD; due to the length of the force main the head loss is 286 feet with the conservative analysis friction coefficient (C-value) of 100, or 143 feet for a probable C-value of 140. The force main was constructed in 1990 of PVC pipe, and probably has a friction coefficient closer to 140 than 100. New higher-head pumps are required to deliver the projected peak flow at the required pumping head. The force main friction coefficient should be determined before sizing replacement pumps for Lift Station No. 27.

The modeled peak flows delivered to Lift Station No. 40 at 21st Street North and Zoo Blvd. will exceed its firm capacity of 3.1 cfs. The modeled peak flows are 2.968

cfs for year 2010 and 3.514 cfs for 2050. Additional firm pumping capacity of 0.91 cfs is required for year 2010 peak flows. A further expansion may be required if projected year 2050 flows are realized.

The modeled peak flows delivered to Lift Station No. 56 at 21st Street North and 135th Street West will exceed its firm capacity of 3.154 cfs. The modeled peak flows are 6.108 cfs for year 2010 and 10.948 cfs by year 2050. Additional firm pumping capacity of 0.91 cfs is required for projected year 2010 peak flows. A further expansion may be required if projected year 2050 flows are realized.

Actual capacities for the Lift Stations 22 (Moorings), 41 (29th Street North and Ridge Road), and 57 (47th and Floodway) were not available from City of Wichita records. The pumping capacities for these stations should be determined and compared to the expected flows.

Table 12-11 shows the modeled peak flows to each modeled lift station and the recommended improvements.

Table 12-11. Existing Lift Station Capacity Evaluation

Lift Station Number	*2010 PWF (cfs)*	*2050 PWF (cfs)*	*Firm Cap (cfs)*	*2050*	*2010*	*2010 Added Capacity (cfs)*	*Construction Cost ($)*	*Capital Cost ($)*
1	1.40	1.56	3.34	OK	OK			
4	1.88	1.88	1.89	OK	OK			
6	3.74	3.74	7.13	OK	OK			
9	1.09	1.49	2.05	OK	OK			
14	0.03	0.04	0.424	OK	OK			
18	2.15	0.75	0.76	OK	OK			
20	0.03	0.04	0.42	OK	OK			
22	0	0	0.000	Determine actual capacity[1]				
24	0.03	0.04	0.43	OK	OK			
27	19.14	21.19	26.29	Expand	Expand	21.19	$6,121,700	$7,652,100
28	0.27	0.38	1.11	OK	OK			
29	N/A	N/A	0.22	N/A	N/A			
32	0.07	0.07	0.22	OK	OK			
33	0.03	0.05	0.61	OK	OK			

Lift Station Number	*2010 PWF (cfs)*	*2050 PWF (cfs)*	*Firm Cap (cfs)*	*2050*	*2010*	*2010 Added Capacity (cfs)*	*Construction Cost ($)*	*Capital Cost ($)*
34	0.09	0.09	0.60	OK	OK			
35	0.80	0.82	3.12	OK	OK			
40	2.97	3.51	2.06	Expand	Expand	0.91[2]	$263,900	$329,900
41	0.68	0.98	0.00	Determine actual capacity[1]				
56	6.11	10.95	3.15	Expand	Expand	2.95[2]	$852,800	$1,066,000
57	0.24	2.34	0.00	Determine actual capacity[1]				
		Total Lift Stations					$7,238,400	$9,048,000

[1] Capacities of LS 22, 41 and 57 not available in the City of Wichita maintenance database.

[2] Expansion sizing for near term (2010) development. A second expansion will be required depending on actual development

[3] Lift Station No. 27 expansion to increase both firm pumping capacity and rated head for peak flows. Field testing to confirm flows and head requirements is required.

All force mains modeled velocities were within the 8 fps criteria and modeled head losses were within the available pumping heads, with the exception of the 14-inch Lift Station 56 force main. Lift Station 56 discharges to the CCWQRF. By year 2050, the peak flow velocity through the existing force main will be 10.8 fps, requiring a parallel 20-inch sewer. For redundancy in operations and to extend the useful service of the east pumps, the 20-inch force main should be constructed to gain additional capacity in 2010. Table 12-12 shows the force main requirement.

Table 12-12. Existing Force Main Capacity Evaluation

Upstream Manhole	*Downstream Manhole*	*Length (ft)*	*Existing Dia. (in)*	*Proposed Parallel Dia. (in)*	*Probable Construction Cost*	*Probable Total Project Cost*
4649-LS56TEMP	CCWQRF	2,251	14	20	$378,200	$472,700
Total Force Mains		2,251			$378,200	$472,700

RECOMMENDED PLAN

The following summarizes the recommended activities which should be undertaken to assure the City of Wichita a planned growth strategy to meet the needs of the City over the next 30 to 40 years.

Sewer Extensions and new Lift Stations and Force Mains

The availability of a city's sanitary sewer infrastructure is the greatest influence the city's utility has on potential growth and development. Inadequate planning can lead to undersized sewers in future expansion areas. An undersized sanitary sewer infrastructure can either restrict development, or lead to substantial costs for replacing existing lines to service growth. In order to provide adequate opportunity for both residential and industrial growth, a comprehensive planning approach is required.

The map of Recommended Sewer Extensions in Appendix G provides the City of Wichita with a long range plan by establishing the projected sizes of the gravity trunk sewer lines required to service growth areas identified in Section 2. Lift stations and force mains are shown on the map in areas where gravity service cannot be extended. Each of these infrastructure items have been sized to handle the 2050 development and where possible are staged to match forecasted growth rates. This allows the sewer infrastructure expansion to be built according to actual development.

A best guess has been made for implementation for these improvements as well as estimated costs.

Relief Sewers and upgraded Lift Stations and Force Mains

The dynamic modeling software program was utilized to determine the location of existing sections of sanitary sewer infrastructure that are not expected to adequately provide for the long term service needs of the City of Wichita. Parallel relief sewers are proposed for the sections of sewer line that will not be able to convey the projected peak flows. The assigned costs and recommended installation dates for the parallel lines are shown in tables throughout this Section. These are also shown on the Recommended Sewer Extension map in Appendix F.

Each of the City's lift stations and force mains were also evaluated to locate potential capacity issues. Necessary upgrades are also on the Recommended Sewer Extension map in Appendix F. Costs and estimated dates for each improvement are shown in tables throughout this Section.

Flow Monitoring Program

A flow monitoring program is recommended as described in the preceding sections and detailed in Appendix J. Costs are not included in the CIP as the City would be able to pursue this program with currently budgeted funds. The purposes of initial flow monitoring include determining actual sewer flows prior to design of facilities, providing flow parameters for modeling the Four Mile Creek basin, and determining current flow parameters for the areas that had the highest levels of I/I in previous flow monitoring. A longer term flow monitoring objective is to provide information for an updated calibration of the hydraulic model to improve its utility and reliability in the City of Wichita's ongoing activities.

Ongoing Rehabilitation and Lining Program

The City of Wichita has achieved exceptional results from their ongoing sewer line replacement and sewer lining program. VCP comprises approximately 50 percent of the sewer system and approximately 6.6 percent of the clay pipe has been relined or replaced since 1999. This effort, along with the City's sump pump removal program, has lead to reduced infiltration and inflow into the sewer system resulting in documented additional capacity in the sanitary sewer system and the treatment facilities. This effort to reline or replace pipe as well as identification of other sources of infiltration and inflow should continue.

Additional Rehabilitation and Upgrade Needs

Provisions for ongoing inspection of the collection system to determine rehabilitation needs are not determined in this update of the Sanitary Sewer Master Plan. Inspection and rehabilitation is needed to maintain the integrity of the existing system. The City has established a list of known rehabilitation and upgrades which are described in this Section. Cost opinions were not developed for the additional rehabilitation and upgrade needs.

The City has identified a major trunk sewer line rehabilitation project in the Sanitary Sewer No. 1 drainage basin. This project is to reline approximately 16,000 linear feet of 20-inch trunk sewer.

Section 6 summarizes the length of pipes by material type and the lengths that have been rehabilitated by various lining methods. Information on the age and condition of the pipes is not available.

The City of Wichita identified the following needed improvements to existing lift stations:

- Lift Station No. 1 – provide a generator
- Lift Station No. 4 – rehabilitate pumps and possibly the drives
- Lift Station No. 5 – provide a generator
- Lift Station No. 6 – rehabilitate wetwell, pump drives, and clean water line
- Lift Station No. 8 – provide a generator
- Lift Station No. 35 – upgrade elevator
- Lift Station No. 47 – replace pumps
- Lift Station No. 49 – complete replacement
- Lift Station No. 52 – replace station lid top

Summary of Sanitary Sewer System Collection System Recommendations

The total probable capital cost opinion of the recommended collection system facility improvements is $117.2 million through year 2050. These costs do not include wastewater treatment costs.

The recommended collection system facility improvements identified for year 2010 are summarized in Table 12-13. The projected capital costs listed in Table 13 for capital projects include construction cost plus allowances of 30 percent for contingencies and 25 percent for engineering, legal, and administrative costs. Costs for land, rights-of-way, or rock excavation are not included.

Table 12-13. Summary of Year 2010 Sanitary Sewer Collection System Recommendations

Line	*Item*	*Sub-Basin*	*Length*	*Size ($)*	*Probable Capital Cost ($)*
1	Future North Area Extension Sewers (5 segments)	F-N-02	11,902	10 to 15-inch	$1,919,500
	Future Northwest Area Extension Sewers (4 segments)	F-NW-01	8,171	21 to 27-inch	$2,374,700
3	Future Southwest Area Extension Sewers (11 segments)	F-SW-03, F-SW-06	24,831	12 to 18-inch	$4,702,100
4	Future West Area Extension Sewers (4 segments)	F-W-02	8306	8 to 12-inch	$1,130,800

Line	*Item*	*Sub-Basin*	*Length*	*Size ($)*	*Probable Capital Cost ($)*
5	Force Main, PLS-008 to 48430-046	F-SW-03	3336	12-inch	$525,900
6	Lift Station PLS-008	F-SW-03	NA	0.783 MGD Firm Capacity	$379,500
7	Lift Station 40 Expansion	SWI-10	NA	0.91 cfs Add'l Firm Capacity	$329,900
8	Lift Station 56 Expansion	NWI-04		2.95 cfs Add'l Firm Capacity	$1,066,000
9	Relief Sewer Projects, R1 through R11		68,600	12 to 48-inch	$24,688,800
	Total 2010 Projects		125,146		$37,117,200

SECTION 13

Plants No. 1 and No. 2 Improvements

GENERAL

This section of the Master Plan will address the short term and long term improvements proposed for Wichita's Treatment Plants No. 1 and No. 2. The needs outlined below are not meant to be all inclusive, but to provide a budget and a schedule for completing the additions or modifications to each plant. During any major modification the City should commission a study or a design memorandum to verify need (maintenance, regulatory, or capacity), sizing, estimated costs, and any phasing which may benefit the City.

SHORT TERM NEEDS

As discussed in the evaluation section of the Master Plan there are several short term improvements needed to provide enhanced operation of the Treatment Plants No. 1 and No. 2. Short term improvements and budgetary allocations are outlined in Section 17, Capital Improvements Plan (CIP).

Plant No. 1

The primary function of Plant No. 1 has been modified from treatment to transportation. It now operates as the main pump station for the City of Wichita, transporting flows to Plant No. 2 for treatment. Additional variable frequency drives are being added to the existing pumps to improve overall function of the station. The short-term focus for this pump station includes enhancing its performance, reducing maintenance, and making it a better neighbor. These items encompass an upgrade to the SCADA system, odor control, and modification to the discharge area primarily in the maintenance and odor control areas. The short-term needs for Plant No. 1 include the following:

Project	*Cost*
Replace odor control system	$300,000
Demolish abandoned structures	$1,300,000
Replace influent screen	$200,000

Plant No. 2

Plant No. 2, while producing excellent quality discharge, has some routine operational difficulties to be addressed. The short term issues are primarily restricted to sludge and scum disposal from the primary and final clarifiers as well as odor control. Generally clarifier waste disposal in a facility the size of Plant No. 2 should not require excessive manpower. The installation of pumps to transport the waste would eliminate the need for manual transportation by trucks. The City of Wichita is conscientious of the effects their facilities may have on the surrounding community, and the most apparent issue is excessive odor. In the City's efforts to maintain their "good neighbor" status they have made this issue a high priority. There are several locations within Plant No. 2 where odors originate and mitigating measures are possible. The short-term needs for Plant No. 2 include the following:

Project	*Cost*
Replace influent screen washer-grinder unit	$80,000
Install new primary clarifier scum pump system	$200,000
Install final clarifier scum pumping and launder covers	$800,000
Replace support structure and media in biofilter for headworks odor control	$40,000
Construct odor control system for primary clarifiers and solids handling systems	$1,500,000
Replace influent bar screen openings	$300,000
Construct Phase 1, 18 MGD BNR expansion	$62,400,000

LONG TERM NEEDS

Wichita's Treatment Plants No. 1 and 2 are performing successfully within the current KDHE regulations and are complying with their current NPDES Permit. It is anticipated that the City's NPDES permit will be revised and the discharge limitations will become more stringent.

Plant No. 1

Plant No. 1 site will always be a portion of the City's wastewater collection and treatment systems through the use of the pump station and extraneous flow holding basins. Currently the site contains several abandoned structures and buildings that are not utilized. Since the site is visible from the interstate, and in the spirit of a "good neighbor" program, it is recommended that these structures be removed and the site reclaimed for other useful purposes.

Plant No. 2

It is anticipated that the projected regulations outlined in the Water Quality Section of the Master Plan will be adopted by the KDHE over the next 5 to 15 years. The required effluent quality limitations are proposed to be 8.0 mg/L total nitrogen and 1.5 mg/L total phosphorus. This forecast permit limitation will result in the need for a Biological Nutrient Removal (BNR) process to be installed at Plant No. 2. These new standards will become effective when the KDHE elects to implement them through the modification of the City's NPDES Permit. The permit is issued once every five years and the next cycle will be in 2007 for Plants No. 1 and 2.

It is anticipated the NPDES Permit compliance schedule will require that the City complete a treatment facility design study for Plant No. 2. Subsequently, the City will need to develop engineering design, plans, specifications and cost estimates for the addition of a BNR process. Construction should be complete and the plant should be 100% operational by the year 2031. It is also anticipated that the KDHE will allow the BNR processes to be phased based on the projections made in this study and the Arkansas River will not experience a loss in water quality between 2012 and 2030. See Section 5.

The following paragraphs in this section will focus on the long term needs at Treatment Plants No. 1 and No. 2.

OPTIONS

Several treatment options which can achieve the projected water quality limitations were presented and discussed during several workshops. The options which were presented are listed below:

- Multiple treatment sites utilizing biological nutrient removal with membranes to promote beneficial reuse of effluent waters.
- Consolidation into one large biological nutrient removal facility with filtration and UV disinfection south of the city, to expand the sewerage area.
- Re-open Plant No. 1 into a biological nutrient removal treatment plant in combination with converting Plant No. 2 into biological nutrient removal.
- Retain Plant No. 2 in its present configuration and add chemical treatment.
- Convert Plant No. 2 to a biological nutrient removal (BNR) facility utilizing clarification, filtration and UV disinfection.
- Convert Plant No. 2 to a biological nutrient removal (BNR) facility utilizing membranes and UV disinfection.

After considerable discussion, the list of options was reduced to two processes for biological nutrient removal followed by either membranes for final treatment or conventional clarification/filtration. It was decided that these two options would satisfactorily meet the projected water quality limitations and also had the potential to produce an even higher water quality effluent which could meet additional reduction in maximum discharge limitations.

The two options are referred to in the following discussions as "Option A – BNR with Membranes" and "Option B – BNR with Clarification/Filtration."

Option A and B

Options A and B involve a complete change in the treatment process currently being employed at Plant No. 2. The current process includes carbonaceous BOD removal using primary clarification, trickling filters, and intermediate clarification; ammonia removal using activated sludge and clarification; and disinfection with UV and reaeration prior to discharge to the Arkansas River.

The new process will abandon the carbonaceous phase - primary clarification, trickling filters and intermediate clarification. Carbonaceous BOD removal will occur in the activated sludge treatment basin and become part of the BNR Process. The BNR Process will include reuse of the existing activated sludge units with the addition of three additional basins. The first basin will provide anaerobic treatment (to promote phosphorus removal), the second basin will provide anoxic treatment (to promote total nitrogen removal), and the third basin will add additional capacity to the existing aeration basin (to promote carbonaceous removal and nitrification).

It has also been determined that this major change in treatment process can be constructed over a significant period of time in three phases. By constructing the

project in three phases it can reduce the impact on the rate payer. The three phases will be constructed on a schedule which will provide continuous reduction of nitrogen and phosphorus to the Arkansas River. In Section 16 – "Effluent Water Quality Improvements" the target levels are listed for these nutrient components for each phase.

The treatment process for Options A and B, as noted above, are divided into phases and each phase for each option is described below. Following the treatment process is disinfection and re-aeration. The existing UV disinfection units and re-aeration basins will continue in service and will only require normal upkeep of equipment. The facility will be ultimately sized to process 54 million gallons per day and will have a peaking capacity of 76.23 million gallons per day.

OPTION A – BNR WITH MEMBRANES

Option A – BNR with Membranes is shown on Figure 13-1 and is divided into three phases. As discussed above the primary clarifiers, trickling filters, final clarifiers and all recycle pump stations would be eventually abandoned. All untreated wastewater arriving at Plant No. 1 and Plant No. 2 would be pumped directly to the new process. The flow would be screened, pass through the new BNR Process, be disinfected, re-aerated and discharged to the Arkansas River. The description of each phase is provided below.

Phase 1 Improvements

Phase 1 improvements would include the abandonment of one set of trickling filters, and one recycle pump. In this first phase the flow would continue to be pumped from Plant No. 1 and No. 2 into the primary clarifier and intermediate pump station and continue to be processed through the remaining set of trickling filters. Flow from the one set of trickling tilters will pass through the intermediate clarifiers and combine with the flow passed through the intermediate pump station on to the screw pump station. From the screw pump station the flow would then be delivered to the proposed new fine screen.

Fine Screen

The new fine screen would be a 2 millimeter (just larger than 1/16 inch) opening, consisting of 4 units with 20 MGD capacity each. The material removed from the screen would be washed, dewatered, compacted, deposited in a dumpster, and disposed of as solid waste. Following the fine screens would be a flow control structure which can divide the flow into three (3) streams.

Control Structure

The control structure that receives the flow from the fine screens would be automated to allow the operational staff to direct flows to any or all of the desired treatment process trains that follow the control structure. Automation would involve actuated gates and flow meters.

Treatment Process

There are three existing trains of two parallel basins providing nitrification in the current treatment process. In Phase 1, one of the existing activated sludge trains would be converted to a nutrient removal process followed by membrane solids separation. This effort would include the construction of an anaerobic basin, an anoxic basin, the construction of additional aeration basin capacity and modification of the aeration equipment in the existing basins. To provide the process capacity, the anaerobic basin would contain a volume of 675,000 gallons and have a detention time of 0.9 hours, the anoxic basin would contain a volume of 3,825,000 gallons with a detention time of 5.1 hours and the combined aeration horsepower would more than double from the current 900 horsepower to approximately 2,000 horsepower. This process was sized with a solids retention time (SRT) of 14-18 days. Sludge age is selected to ensure that the effluent requirements for the installation are met. MLSS concentrations have minimal impact on the downstream membranes, allowing MLSS for this process to be in the range of 4,600 to 6,000 mg/L.

The wastewater would flow through each basin in series with recycle flows being returned from the aeration basin to the anoxic basin. These combinations of oxygen and non-oxygen environments cause nitrification and denitrification, the reduction of organics and total suspended solids, as well as a release of phosphorus from the microorganism with a resultant luxury uptake of phosphorus, all combined to provide a system of biological nutrient removal.

Membranes

Following the biological treatment process is liquid/solid separation using membranes. The membrane process would consist of nine (9) elements of 2 MGD each for combined capacity of 18 MGD. Low pressure or vacuum style units would be able to fulfill the treatment requirements. Regular backflushing of the elements is required. Solids rejected by the membranes would be returned to the anaerobic basins to maintain the necessary microorganism balance in the process. Solids would also be wasted from this process to be further processed in the solids digestion portion of the treatment plant. A critical parameter with the membranes will be hydraulics, as the effluent from these units must pass through the existing ultraviolet disinfection process, re-aeration process and outfall pipe to discharge into the Arkansas River.

Side Stream Treatment

In addition to the wastewater treatment process improvements, it is recommended that an additional side stream treatment process be constructed to reduce the phosphorus levels in the subnatant, supernatant, and filtrate associated with thickening, digestion and dewatering of the biosolids.

Demolition

Phase 1 demolition would consist of the decommissioning of one bank of trickling filters and associated intermediate clarifier as outlined above. Related piping and site work would be included with the upgrade.

Phase 2 Improvements

This phase includes the demolition of the primary clarifiers, demolition of the second set (last set of trickling filters), demolition of the last intermediate clarifier, removal of the intermediate pump station, and removal of the screw pump station. This phase also includes the addition of 18 MGD of biological nutrient removal (BNR) capacity through the conversion of the second activated sludge train. With these improvements the facility would be transformed from a secondary wastewater treatment facility to an advanced nutrient removal facility.

Transfer Piping

Along with the demolition of the primary clarifiers, the Phase 2 work would include the re-piping of the transfer line to divert the incoming wastewater streams to the fine screen constructed during Phase 1. This re-piping of the transfer lines would incur a small increase in total dynamic head for the influent pumps which will result in a small decrease in pumping capacity. The actual percent reduction would be small but can not be determined until the final piping configuration is established.

Treatment Process

The second activated sludge train would be converted to a BNR facility as outlined in Phase 1. This would include the construction of two additional basins; one for anaerobic treatment, and one for anoxic treatment. The aeration basin will need to be supplemented with aeration capacity with the addition of another basin and the equipment will require replacement. As noted in Phase 1, this phase will also require the addition of blower horsepower increasing the capacity from 900 to 2,000 horsepower.

Membranes

Following the biological treatment process is the liquid/solids separation using membranes. This will be similar to Phase 1 and would consist of nine (9) elements of 2 MGD each.

Demolition

The work involved in this phase is the decommissioning of the primary clarifiers, the last of the trickling filters, intermediate clarifier, intermediate pump station, the screw pump station, and the rerouting of the drains and process returns from the balance of the treatment process. The grit unit will also be decommissioned in this phase.

Phase 3 Improvements

The third phase of improvements includes the modification of the remaining aeration train to include an anaerobic basin, an anoxic basin and an additional basin to expand the aeration capacity. This upgrade will provide another 18 MGD of biological nutrient removal (BNR) capacity providing the needed redundancy.

Treatment Process

Following the installation of Phase 1 and Phase 2 work all of the transfer piping will be in place. Phase 3 will include the piping required to connect the control structure directly to the treatment process. The flow will then pass through the screens as noted above, through the control structure where the flows will be split according to the operators' preference between one of the three treatment trains. The new train will be identical to the processes outlined above. This will upgrade of the blowers from 900 horsepower to 2,000 horsepower.

Membranes

As discussed for Phase 1 and 2, the Phase 3 membranes will follow the biological treatment process providing the liquid/solids separation. This will consist of nine (9) elements of 2 MGD each.

Demolition

There would only be minor demolition associated with this phase and would consist of the piping, structures and equipment removed from the existing activated sludge process to make room for the new equipment.

Option A Capital Costs

Projected construction and project costs for each option are delineated in Table 13-1.

Table 13-1. Capital costs for Option A, Phases 1, 2, and 3

Phase 1	*Costs*
Fine screens	$2,979,000
Biological treatment basins	$4,230,000
Aeration equipment	$4,465,000
Membranes	$19,132,000
Side stream treatment for solids process	$517,500
Demolition	$110,000
Site work	$1,930,000
Construction project costs	$5,004,600
Subtotal	$38,369,000
Contingency	$11,511,000
Opinion of Construction	$49,880,000
Engineering, Legal, Admin.	$12,470,000
Opinion of Total Phase 1 Project Costs	$62,350,000

Phase 2	*Costs*
Biological treatment basins	$4,230,000
Aeration equipment	$4,465,000
Membranes	$19,132,000
Existing pump station reconfiguration	$120,000
Demolition	$160,000
Site work	$1,850,000
Construction project costs	$4,493,600
Subtotal	$34,451,000
Contingency	$10,336,000
Opinion of Construction	$44,787,000
Engineering, Legal, Admin.	$11,197,000
Opinion of Total Phase 2 Project Costs	$55,984,000

Phase 3	*Costs*
Biological treatment basins	$4,230,000
Aeration equipment	$465,000
Membranes	$19,132,000
Site work	$1,600,000
Construction project costs	$4,414,100
Subtotal	$33,842,000
Contingency	$10,153,000
Opinion of Construction	$43,995,000
Engineering, Legal, Admin.	$10,999,000
Opinion of Total Phase 2 Project Costs	$54,994,000
Total Phase 1, 2, and 3 Project Costs for Option A	**$173,328,000**

OPTION B – BNR WITH CLARIFICATION AND FILTRATION

"Option B – BNR with Clarification and Filtration" adds 2 new biological nutrient removal (BNR) treatment trains and converts the existing 3 aeration trains into BNR units. The final process will include 5 BNR treatment trains. The following describes how this Option can be constructed in 3 phases. Figure 13-2 schematically portrays the process and indicates the phases of construction. As proposed for Option A, the primary clarifiers, trickling filters, final clarifiers and all recycle pump stations would be eventually abandoned. All untreated wastewater would be pumped from Plant No. 1 and Plant No. 2 directly to the new process. The flow would be screened, pass through the new BNR Process, be disinfected, re-aerated and discharged to the Arkansas River. The description of each phase is provided below.

Due to use of conventional clarification, this process cannot operate at the high MLSS level proposed for Option A and, consequently, will require more aeration volume. This results in two additional aeration trains noted above and shown on Figure 13-2.

Phase 1 Improvements

Phase 1 improvements would include the abandonment of one set of trickling filters, and one recycle pump. In this first phase the flow would continue to be pumped from Plant No. 1 and No. 2 into the intermediate pump station and continue to be processed by the remaining trickling filters. The Plant No. 1 flows, prior to entering the intermediate pump station, would be screened.

Fine Screen

Phase 1 would include the installation of 4 fine screens at Plant No. 2 for Plant No. 1 flows. Each of the screens would be rated for 15 MGD and would remove objects larger than ¼ inch. Influent will pass through the screen and into a new grit removal unit also constructed at Plant No. 2 for Plant No. 1 flows. The grit and screenings that are removed from these units will be dewatered and placed in a dumpster for disposal at the landfill.

The flow will continue to pass through the existing clarifiers on to the intermediate pump station and through the trickling filters. Following the trickling filters the flow is either recycled to the intermediate pump station or passes to the screw pump station. The screw pump station lifts the flow to a new control structure.

Control Structure

The new flow control structure will be equipped with the ability to split the plant flows between 3 different biological nutrient trains, one of which will be constructed in this phase. The second train will be constructed during Phase 2. And the third train consists of the existing activated sludge facilities. The existing activated sludge facilities also contain three parallel trains that will have smaller treatment trains. These three existing trains will be modified as part of Phase 3 (see below). The flow control structure should be automated to allow the operational staff to direct flows to the desired treatment process. Automation would involve actuated gates and flow meters.

As described above, the new control structure would split the flow between the new aeration basin, the future (Phase 2) train, and the existing three aeration trains. The flow directed to the existing three aeration trains would continue to utilize the existing control structure to divide the flows evenly between those 3 trains.

Treatment Process

Phase 1, as shown on Figure 13-2, consists of constructing a new BNR treatment train which will include an anaerobic basin, an anoxic basin, and an aerobic basin with associated aeration equipment. This new facility would provide 18 MGD of capacity. The anaerobic basin would contain a volume of 745,000 gallons and have a

detention time of 0.99 hours. The anoxic basin would contain a volume of 3.65 million gallons with a detention time of 4.87 hours. The aerobic basin would contain a volume of 10.5 million gallons and have a detention time of 14.0 hours.

The process was sized with a solids retention time (SRT) of 14 days. Sludge age is selected to ensure that the effluent requirements for installation are met on a consistent basis while also considering the solids loading limitations of the clarifiers. Normal MLSS concentrations for this process are expected to be in the range of 3,500 to 3,600 mg/L. Recycle pumps will be added with the new activated sludge train, with some of the pumps responsible for transferring the RAS back to the anaerobic basin and other pumps responsible for recycle between the aeration basin and anoxic basin necessary for denitrification.

Final Clarifiers

The purpose of the new final clarifiers is to provide separation of the MLSS and the treated water prior to discharge. Additionally, the clarifier will provide thickening of the MLSS/WAS. The 18 MGD treatment train in Phase 1 will include 3 final clarifiers, each 140 ft in diameter. A critical parameter with the clarifiers will be hydraulics, as the effluent from these units must pass through the existing ultraviolet disinfection process, re-aeration process and outfall pipe to discharge into the Arkansas River.

Side Stream Treatment

In addition to the wastewater treatment process improvements, it is recommended that an additional side stream treatment process be constructed to reduce the phosphorus levels in the subnatant, supernatant, and filtrate associated with thickening, digestion and dewatering of the biosolids.

Demolition

Phase 1 demolition would consist of the decommissioning of one bank of trickling filters and associated intermediate clarifier. Related piping and site work would be included with the upgrade.

Phase 2 Improvements

The next phase of improvements would increase the total BNR treatment capacity to 36 MGD and approximately 10 MGD of secondary wastewater treatment capacity. The existing secondary system will need to be down-rated since the current facility would have reduced capacity due to the reduction in pretreatment. During Phase 2 construction, the primary clarifiers utilized in Phase 1 will be demolished. The remaining trickling filters, intermediate clarifiers, and screw pump station will be demolished as well.

Screening

This phase will include the installation of a new ¼-inch screen added at Plant No. 2 handling the west side wastewater stream. This new screen will consist of two separate screens each having a 10 MGD design capacity. The flow from the new screen will pass through the existing grit unit and flow directly to the control structure built during Phase 1 improvements.

Treatment Process

During this phase of construction the second new activated sludge train would be added and connected to the control structure built in Phase 1. This new train will be capable of treating another 18 MGD and be similar to the train added in Phase 1. It will include an anaerobic basin, an anoxic basin, and an aerobic basin. This phase, in conjunction with Phase 1, will provide 36 MGD of BNR treatment.

To meet the design needs for 18 MGD the anaerobic basin for this phase would contain a volume of 745,000 gallons and have a detention time of 0.99 hours. The anoxic basin would contain a volume of 3.65 million gallons with a detention time of 4.87 hours and the aerobic basin would contain a volume of 10.5 million gallons with a detention time of 14.0 hours. The process is sized with a solids retention time (SRT) of 14 days. Sludge age is selected to ensure that the effluent requirements for the installation are met on a consistent basis while also considering the solids loading limitations of the clarifiers. Normal MLSS concentrations for the BNR process are expected to be in the range of 3,500 – 3,600 mg/L.

Recycle pumps will be added with the new activated sludge train, with some of the pumps responsible for transferring the RAS back to the anaerobic basin and other pumps responsible for recycle between the aeration basin and anoxic basin necessary for denitrification.

Final Clarifiers

To complete the treatment of the wastewater, three final clarifiers will need to be added to the treatment facility. The clarifiers will be 140 ft in diameter and will perform the same function described in Phase 1 final clarifiers. Hydraulics will be important and should be examined as part of the design process. The flow discharged from the final clarifiers will travel to the existing UV disinfection process, re-aeration process and discharge into the Arkansas River.

Demolition

Demolition will be a major task in the phase of the work. The primary clarifiers are designated for demolition as well as the last of the trickling filter trains. This would include the intermediate clarifier, the intermediate pump station, the screw pump station and the rerouting of the drains and process return lines.

Phase 3 Improvements

The last phase of improvements will convert the remaining existing activated sludge process to BNR and provide Plant No. 2 with 54 MGD of treatment capacity. This phase will also add a 54 MGD filtration improvement which will provide redundancy for phosphorus removal. This process will provide back up to the biological process should support. The filters will also assure the City that they will have the ability to meet the proposed phosphorus removal levels.

Treatment Process

The final phase of improvements for the Option B – BNR with Clarification and Filtration will deal entirely with the modification of the treatment process. The existing ammonia removal system which consists of three aeration systems having two aeration basins each will be converted to a BNR system. As the flow leaves the control structure built as part of Phase 1 a flow stream will be split with one third of the flow being sent to the phase 3 BNR system. The Phase 3 BNR system will require that the existing aeration system be modified through the addition of an anaerobic and anoxic basin. Each anaerobic basin will have a volume of 0.24 million gallons and a detention time of 0.96 hours at 6 MGD average flow. Each anoxic basin will have a volume of 1.26 million gallons a detention time of 5.04 hours at 6 MGD average flow.

Pumps similar to those added in Phase 1 and Phase 2 will be added to the three trains during Phase 3 for the RAS to the anaerobic basin and recycle between the aeration basins and the new anoxic basins.

The existing clarifiers will remain as the liquid/solids separation method for this treatment train. Four of the six existing clarifiers will, however, be retrofitted with updated internals for improved sludge collection and removal. Piping modifications will be required to allow four clarifiers to share the load from the six aeration basins.

Filtration

Filtration will be added during Phase 3. All of the plant flow will travel from each of the trains constructed during the 3 phases to the filtration process before traveling to the UV disinfection unit. New intermediate pumping will be required to add hydraulic head after clarification to accommodate the new filters. After the effluent is filtered, UV disinfection, reaeration and discharge to the Arkansas River will occur.

Capital Costs

Projected construction and project costs for Option B are delineated in Table 13-2.

Table 13-2. Capital costs for Option B, Phases 1, 2, and 3

Phase 1	*Costs*
Influent headworks	$4,040,000
Flow control structure	$260,000
Biological treatment basins	$9,050,000
Aeration equipment	$5,195,000
Final clarifiers	$5,642,500
Side stream treatment for solids process	$517,500
Demolition	$90,000
Site work	$1,930,000
Construction project costs	$4,008,800
Subtotal	$30.734,000
Contingency	$9,221,000
Opinion of Construction	$39,955,000
Engineering, Legal, Admin.	$9,989,000
Opinion of Total Phase 1 Project Costs	$49,944,000

Phase 2	*Costs*
Influent headworks	$2,172,500
Biological treatment basins	$9,050,000
Aeration equipment	$5,075,000
Final clarifiers	$5,642,500
Demolition	$150,000
Site work	$1,800,000
Construction project costs	$3.583,500
Subtotal	$27,474,000
Contingency	$8,243,000
Opinion of Construction	$35,717,000
Engineering, Legal, Admin.	$8,930,000
Opinion of Total Phase 2 Project Cost	$44,647,000

Phase 3	*Costs*
Biological treatment basins	$4,075,000
Aeration equipment	$1,910,000
Final clarifiers equipment	$4,950,000
Final pump and filtration system	$25,347,000
Site work	$1,850,000
Construction project costs	$5,719,900
Subtotal	$43,853,000
Contingency	$13,156,000
Opinion of Construction	$57,009,000
Engineering, Legal, Admin.	$14,253,000
Opinion of Total Phase 3 Project Costs	$71,262,000
Total Phase 1, 2, and 3 Project Costs for Option B	**$165,853,000**

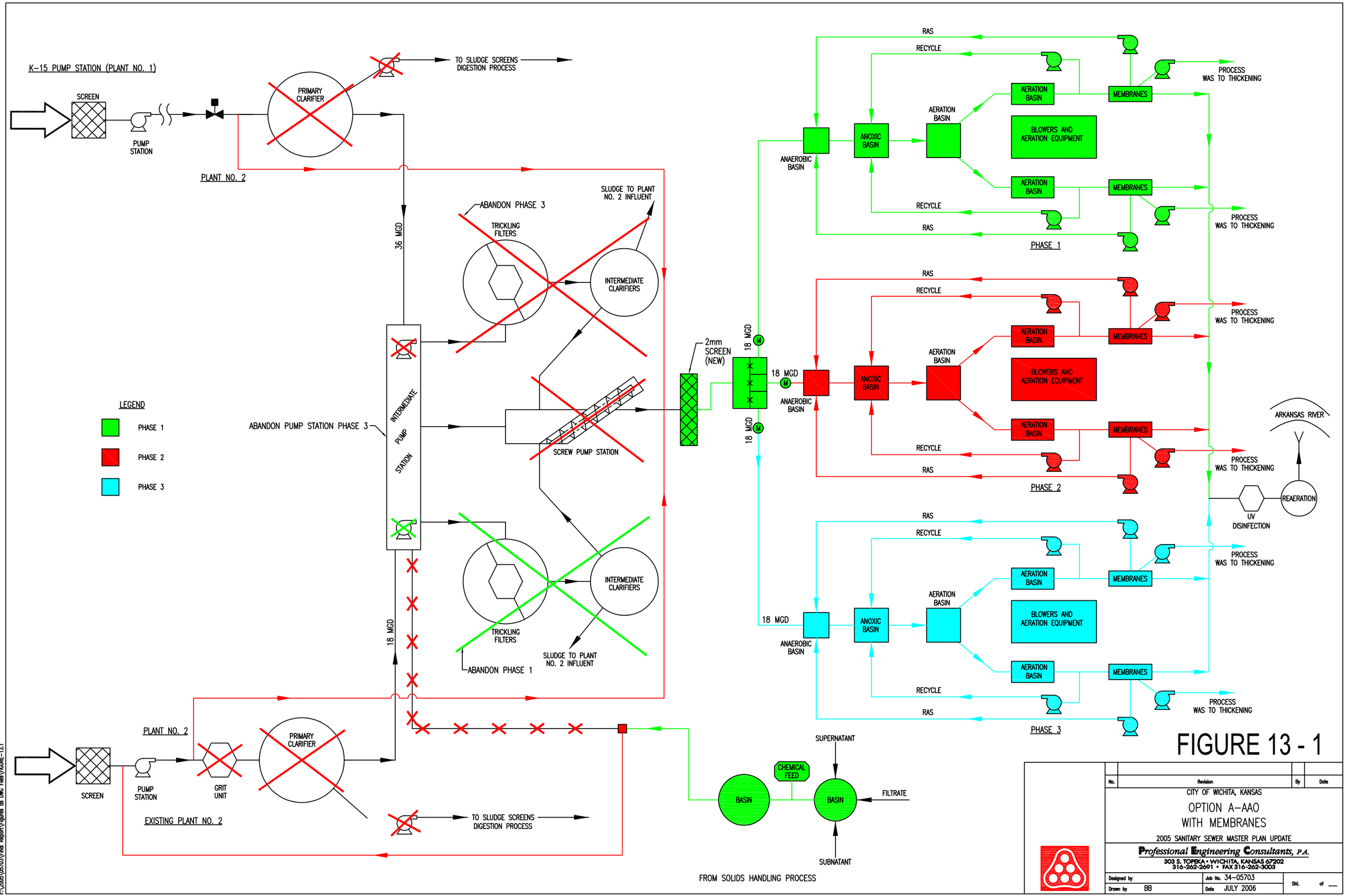

FIGURE 13 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

OPTION A-AAO
WITH MEMBRANES

2005 SANITARY SEWER MASTER PLAN UPDATE

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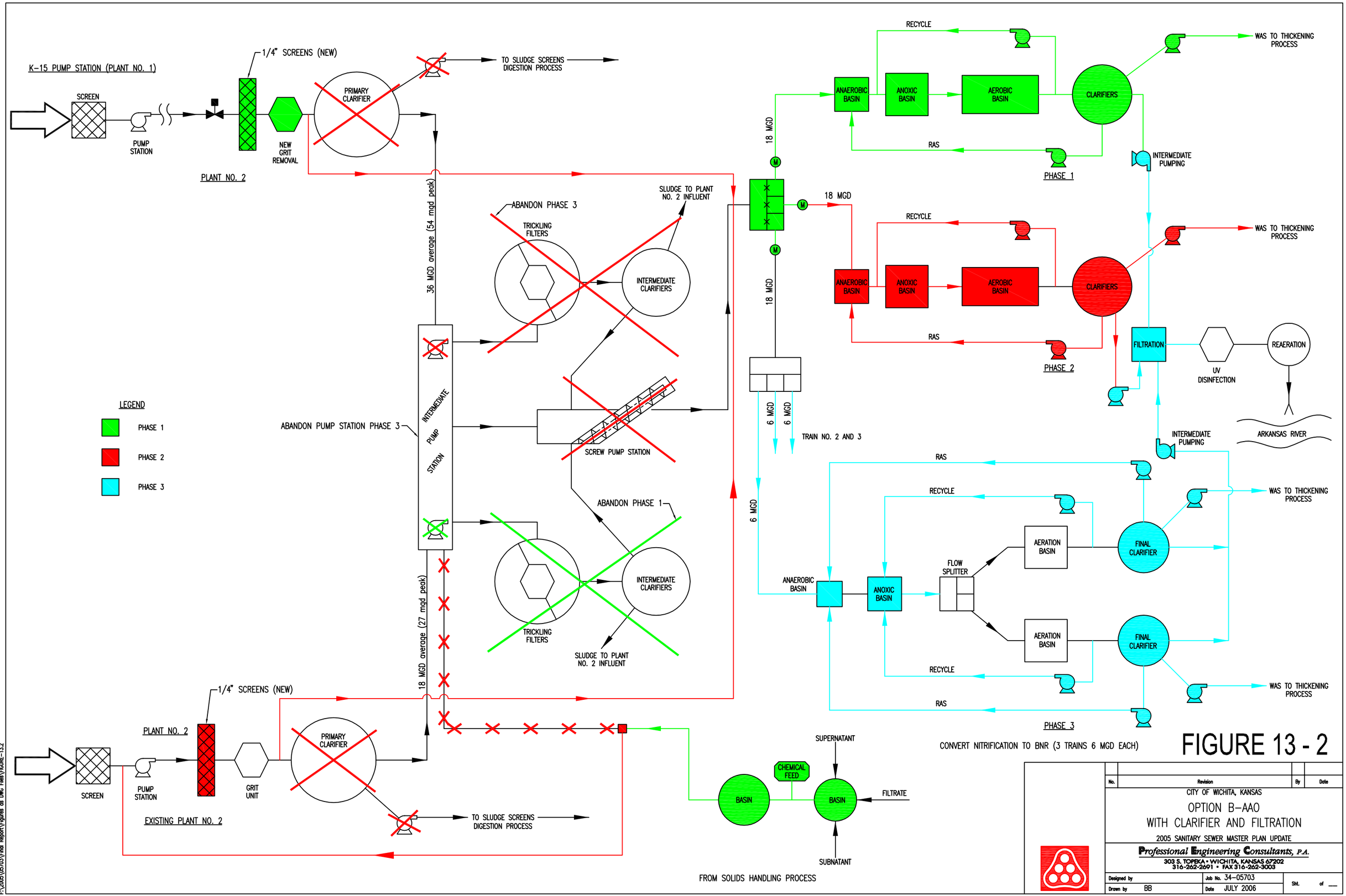

FIGURE 13 - 2

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

OPTION B-AAO
WITH CLARIFIER AND FILTRATION

2005 SANITARY SEWER MASTER PLAN UPDATE

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F:\2005\05703\Final Report\Figures as DWG Files\FIGURE-13.2

SECTION 14

CCWRQF Improvements

IDENTIFICATION OF NECESSARY IMPROVEMENTS

The CCWQRF includes every process component necessary to meet or exceed the forecasted future regulations. The major modification of the facility during this planning period will be to increase capacity. The facility features BNR, filtration, and UV disinfection. It was originally designed for 2 MGD ADF and 6 MGD PDF with expansion capabilities to 4 MGD ADF and 12 MGD PDF, respectively. The 2000 Master Plan Update projected that the 2 MGD expansion would be completed in one phase between 2018 and 2020; however, the City would like to implement smaller phases to more evenly distribute capital funds throughout the planning period. As a result, the expansion will be divided into two phases at least 10 years apart. Recent changes to the projected service area support the division of construction.

PROPOSED IMPROVEMENTS

Phase No. 2

CCWQRF Phase 2 improvements should be completed by 2017, as shown in the Capital Improvement Plan, and include the following:

- Increased on-site influent pumping capacity
- Parallel existing 2 MGD biological treatment train, which includes the anoxic, anaerobic, and aeration basins and associated RAS and WAS pumping.
- New dedicated final clarifiers and splitter box

The on-site influent pump station currently serves the facility itself. Basin projections anticipate that FNW-01 sub-basin will also be served by this pump station by 2010. The anticipated flows from these service areas will meet or exceed firm capacity in 2014. Phase 2 includes the expansion of the existing pump station with the addition of two (2) 2.3 MGD pumps. This will provide firm pumping capacity at peak flows through 2050.

The biological treatment train is anticipated to meet or exceed its firm aeration capacity by 2018. An identical 2 MGD treatment train is recommended in Phase 2 complete with anaerobic, anoxic, and aeration basins. This will double plant capacity and provide sufficient BNR capabilities through 2050. The following process equipment will be required for the construction of the parallel treatment train:

- Anaerobic Basin (5) – 4, 3 HP submersible mixers, 1, 7.5 hp submersible mixers
- Anoxic Basin (2) – 2, 15 hp submersible mixers
- Aeration Basin (1) – 2, 150 hp slow speed vertical surface aerators
- RAS - (3) 15 hp, 1.58 MGD screw centrifugal pumps
- WAS – (2) 3 hp, 0.28 MGD screw centrifugal pumps
- Scum Pumping – (2) 2 hp, 0.14 MGD submersible pumps

The existing final clarifiers are dedicated to the existing biological treatment train. In order to construct the new biological treatment train, a splitter box and two new 60 ft final clarifiers are necessary.

Phase 3

Phase 3 of the improvements will include additional expansion and bring the treatment plant to ultimate capacity. The expansion is recommended for completion by 2028, and includes the following:

- Addition of second grit chamber unit in the headworks building
- Addition of second disk filter in the filter building
- Addition of second UV system in the filter building.

The expansion in capacity for these three systems was planned for during the original construction of the facility. The necessary building space, piping, and channels are in place. Phase 3 requires the installation of the actual equipment as well as incorporation into the existing controls system.

CAPITAL COSTS

Projected equipment, construction, and project costs for each phase are delineated in Table 14-1.

Table 14-1. Capital costs for CCWQRF improvements

Phase 2	*Costs*
Influent pump station (modify existing pumps)	$70,000
Anaerobic and anoxic zones	$481,500
Aeration basin	$1,843,000
Final clarifiers	$941,500
RAS/WAS/Scum pump station	$97,500
Electrical and controls systems	$550,000
Site work	$400,000
Contractor Costs	$657,600
Subtotal	$5,042,000
Contingency	$1,513,000
Opinion of Construction	$6,555,000
Engineering, Legal, Admin.	$1,639,000
Opinion of Total Phase 2 Project Costs	$8,194,000

Phase 3	*Costs*
Headworks – New grit unit	$315,000
Filtration	$440,000
UV disinfection	$420,000
Electrical and controls systems	$275,000
Site work	$20,000
Contractor costs	$220,500
Subtotal	$1,691,000
Contingency	$508,000
Opinion of Construction	$2,199,000
Engineering, Legal, Admin.	$550,000
Opinion of Total Phase 3 Project Costs	$2,749,000
Total Project Costs for Phase 2 and 3	**$10,943,000**

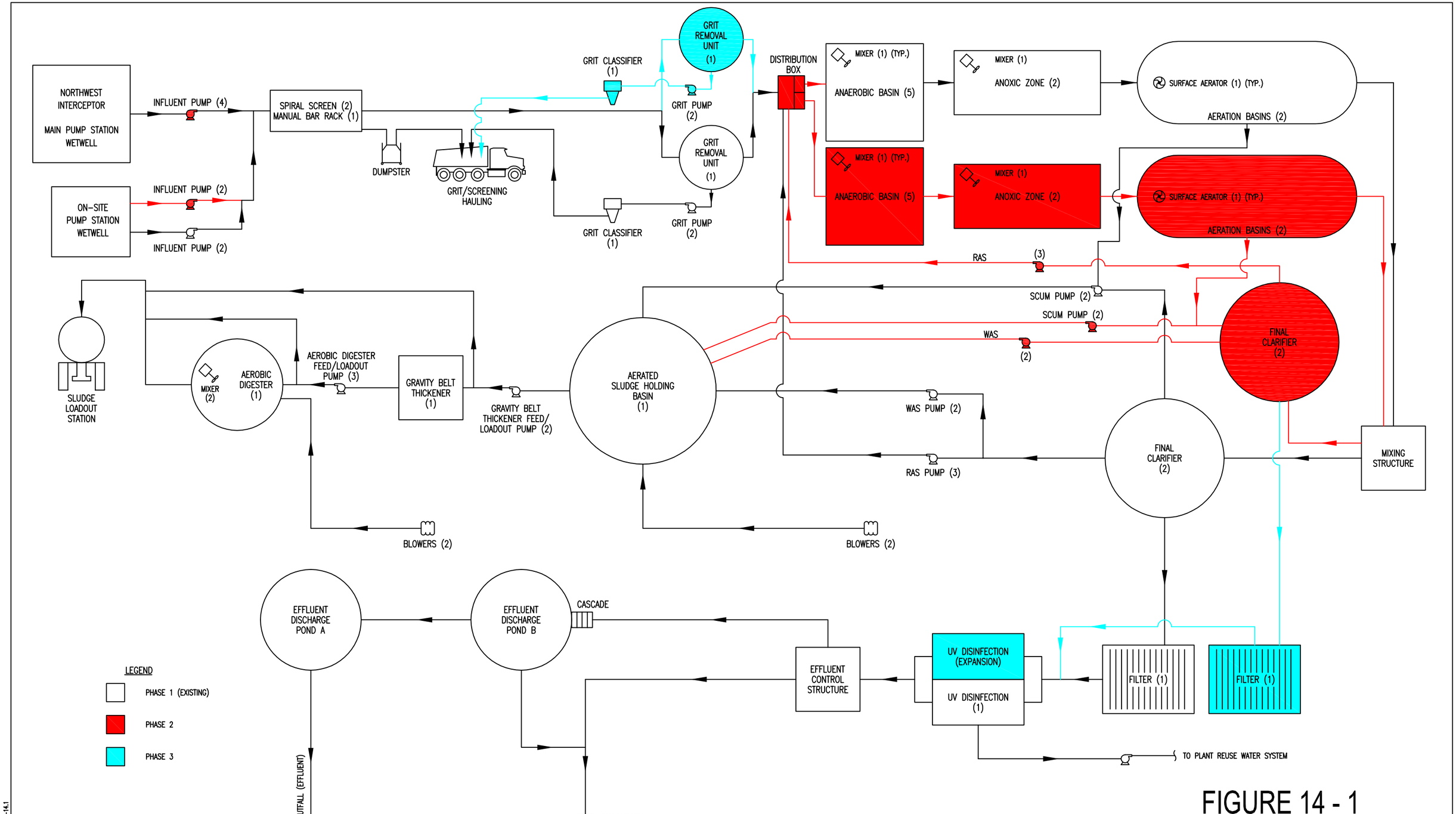

FIGURE 14 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

COWSKIN CREEK WATER QUALITY RECLAIMATION FACILITY IMPROVEMENTS

2005 SANITARY SEWER MASTER PLAN UPDATE

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SECTION 15

Four Mile Creek Treatment Facility Improvements

IDENTIFICATION OF NECESSARY IMPROVEMENTS

The existing Four Mile Creek treatment process has excellent BNR capabilities which will most likely meet or exceed future regulations. The 2000 Master Plan Update projected three phases to be completed by 2050. The first phase included a capacity expansion from 1.5 MGD to 3.0 MGD and the addition of BNR to the process which was completed in March of 2004. The two additional phases outlined in the 2000 Master Plan Update are as follows:

- Phase No. 2 – Addition of effluent filtration, conversion to UV disinfection (between 2012 and 2014)
- Phase No. 3 – Paralleling of the 3 MGD treatment train with a second 3 MGD train, for a total average day treatment capacity of 6.0 MGD (to be completed by 2022).

Since the finalization of the 2000 Master Plan Update, there have been several changes in the basin projections for Four Mile Creek as well as updated projections for regulatory requirements. The previous 2000 Master Plan Update improvement recommendations have been revised to reflect these changes. The updated recommendations for the expansion and process improvements are identical to the 2000 Master Plan Update, however the phasing and timing of the improvements and expansions has been reorganized.

PROPOSED IMPROVEMENTS

The projected flows predict that the plant will reach rated capacity (ADF) between 2015 and 2016, however several key processes will have reached capacity between 2010 and 2014 as shown in Table 11-3. It is now recommended that the next phase of expansion/improvements (revised Phase 2) be completed on or before 2011. Phase 3 will be scheduled for 2025 and will incorporate expansions of existing treatment processes.

Phase 2

Phase 2 now includes the majority of the process expansions and improvements. Although the biological treatment train and the influent pumping do not reach capacity until 2014, it is recommended that the improvements be completed by 2011 to avoid any capacity issues in the disinfection process which is expected to reach capacity in approximately 2010. Splitting the construction of these processes would cause the City increased mobilization and inspection costs. Phase 2 includes the following processes expansions and improvements:

- Increase firm capacity of influent pumping from 5.04 MGD to 9.04 MGD
- Parallel existing 3 MGD biological treatment train, which includes the anoxic, anaerobic, and aeration basins and associated RAS and WAS pumping.
- Construct additional 80 ft clarifier
- Addition of intermediate pumping to a new filtration process
- Construction of UV disinfection

The influent pumps will exceed firm capacity by approximately 2014. Phase 2 of the improvements will include the addition of two 4 MGD pumps which will increase firm pumping capacity to 9.04 MGD. This extends the firm pumping capacity capabilities to approximately 2048. The remaining two 2.52 MGD pumps will be replaced in Phase 3 of the expansions/improvements. In order to increase capacity without increasing headloss, a parallel 16-inch force main will be constructed between the influent pump station and the headworks.

The biological treatment train is anticipated to exceed its firm aeration capacity by 2014. Phase one will include a parallel biological 3 MGD treatment train and one additional 80 ft clarifier. This will create a 6.0 average and 12.0 peak biological treatment capacity which will be sufficient beyond 2050. The clarifiers are rated against average flow conditions and the additional 2 MGD will bring total clarification capacity to 5.0 MGD which is sufficient to treat average day flow through 2050, however an additional clarifier is recommended for construction in a subsequent phase for redundancy at ADF and additional capacity at peak. The expansion of the biological and clarification processes includes the addition of the following ancillary equipment:

- Anaerobic Basin (3) – 3 (one in each basin) 7.5 hp submersible mixers
- Anoxic Basin (1) – 2, 20 hp submersible mixers
- Aeration Basin (1) – 2, 200 hp slow speed vertical surface aerators
- Anoxic Recycle - (2) 30 hp, 6.0 MGD screw centrifugal pump
- RAS - (1) 7.5 hp, 1.5 MGD screw centrifugal pump

With the 3 MGD capacity increase in the biological treatment train, additional clarification will be necessary. The plant is ultimately designed for three 80 ft clarifiers and one 60 ft clarifier. Currently there is one 80 ft clarifier and one 60 ft clarifier that provide a combined average of 3.02 MGD treatment. Phase 2 of the project will include the addition of one 80 ft clarifier which will bring the average daily flow capacity through the clarifiers to approximately 5.0 MGD.

Post clarification, Phase 2 of the improvements will include the addition of filtration and UV disinfection to the process. This addition will increase the headloss in the plant which further limits the plant's ability to gravity discharge into Four Mile Creek. An intermediate pump station designed against 100 year flood at 12.0 MGD will provide the necessary hydraulic head to move the water through the new filtration, and UV, while increasing the plant's ability to gravity discharge to the creek from the existing capacity of 7 MGD to the design capacity of 12 MGD. The lift station will contain three 6 MGD pumps to provide a firm capacity at plant peak of 12 MGD.

Once the effluent from the clarifiers has been pumped to the required hydraulic gradeline, it will be sent trough a filtration system for polishing. The system will have two 12 MGD filters for redundancy and a fully redundant filter backwash system. The polishing will increase the clarifier effluent transmissivity for better UV disinfection efficiency. The filters will also support additional phosphorus removal.

The current disinfection system is expected to exceed capacity in 2012. The new disinfection system incorporated in Phase 2 will be located in the new filter building and include two 12 MGD UV disinfection units for redundancy at PDF. Currently the City has open channel UV disinfection at both Plant 2 and CCWQRF. It is recommended that the City install open channel UV at Four Mile Creek for consistency.

The current reaeration basin is incorporated into the existing chlorination/dechlorination basins and has been in service for approximately 20 years. The basin's existing hydraulic gradeline can not discharge flows over 7 MGD into Four Mile Creek. With the addition of the lift station and UV disinfection as described above, it is recommended that the City abandon the reaeration process and construct a new discharge/outfall into Four Mile Creek at the new hydraulic gradeline. The new outfall will be a cascade which will be designed to provide an effluent DO between 6.0 and 6.5 mg/L which is the anticipated NPDES permit level. The outfall will also be capable of discharging the plant peak flow of 12 MGD against a 100 year flood.

Phase 3

The purpose of Phase 3 is to bring the entire plant up to ultimate capacity. It is strictly a capacity increase and will not include any process improvements. It is recommended that Phase 3 expansion be completed by 2025 and include the following:

- Increase in firm influent pumping capacity from 9.04 MGD to 12.0 MGD
- Redundancy in grit chamber
- Addition of fifth anoxic recycle pump
- Additional clarification and RAS pumping

The influent pumping capacity increase will include the replacement of the remaining two 2.52 MGD pumps with two 4.0 MGD pumps. This increase will extend the firm pumping capacity from 9.04 MGD to 12.0 MGD. The pumps will be identical to those installed in Phase 2.

The existing grit chamber will reach capacity in 2022 under peak flow conditions. The plant currently has two grit chambers, but only one was fitted with equipment in Phase 1 of the improvements. Phase 3 includes the installation of a 1 hp, 6.0 MGD grit unit in the second existing grit chamber, identical to the equipment in the first grit chamber. This will afford the City full redundancy at ADF and full grit processing capabilities at PDF.

The sludge pump station was constructed to accommodate five anoxic recycle pumps. The addition of the final pump is incorporated into this phase to provide a redundant unit for either basin.

Phase 3 also incorporates the addition of the final 80 ft clarifier and accompanying 7.5 hp RAS pump. The clarifier will increase the capacity of the clarification system from 5 MGD to 6.86 MGD.

Capital Costs

Projected equipment, construction, and project costs for each phase are delineated in Table 15-1.

Table 15-1. Capital costs for Four Mile Creek improvements

Phase 2	*Cost*
Influent pump station – modify existing pumps	$104,000
Anaerobic and anoxic zones	$504,000
Aeration basin	$1,014,250
Final clarifiers	$332,500
Anoxic recycle pumping station	$132,500
RAS/WAS/Scum pump station	$37,500
Pumping to filtration	$175,000
Filtration	$1,202,500
UV disinfection	$942,000
Reaeration and outfall	$97,800
Electrical and controls systems	$650,000
Site work	$380,000
Contractor Costs	$835,900
Subtotal	$6,408,000
Contingency	$1,923,000
Opinion of Construction	$8,331,000
Engineering, Legal, Admin.	$2,083,000
Opinion of Total Phase 2 Project Cost	$10,414,000

Phase 3	*Cost*
Influent pump station – modify existing pumps	$80,000
Headworks – New grit unit	$112,500
Final clarification	$365,000
Electrical and controls systems	$70,000
Site work	$100,000
Contractor costs	$109,200
Subtotal	$837,000
Contingency	$252,000
Opinion of Construction	$1,089,000
Engineering, Legal, Admin.	$273,000
Opinion of Total Phase 3 Project Costs	$1,362,000
Total Project Costs for Phase 2 and 3	**$11,776,000**

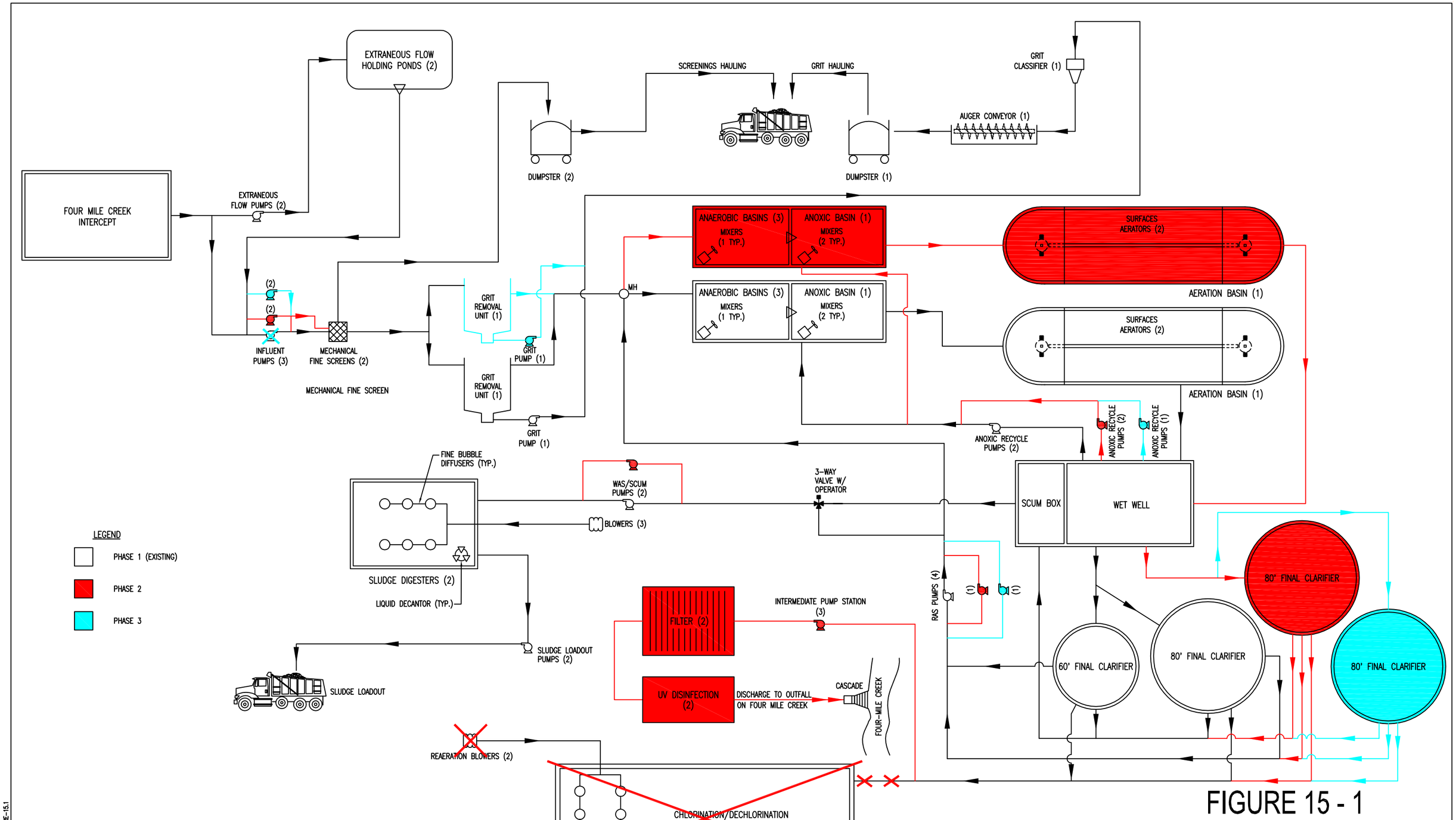


FIGURE 15 - 1

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

FOUR MILE CREEK IMPROVEMENTS

2005 SANITARY SEWER MASTER PLAN UPDATE

Professional Engineering Consultants, P.A.
303 S. TOPEKA • WICHITA, KANSAS 67202
316-262-2691 • FAX 316-262-3003

Designed by	Job No. 34-05703	Sht. PS of ___
Drawn by JTS	Date JULY 2006	

Saved 10-24-2007 1:12:46 PM by TVP
Plot Scale 1:1.9741 10-24-2007 1:45:47 PM by BB
F:\2005\05703\Final Report\Figures on DWG Files\FIGURE-15.1

SECTION 16

Effluent Water Quality Improvements

INTRODUCTION

Section 5 of this Master Plan Update discusses anticipated discharge regulations. KDHE has indicated a desire to implement a nutrient reduction removal plan for surface waters in the State of Kansas. The anticipated regulations will limit total effluent nitrogen to 8 mg/L and total phosphorus to 1.5 mg/L. Through this approach, KDHE hopes to achieve a 30% reduction for nitrogen and phosphorus in surface waters across the State.

The changes to the City of Wichita NPDES permits are expected on their next permit renewal applications. Section 16 demonstrates the reduction of TN and TP expected to occur given the treatment facility improvements presented in Sections 13-15 of this Master Plan Update.

NUTRIENT MANAGEMENT PLAN

The concept of the Nutrient Management Plan is based upon evaluating the pounds of nutrients discharged by the City of Wichita Wastewater as a whole and not plant by plant. The City of Wichita has made several investments in satellite treatment facilities to promote beneficial reuse of wastewater and to reduce load from Treatment Plant No. 2. Each of these satellite treatment facilities has been designed as nutrient removal facilities, and their performance in nutrient removal exceeds Plant No. 2. These expenditures have demonstrated Wichita's commitment to water quality therefore the focus of this plan is to manage the investment in wastewater treatment so that incrementally nutrient management is achieved by 2031.

PROJECTED INFLUENT LOADS

In order to demonstrate the impact the proposed improvements will have on the effluent water quality, it is necessary to calculate the anticipated loads coming into the

system to be treated. The following projected flows and loadings were calculated using the assumptions made in Section 3, however the population used in this Section were updated to reflect the addition of the Mid Continent airport facility as well as projected changes in service areas.

Table 16-1 summarizes the flows expected through each facility through 2050. The table further separates out flows at Plants No. 1 and No. 2 into phases which correspond with the construction phases presented in Section 13.

Table 16-1. Average Daily Flow

	Average Daily Flow (MGD)							
	2002	*2010*	*2015*	*2020*	*2025*	*2030*	*2040*	*2050*
Plant No. 1 and No. 2								
Existing	39.84	38.54	21.11	21.68	4.14	N/A	N/A	N/A
Phase I			18	18	18	18	18	18
Phase II					18	18	18	18
Phase III						4.6	5.47	6.32
Mid Continent		3.0	3.0	3.0	3.0	3.0	3.0	3.0
CCWQRF	0.65	1.15	1.4	1.64	1.93	2.21	2.68	3.16
Four Mile Creek	1.79	2.63	2.92	3.2	3.46	3.72	4.02	4.63
Total Wichita Flow	**42.28**	**45.32**	**46.43**	**47.52**	**48.53**	**49.53**	**51.17**	**53.11**
Surrounding Communities Service Area	6.7	7.54	8.4	9.26	9.6	9.92	11.28	12.13

Table 16-2 summarizes the total nitrogen loads expected at each facility using individual facility population projections (located in Sections 13-15), and the p/c/d listed in Section 3.

Table 16-2. Daily Influent Total Nitrogen in pounds per day

	Total Influent Nitrogen (ppd)							
	2002	*2010*	*2015*	*2020*	*2025*	*2030*	*2040*	*2050*
Plant No. 1 and No.2								
Existing	9870	9548	5230	5371	1025	N/A	N/A	N/A
Phase I			4,459	4,459	4,459	4,459	4,459	4,459
Phase II					4,459	4,459	4,459	4,459
Phase III						1,139	1,355	1,565
Mid Continent		743	743	743	743	743	743	743
CCWQRF	201	357	453	510	599	688	834	982
Four Mile Creek	385	613	698	783	868	953	1123	1293
Wichita Total	**10,456**	**11,261**	**11,583**	**11,866**	**12,153**	**12,441**	**12,973**	**13,501**
Surrounding Communities Service Area	2,083	2,346	2,612	2,881	2,986	3,085	3,509	3,774

Table 16-3 summarizes the total phosphorus loads expected to arrive at each facility using individual facility population projections (located in Sections 13-15), and the p/c/d listed in Section 3.

Table 16-3. Daily Influent Total Phosphorus

	Total Influent Phosphorus (ppd)							
	2002	*2010*	*2015*	*2020*	*2025*	*2030*	*2040*	*2050*
Plant No. 1 and No.2								
Existing	2,111	2,042	1,118	1,149	219	N/A	N/A	N/A
Phase I			954	954	954	954	954	954
Phase II					954	954	954	954
Phase III						244	290	335
Mid Continent		159	159	159	159	159	159	159
CCWQRF	43	76	93	109	128	147	178	210
Four Mile Creek	82	131	150	168	186	204	240	277

				Total Influent Phosphorus (ppd)				
Wichita Total Flow	**2,236**	**2,408**	**2,474**	**2,539**	**2,600**	**2,662**	**2,775**	**2,889**
Surrounding Communities Service Area		503	560	617	639	661	752	809

PROJECTED EFFLUENT LOADS

From review of the plant operational data it has been determined that the existing Plant No. 2 has approximately 10 % reduction in total nitrogen and a 5% reduction in total phosphorus while the satellite plants are producing effluent qualities that have approximately 6 mg/l total nitrogen and 1.5 mg/l of total phosphorus. The satellite plants are currently meeting or exceeding the proposed nutrient limits of 8 mg/l total nitrogen and 1.5 mg/l.

For purposes of this projection all new improvements for Plants No. 1 and No. 2 were assigned discharge values equal to the permitted values. This assumption is reasonable because the proposed Plant No. 1 and 2 improvements include the addition of BNR capabilities equal or superior to those of the existing satellite treatment facilities which as stated above are operating at or above projected regulations. Projections for the satellite plants were held constant at 6 mg/L total nitrogen and 1.5 mg/L total phosphorus.

Table 16-4 is the total daily nitrogen projected in the effluent of each facility.

Table 16-4. Daily Effluent Total Nitrogen

				Total Effluent Nitrogen (ppd)				
	2002	*2010*	*2015*	*2020*	*2025*	*2030*	*2040*	*2050*
Plant No. 1 and No.2								
Existing	8,880	8,590	4,700	4,830	920	N/A	N/A	N/A
Phase I			1,200	1,200	1,200	1,200	1,200	1,200
Phase II					1,200	1,200	1,200	1,200
Phase III						300	360	420
Mid Continent		200	200	200	200	200	200	200
CCWQRF	30	60	70	80	100	110	130	160

	Total Effluent Nitrogen (ppd)							
Four Mile Creek	90	130	150	160	170	190	200	230
Wichita Total	**9,000**	**8,980**	**6,320**	**6,470**	**3,790**	**3,200**	**3,290**	**3,410**
Surrounding Communities Service Area	2,083	2,346	2,612	2,881	2,986	3,085	3,509	3,774

Table 16-5 is the total daily phosphorus projected in the effluent of each facility.

Table 16-5. Daily Effluent Phosphorus

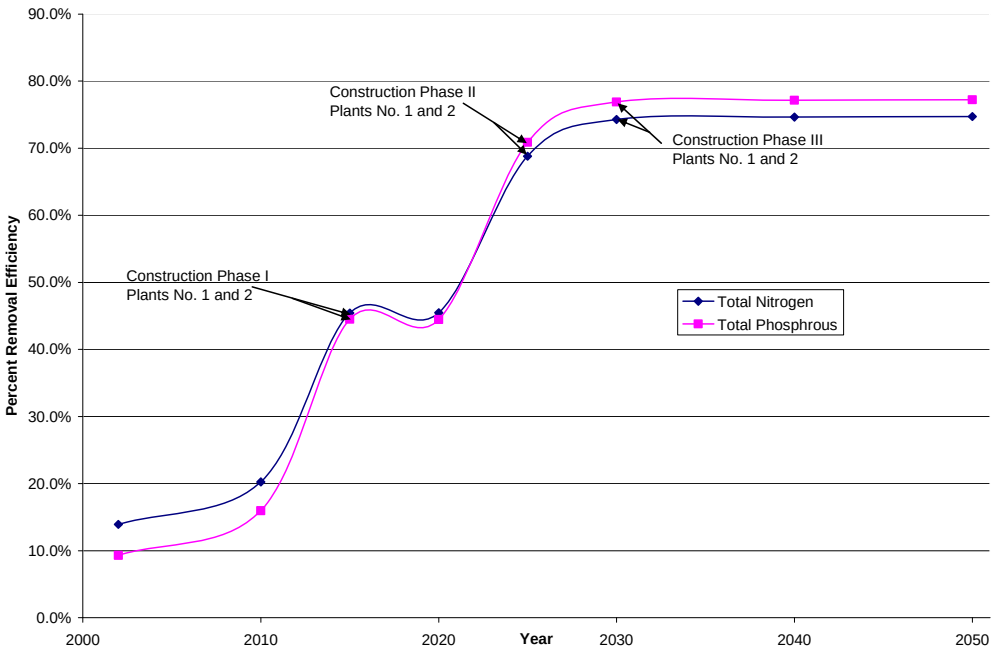
	Total Effluent Phosphorus (ppd)							
	2002	*2010*	*2015*	*2020*	*2025*	*2030*	*2040*	*2050*
Plant No. 1 and No.2								
Existing	2,000	1,940	1,060	1,090	210	N/A	N/A	N/A
Phase I			220	220	220	220	220	220
Phase II					220	220	220	220
Phase III						60	70	80
Mid Continent		40	40	40	40	40	40	40
CCWQRF	8	14	17	20	24	28	34	40
Four Mile Creek	20	30	36	40	43	47	50	58
Wichita Total	**2,028**	**2,024**	**1,373**	**1,410**	**757**	**615**	**634**	**658**
Surrounding Communities Service Area		503	560	617	639	661	752	809

As can be seen on Table 16-6 and Figure 16-1, the City of Wichita is reducing the amount of total nitrogen and phosphorus being discharged by an effective amount over the next 25 years.

Table 16-6. Percent Nutrient Removal through all Wichita Treatment Facilities

	2002	*2010*	*2015*	*2020*	*2025*	*2030*	*2040*	*2050*
Percent Removal of Total Nitrogen	13.9%	20.3%	45.4%	45.5%	68.8%	74.3%	74.6%	74.7%
Percent Removal of Total Phosphorus	9.3%	15.9%	44.5%	44.5%	70.9%	76.9%	77.2%	77.2%

Figure 16-1. Nutrient Removal



If further consideration is given to the amount of nutrient being removed by the neighboring communities with their treatment plant upgrades it can be seen that south central Kansas is effectively controlling nutrient discharge.

SECTION 17 *Capital Improvement Plan*

The Capital Improvement Plan (CIP) presents a proposed implementation schedule and budgetary allocations for improvements identified in this report. The following pages enumerate annual capital costs for each project over the next decade and show cash disbursement plans to the year 2050. Actual project construction costs were used as a basis for much of the cost estimating on wastewater treatment process equipment and various plant-wide improvements. Improvement costs for sanitary sewers were based on unit construction costs, and average bury depths were assumed with minimal rock excavation. Other cost data sources include manufacturers, suppliers of material and equipment, local contractors, and project data provided by professional journals and construction publications.

In reviewing the capital costs presented herein, it is essential to realize that adjustments and changes during design will alter the estimates to some degree and that future changes in the cost of materials, labor, and equipment will also cause changes in the costs summarized.

Actual sites for any new treatment facilities and alignments for new pipelines cannot currently be identified. Physical characteristics such as slope of the land, depth to groundwater, and conflicting utilities are not be individually estimated, therefore a contingency factor is used to account for these costs.

Additional project costs include:

- Legal services (required to coordinate construction with the local governmental agencies)
- Land purchase
- Easement and right-of-way transactions
- Special investigations
- Surveys
- Foundation reports
- Location of interfering utilities
- Detailed design
- Preparation of plans and specifications
- Construction inspection

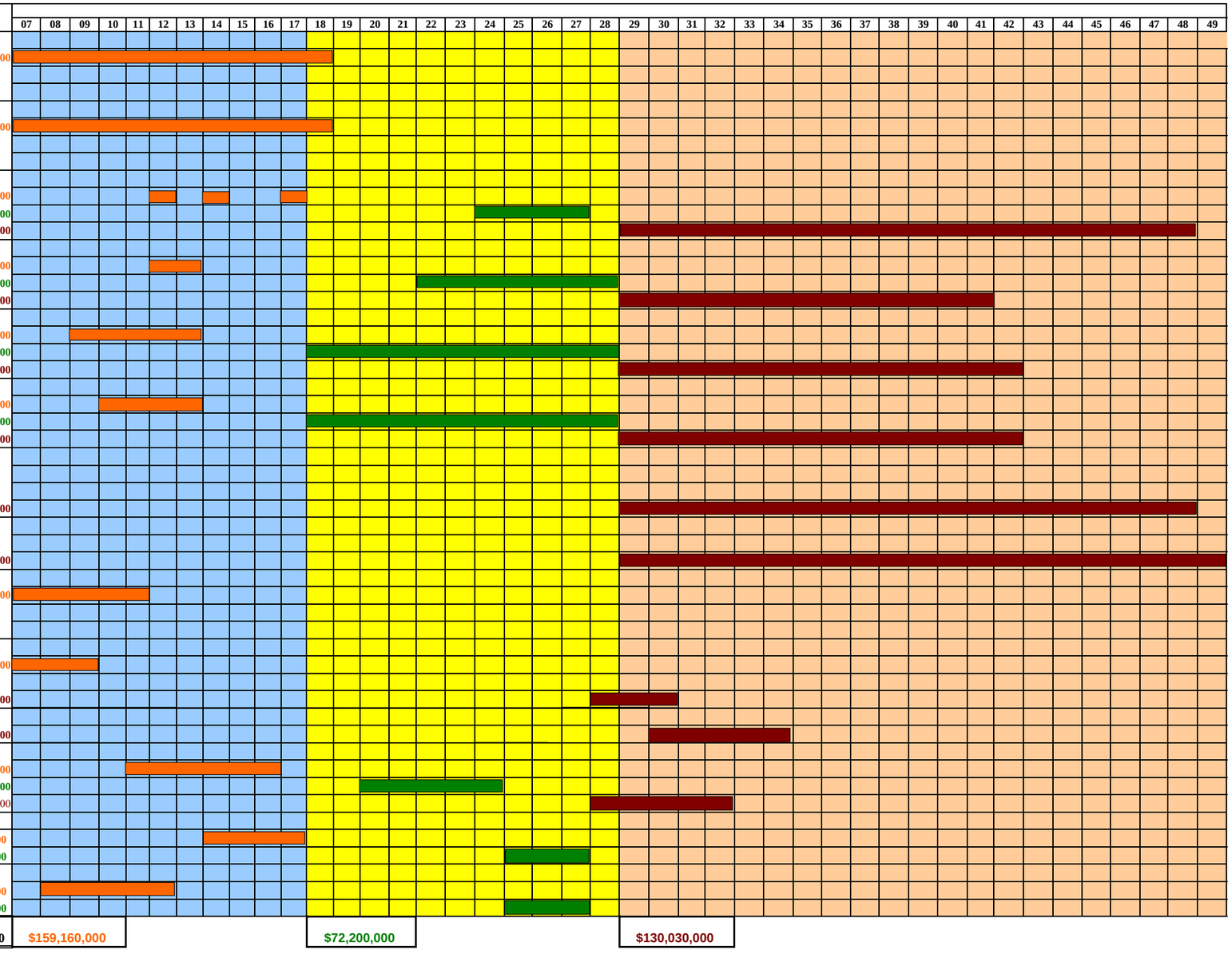
- Materials testing
- Start-up assistance
- O&M manual preparation
- Project administration

These items are included in the cost estimates by assuming their cost as a percentage of construction.

2007 Master Plan CIP

Proposed Implementation Schedule

Phase and Task	Cost
Existing Collection System (Parallel Interceptors)	
	$29,540,000
Existing Collection System (Lift Station and Force Mains)	
	$10,270,000
New Collection Systems - North	
	$1,920,000
	$1,000,000
	$2,170,000
New Collection Systems - West	
	$1,130,000
	$1,000,000
	$1,420,000
New Collection Systems - Northwest	
	$2,380,000
	$4,000,000
	$10,700,000
New Collection Systems - Southwest	
	$4,700,000
	$6,000,000
	$7,850,000
New Collection Systems - Southeast	
	$6,600,000
New Collection Systems - Walnut/Four Mile Creek	
	$12,590,000
Misc. Treatmnt Plant Modifications	
	$5,220,000
Mid Continent Satellite Treatment Plant	
Phase 1 Treatment Plant Design and Construction	$23,000,000
Phase 2 Treatment Plant Design and Construction	$15,700,000
North Satellite Treatment Plant	
Treatment Plant Design and Construction	$18,000,000
Plants No. 1 & No. 2 Improvements	
Phase 1 Treatment Plant Design and Construction	$62,400,000
Phase 2 Treatment Plant Design and Construction	$56,000,000
Phase 3 Treatment Plant Design and Construction	$55,000,000
CCWQRF Improvements	
Phase 2 Treatment Plant Design and Construction	$8,200,000
Phase 3 Treatment Plant Design and Construction	$2,800,000
Four Mile Creek Improvements	
Phase 2 Treatment Plant Design and Construction	$10,400,000
Phase 3 Treatment Plant Design and Construction	$1,400,000
WASTEWATER SYSTEM GRAND TOTAL	**$361,390,000**



Ten Year CIP (2007 to 2017)

Cash Disbursement Plan (Thousands of Dollars)

Phase and Task	Year										
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Existing Collection System - Parallel Interceptors											
				$ 6,486	$ 5,551	$ 5,232	$ 4,413	$ 1,636	$ 1,533	$ 1,271	$ 2,596
Existing Collection System - Lift Stations and Force Mains		$ 80	$ 2,066	$ 1,000	$ 2,000	$ 2,000	$ 1,887	$ 330	$ 905		
New Collection Systems - North											
						$ 640		$ 640			$ 640
New Collection Systems - West						$ 565	$ 566				
New Collection Systems - Northwest											
			$ 594	$ 594	$ 594	$ 594					
New Collection Systems - Southwest											
				$ 1,567	$ 1,567	$ 1,000	$ 568				
New Collection Systems - Southeast											
New Collection Systems Walnut/Four Mile Creek											
					$ 400	$ 400					
Mid Continent Satellite Treatment Plant	$ 10,000	$ 10,000	$ 3,000								
North Satellite Treatment Plant											
Plant No. 1 Improvements											
			$ 1,300		$ 200				$ 300		$ 300
Plant No.2 Improvements											
					$ 4,000	$ 13,000	$ 14,000	$ 14,000	$ 13,000	$ 4,400	
CCWQRF Improvements											
								$ 500	$ 2,700	$ 2,700	$ 2,300
Four Mile Creek Improvements											
		$ 500	$ 2,500	$ 3,500	$ 3,500	$ 400					
Misc Treatment Plant Modifications											
	$ 480	$ 440	$ 400		$ 1,500		$ 300				
Total Expenditures by Year	**$ 10,480**	**$ 11,020**	**$ 9,860**	**$ 13,147**	**$ 19,312**	**$ 23,831**	**$ 21,734**	**$ 17,106**	**$ 18,438**	**$ 8,371**	**$ 5,836**

CIP (2018 to 2050)

Table . Cash Disbursement Plan (Thousands of Dollars)

Phase and Task	Year																														
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Existing Collection System - Parallel Interceptors																																
Existing Collection System - Lift Stations and Force Mains																																
New Collection Systems - North							$ 250	$ 250	$ 250	$ 250	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109	$ 108	$ 109		
New Collection Systems - West					$ 143	$ 143	$ 143	$ 143	$ 143	$ 143	$ 143	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109	$ 109								
New Collection Systems - Northwest	$ 364	$ 364	$ 364	$ 364	$ 364	$ 364	$ 364	$ 364	$ 364	$ 364	$ 364	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764	$ 764							
New Collection Systems - Southwest	$ 545	$ 545	$ 545	$ 545	$ 545	$ 545	$ 545	$ 545	$ 545	$ 545	$ 545	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561	$ 561							
New Collection Systems - Southeast												$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	$ 330	
New Collection Systems Walnut/Four Mile Creek												$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600
Mid Continent Satellite Treatment Plant											$ 5,233	$ 5,233	$ 5,233																			
North Satellite Treatment Plant													$ 3,600	$ 3,600	$ 3,600	$ 3,600	$ 3,600															
Plant No. 1 Improvements																																
Plant No.2 Improvements			$ 11,200	$ 11,200	$ 11,200	$ 11,200	$ 11,200				$ 11,000	$ 11,000	$ 11,000	$ 11,000	$ 11,000																	
CCWQRF Improvements								$ 933	$ 933	$ 933																						
Four Mile Creek Improvements								$ 467	$ 467	$ 467																						
Misc Treatment Plant Modifications																																
Total Expenditures by Year	**$ 909**	**$ 909**	**$ 12,109**	**$ 12,109**	**$ 12,252**	**$ 12,252**	**$ 12,502**	**$ 2,702**	**$ 2,702**	**$ 2,702**	**$ 17,393**	**$ 18,706**	**$ 22,305**	**$ 17,073**	**$ 17,072**	**$ 6,073**	**$ 6,072**	**$ 2,473**	**$ 2,472**	**$ 2,473**	**$ 2,472**	**$ 2,473**	**$ 2,472**	**$ 2,473**	**$ 2,363**	**$ 1,039**	**$ 1,038**	**$ 1,039**	**$ 1,038**	**$ 1,039**	**$ 930**	**$ 600**

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 – Phase 1 Expansion

DESCRIPTION:

Construct 18 mgd of nutrient removal facilities as phase 1 of 3 phases to upgrade Treatment Plant No. 2

JUSTIFICATION:

The construction is to meet more stringent discharge requirements imposed by the NPDES discharge permit.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

These improvements are necessary to meet the discharge requirements, however, there will also be an increase in operating costs to support the additional facilities.

Year	Amount
2007	
2008	
2009	
2010	
2011	$4,000,000
2012	$13,000,000
2013	$14,000,000
2014	$14,000,000
2015	$13,000,000
2016	$4,400,000
2017	
Project Total	$62,400,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Four Mile Creek – Phase 2 Expansion

DESCRIPTION:

Increase the capacity of the 4 Mile Creek Wastewater Treatment Plant with the addition of 3 mgd of capacity.

JUSTIFICATION:

The modification is based upon growth in the sewerage basin and meeting more stringent discharge requirements.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

These improvements are necessary to support growth in the basin, however, there will also be an increase in operating costs to support the additional facilities.

Year	Amount
2007	
2008	$ 500,000
2009	$ 2,500,000
2010	$ 3,50,0000
2011	$ 3,500,000
2012	$ 400,000
2013	
2014	
2015	
2016	
2017	
Project Total	$10,400,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Cowskin Creek Water Quality Reclamation Facility – Phase 2 Expansion

DESCRIPTION:

Increase the capacity of the Cowskin Creek Water Quality Reclamation Facility with the addition of 2 mgd of capacity.

JUSTIFICATION:

The modification is based upon growth in the sewerage basin and meeting more stringent discharge requirements.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

These improvements are necessary to support growth in the basin, however, there will also be an increase in operating costs to support the additional facilities.

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	$500,000
2015	$2,700,000
2016	$2,700,000
2017	$ 2,300,000
Project Total	$8,200,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 Final Clarifiers – Scum Pumping and Launder Covers

DESCRIPTION:

Install scum pumps and piping at the final clarifiers to transport the scum to the solid handling facilities.

Install Launder Covers over the weirs and launders in the final clarifiers.

JUSTIFICATION:

These improvements are focused directly at reducing operations and maintenance costs for the facility. Scum is removed manually from the scum holding tanks with the use of a vacuum truck. Launders must be kept clean of algae to prevent problems in the UV Disinfection system. Covers prevent the growth of algae.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved system performance, and a reduction in operations and maintenance.

Year	Amount
2007	$200,000
2008	$400,000
2009	$200,000
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$800,000

CITY OF WICHITA
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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Pump Station Evaluation Study

DESCRIPTION:

Wichita has 56 Pump Stations of various configurations dating from the fifties to present. Many are confined entry locations, many have maintenance problems and some are past their useful life. A detailed documentation of the condition, useful life, serviceability, performance and costs of operations, maintenance and replacement, would allow decisions to be made concerning the future of each station and a scheduling of major maintenance or replacement activities.

JUSTIFICATION:

To establish a priority ranking of major maintenance or replacement of the City's Pump Stations along with a schedule of expenses.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Pump Station performance is directly related to growth within the sewerage area for the pump station.

OPERATING BUDGET IMPLICATIONS:

Optimum pump station performance will reduce operational costs, while reduced performance will result in more after-hours call outs.

Year	Amount
2007	
2008	$80,000
2009	
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$80,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Lift Stations No. 3 and No. 8 - Replacement

DESCRIPTION:

Lift Stations No. 3 was installed in 1968, has a capacity of 150 gpm, and is nearly 40 years old. Lift Station No. 8 was installed in 1954, has a capacity of 200 gpm, and is 53 years old. The project should consist of field inspection, capacity review, development of a design memorandum, and recommendations for replacement, and design.

JUSTIFICATION:

The two lift stations exceed their service life and should be replaced.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends replacement.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved operations and more efficient motors. Maintenance will be reduced due to new construction.

Year	Amount
2007	
2008	
2009	$250,000
2010	$250,000
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$500,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE: Lift Stations No. 1 and No. 6 - Replacement and Expansion

DESCRIPTION: Lift Station No. 1 needs to be upgraded from 1500 gallons per minute to 1800 gpm. Lift Station No. 6 needs to also be upgraded from 3,200 gpm to 4,500 gpm. The project should consist of the development of a design Memo outlining the condition of the station, sizing of pumps, discussion.

JUSTIFICATION: Based on the Master Plan the flows arriving at these two lift stations will be in excess of existing capacity. In addition both lift stations are reaching their expected life. Lift Staion No. 1 was installed in 1969 and is nearly 40 years old. Lift Station No. 6 was installed in 1956 and is over 50 years old. The project will include development of a design memorandum discussing various options available for replacement, cost estimates, and how the facility will be

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

This work is included in the Master Plan.

OPERATING BUDGET IMPLICATIONS: This work should result in improved operations and more efficient motors. Maintenance will be reduced due to new construction.

Year	Amount
2007	
2008	
2009	$750,000
2010	$750,000
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$1,500,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Sanitary Sewer Evaluation Survey for Four Mile Creek

DESCRIPTION:

The work shall include flow monitoring, field inspections, hydraulic modeling, engineering analysis, and preparation of an interim report and a final report. Purpose is to identify I/I sources, bottle necks, structural defects, and other conditions such that recommendations can be developed to eliminate wet and dry weather overflows/reduction of I/I.

JUSTIFICATION:

By reducing I/I, potential system bypasses will be eliminated, system capacity assured, reduction in flows to be treated at the Four Mile Creek STP.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work..

OPERATING BUDGET IMPLICATIONS:

This work should result in improved system performance, elimination of possible system overflows, and reduced treatment requirements.

Year	Amount
2007	
2008	
2009	
2010	
2011	$400,000
2012	$400,000
2013	
2014	
2015	
2016	
2017	
Project Total	$800,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Odor Control Study –Treatment Plants, Interceptors, Pump Stations

DESCRIPTION:

This study shall determine the Odor Potential at each location, discuss its effect on the surrounding area, provide mitigation alternatives, and establish capital costs, O&M costs.

JUSTIFICATION:

Current conditions with the environs nears these facilities have little or no acceptance of odors. To promote the value of these facilities odor reduction is of importance.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work will result in the determination of the cost for odor reduction and establish a schedule for improvement to be completed.

Year	Amount
2007	
2008	
2009	$200,000
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$200,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 Odor Control Systems

DESCRIPTION:

Construct Odor Control System for Plant No. 2 Primary Clarifiers and Solids Handling Systems

JUSTIFICATION:

Odors are becoming an increasingly larger issue and to promote the importance of these facilities odor reduction in a factor.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work will result in continued odor reduction at Plant No. 2.

Year	Amount
2007	
2008	
2009	
2010	
2011	$1,500,000
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$1,500,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 Bio Filter Media Replacement

DESCRIPTION:

Replace the support structure and the media in the bio filter for the odor control system in the plant no.2 headworks.

JUSTIFICATION:

The media and system have degraded with use and time and should be replaced to continue the desired performance.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work will result in continued odor reduction at Plant No. 2.

Year	Amount
2007	
2008	$40,000
2009	
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$40,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 1 – Influent Screen Replacement

DESCRIPTION:

Replace the existing ¾-inch bar screen (4 units).

JUSTIFICATION:

The influent screens at Plant No. 1 will require replacement due to years of service and evidence of corrosion on the frames. This work should be coordinated with Plant No. 2 improvements.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved system performance.

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	$300,000
2016	
2017	$300,000
Project Total	$600,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 1 – Odor Control Replacement

DESCRIPTION:

Replace the existing Odor Control System with new system and capture all fugitive odors. The project includes review of Best Available Technology, Design Memorandum, Design, and Construction services.

JUSTIFICATION:

Odor Control at Plant No. 1 needs to be expanded to collect all odors. The existing system has been in service since 1992 and needs replacement.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved quality of life for neighborhood citizens.

Year	Amount
2007	
2008	
2009	$1,300,000
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$1,300,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Abandon Existing Plant No. 1 Structures

DESCRIPTION:

Demolish abandoned tankage and structures located at Plant No. 1 and reclaim area.

JUSTIFICATION:

The abandoned structures are a hazard and should be demolished. In addition to the existing hazard the land space has value and could be reclaimed for other uses.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved quality of life for operational staff and provide a usable space for other services..

Year	Amount
2007	
2008	
2009	
2010	
2011	$200,000
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$200,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 Influent Screens washer-grinder unit replacement

DESCRIPTION:

The screenings washer/grinder unit needs replacement. A review of various alternatives should be conducted, plans prepared, and construction services provided.

JUSTIFICATION:

The screenings washer/grinder unit will fall into disrepair and will require replacement.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved operations and maintenance at Plant No. 2.

Year	Amount
2007	$80,000
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$80,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 Primary Clarifier scum pump station.

DESCRIPTION:

The Primary Clarifier scum pump station is not performing as designed and needs to be replaced. This would involve pumping the scum from the clarifiers to the digestion system.

JUSTIFICATION:

The Scum is currently being removed by a private contractor and continues to be an ongoing expense. This project will eliminate that cost..

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved operations and maintenance at Plant No. 2.

Year	Amount
2007	$200,000
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$200,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Future North Area Extension Sewers, Phase I Projects

DESCRIPTION:

Extension Sewers as follows:
Manholes F-N-02-06 to-N-02-05, 2,013 ft of 10-inch sewer.
Manholes F-N-02-05 to-N-02-04, 2,661 ft of 10-inch sewer.
Manholes F-N-02-04 to-N-02-03, 1,961 ft of 10-inch sewer.
Manholes F-N-02-03 to PLS-005, 3,710 ft of 15-inch sewer.
Manholes F-N-02-01to F-N-02-02, 1,641 ft of 10-inch sewer.
Manholes F-N-02-02 to F-N-02-03,2,577 ft of 10-inch sewer.
Probable total project cost $1,919,000.

JUSTIFICATION:

Establish initial trunk sewer system into sub-area. Timing is dependent on actual development.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	$640,000
2013	
2014	$640,000
2015	
2016	
2017	$64,0000
Project Total	$1,919,000

CITY OF WICHITA
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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Future Northwest Area Extension Sewers, Phase I Projects

DESCRIPTION:

Extension Sewers as follows:
Manholes F-NW-01-11 to-F-NW-01-07, 1,340 ft of 21-inch sewer.
Manholes F-NW-01-09 to-F-NW-01-07, 1,264 ft of 21-inch sewer.
Manholes F-NW-01-07 to-F-NW-01-08, 2,683 ft of 27-inch sewer.
Manholes F-NW-01-08 to-4652-TP3, 2,884 ft of 12-inch sewer.
Probable total project cost $2,374,700.

JUSTIFICATION:

Establish initial trunk sewer system into sub-area. Timing is dependent on actual development.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	$593,700
2010	$593,700
2011	$593,700
2012	$593,700
2013	
2014	
2015	
2016	
2017	
Project Total	$2,374.70

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Future Southwest Area Extension Sewers, Phase I Projects

DESCRIPTION:

Extension Sewers as follows:
Manholes F-SW-03-10 to-F-SW-03-11, 2,461ft of 12-inch sewer.
Manholes F-SW-03-11 to-F-SW-03-13, 2,690 ft of 12-inch sewer.
Manholes F-SW-03-13 to-F-SW-03-12, 2,513 ft of 12-inch sewer.
Manholes F-SW-03-12 to-F-SW-03-14, 2,549 ft of 12-inch sewer.
Manholes F-SW-03-14 to-PLS-008, 358 ft of 12-inch sewer.
Manholes F-SW-06-16 to-F-SW-06-17, 208 ft of 18-inch sewer.
Manholes F-SW-06-17 to-F-SW-06-18. 2,585 ft of 18-inch sewer.
Manholes F-SW-06-18 to-F-SW-06-20, 2,670 ft of 18-inch sewer.
Manholes F-SW-06-20 to-F-SW-06-21, 2,775 ft of 18-inch sewer.
Manholes F-SW-06-21 to-F-SW-06-22, 3,729 ft of 18-inch sewer.
Manholes F-SW-06-22 to-4844-001, 2,293 ft of 18-inch sewer.
Probable total project cost $4,702,100.

JUSTIFICATION:

Establish initial trunk sewer system into sub-area. Timing is dependent on actual development.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	$1,567,300
2011	$1,567,300
2012	$1,000,000
2013	$1,567,300
2014	
2015	
2016	
2017	
Project Total	$4,702,100

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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Future West Area Extension Sewers, Phase I Projects

DESCRIPTION:

Extension Sewers as follows:
Manholes F-W-02-11 to-F-W-02-10, 1,846 ft of 8-inch sewer.
Manholes F-W-02-10 to-F-W-02-13, 1,846 ft of 8-inch sewer.
Manholes F-W-02-09 to-F-W-02-10, 2,768 ft of 8-inch sewer.
Manholes F-W-02-13 to-F-W-02-12, 1,846 ft of 12-inch sewer.
Probable total project cost $1,130,800.

JUSTIFICATION:

Establish initial trunk sewer system into sub-area. Timing is dependent on actual development.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	$565,400
2013	$565,400
2014	
2015	
2016	
2017	
Project Total	$1,130,800

CITY OF WICHITA
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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R1

DESCRIPTION:

2,800 ft of 12-inch relief sewer to parallel existing 24-inch sewer from existing manholes 4847-001 to 4847-09. Probable total project cost $441,400.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 126%. Known bottleneck sewer. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	$441,400
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$441,400

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R2

DESCRIPTION:

3,000 ft of 15-inch relief sewer to parallel existing 18-inch sewer from existing manholes 4847-024 to 4847-009. Probable total project cost $550,900.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 145%. Known bottleneck sewer. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	$551,000
2013	
2014	
2015	
2016	
2017	
Project Total	$551,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R3

DESCRIPTION:

4,500 ft of 24-inch relief sewer to parallel existing 30-inch sewer from existing manholes 4847-001 to 4847-011. Probable total project cost $1,243,100.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 161%. Known bottleneck sewer. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	$621,500
2013	$621,600
2014	
2015	
2016	
2017	
Project Total	$1,243,100

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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R4

DESCRIPTION:

3,000 ft of 15-inch relief sewer to parallel existing 12-inch sewer from existing manholes 4743-005 to 4843-038. Probable total project cost $550,900.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 238%. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	$550,900
2015	
2016	
2017	
Project Total	$550,900

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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R5

DESCRIPTION:

7,200 ft of 18-inch relief sewer to parallel existing 18-inch sewer from existing manholes 4843-038 to 4844-001. Probable total project cost $1,532,800.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 165%. Flows will increase after pump station PLS-008 is built to serve growth area F-SW-003. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	$1,532,800
2016	
2017	
Project Total	$1,532,800

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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R6

DESCRIPTION:

4,600 ft of 24-inch relief sewer to parallel existing 36-inch sewer from existing manholes 5246-010 to 5244-013. Probable total project cost $1,270,800.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 130%. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	
2016	$1,270,800
2017	
Project Total	$1,270,800

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R7

DESCRIPTION:

7,500 ft of 30-inch relief sewer to parallel existing 36-inch sewer from existing manholes 5245-006 to 5244-013. Probable total project cost $2,596,000.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 189%. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	$2,596,000
Project Total	$2,596,000

CITY OF WICHITA
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2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R8

DESCRIPTION:

13,100 ft of 42-inch relief sewer to parallel existing 54-inch sewer from existing manholes 5243-011 to 5342-001. Probable total project cost $6,045,600.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 175%. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	$6,045,600
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$6,045,600

CITY OF WICHITA
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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R9

DESCRIPTION:

10,600 ft of 48-inch relief sewer to parallel existing 54-inch and 60-inch sewer from existing manholes 5342-001 to 5441-009. Probable total project cost $5,580,900.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 195%. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	$5,580,900
2011	$3,000,000
2012	$2,581,000
2013	
2014	
2015	
2016	
2017	
Project Total	$5,581,000

CITY OF WICHITA
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PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R10

DESCRIPTION:

7,200 ft of 36-inch relief sewer to parallel existing 60-inch sewer from existing manholes 5441-009 to 5541-006. Probable total project cost $3,790,800.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 147%. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	$3,790,800
2014	
2015	
2016	
2017	
Project Total	$3,790,800

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R11

DESCRIPTION:

5,100 ft of 18-inch relief sewer from existing manholes 6349-144 to 6248-070. to relieve existing overloaded 10-inch sewer downstream from manhole 6349-144.
Probable total project cost $1,085,600.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 200%. Relieves known bottleneck sewer. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need for this project.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	$1,085,600
2015	
2016	
2017	
Project Total	$1,085,600

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Relief Sewer R13

DESCRIPTION:

16,000 ft of 21-inch relief sewer to parallel existing 8-inch, 18-inch and 21--inch sewer from existing manholes 6448-162 to 6446-215.
Probable total project cost $4,030,000.

JUSTIFICATION:

Modeled flow vs. capacity ratio up to 187 % in the 18-inch and 21-inch sections, The 8-inch section is a known bottleneck sewer. 4-Mile Creek basin has high levels of I/I. Alignment and sizing to be determined during design. Actual flow data is to be determined by flow monitoring before confirming need

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	$2,000,000
2012	$2,030,000
2013	
2014	
2015	
2016	
2017	
Project Total	$4,030,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Lift Station No. 27 Expansion

DESCRIPTION:

Provide firm pumping capacity of 13.7 MGD at 143 feet of head. The existing two large pumps are rated 10 MGD at 70 feet of head, cannot be operated together with the smaller units, and do not deliver the modeled head requirement. Probable total project cost is $5,886,300.

JUSTIFICATION:

Modeled peak flow and required head exceeds current firm capacity and current pump head range. Actual flow data is to be determined by flow monitoring before confirming need. The actual friction coefficient tin the 31,300 ft force main is to be determined to confirm required pumping head.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Modeled flows assume that during peak flows up to 6 MGD will be diverted to the Mid-Continent plant

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	$2,000,000
2012	$2,000,000
2013	$1,887,000
2014	
2015	
2016	
2017	
Project Total	$5,887,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Lift Station No. 40 expansion

DESCRIPTION:

Increase firm pumping capacity to 2.3 MGD by adding 0.6 MGD capacity. Probable total project cost is $329,900.

JUSTIFICATION:

Modeled peak flow exceeds current firm capacity. Actual flow data is to be determined by flow monitoring before confirming need

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	$329,900
2015	
2016	
2017	
Project Total	$329,900

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Lift Station No. 56 expansion

DESCRIPTION:

Increase firm pumping capacity to 3.9 MGD by adding 1.9 MGD capacity to meet modeled 2010 flows. An additional expansion will be needed if projected 2050 flows are realized. Probable total project cost is $1,066,000.

JUSTIFICATION:

Modeled peak flow exceeds current firm capacity. Actual flow data is to be determined by flow monitoring before confirming need

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	$1,066,000
2010	
2011	
2012	
2013	
2014	
2015	
2016	
2017	
Project Total	$1,066,000

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

New Lift Station PLS-008 and Force Main for Growth Area F-SW-03

DESCRIPTION:

New Lift Station PLS-008 with 0.783 MGD firm capacity. New 6-inch force main, extending 3,336 feet from PLS-008 to existing manhole 4843-046. Probable total project cost is $ 379,500 for the lift station and $525,900 for the force main.

JUSTIFICATION:

Lift station and force main are required to connect extension sewers in Growth Area F-SW-03 to the existing collection system. Facilities will be retired if trunk sewers south of the airport are built in the future.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

OPERATING BUDGET IMPLICATIONS:

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	$905,400
2016	
2017	
Project Total	$905,400

CITY OF WICHITA
2006 MASTER PLAN UPDATE
2007-2017 RECOMMENDED CAPITAL IMPROVEMENT PROJECTS

PROJECT CATEGORY:

SEWER

DISTRICT:

TITLE:

Plant No. 2 – Influent Screen Replacement

DESCRIPTION:

Replace the existing bar screen openings.to handle additional screenings.

The influent screens at Plant No. 1 will require replacement due to years of service and evidence of corrosion on the frames. This work should be coordinated with Plant No. 2 improvements.

RELATIONSHIP TO MASTER PLAN & OTHER PROJECTS:

Master Plan recommends the work.

OPERATING BUDGET IMPLICATIONS:

This work should result in improved system performance.

Year	Amount
2007	
2008	
2009	
2010	
2011	
2012	
2013	$300,000
2014	
2015	
2016	
2017	
Project Total	$300,000

A P P E N D I C E S

APPENDIX A

Population Projections

Basin	Sub Basin ID	Population 2002	Population 2010	Population 2020	Population 2030	Population 2040	Population 2050
Outside Sub Basins	Outside Sub Basins	33,958	38,942	44,757	50,158	55,609	61,061
Outside Sub Basins Total		33,958	38,942	44,757	50,158	55,609	61,061
Agreement Areas	BEL AIRE-01	2,215	2,270	2,328	2,375	2,375	2,375
Agreement Areas	BEL AIRE-02	2,174	2,394	2,608	2,759	2,759	2,759
Agreement Areas	BEL AIRE-03	718	1,283	1,776	2,058	2,077	2,096
Agreement Areas	BEL AIRE-04	274	325	429	571	859	1,146
Agreement Areas	BEL AIRE-05	36	327	668	985	1,073	1,161
Agreement Areas	COLWICH	1,682	1,839	2,022	2,192	2,637	3,081
Agreement Areas	DERBY	23,845	27,972	32,788	37,259	41,053	44,847
Agreement Areas	GODDARD	7,030	8,396	8,964	10,099	11,452	12,805
Agreement Areas	HAYSVILLE	13,823	15,988	18,450	20,666	22,863	25,059
Agreement Areas	KECHI	2,000	2,427	3,111	3,947	4,583	5,220
Agreement Areas	MAIZE	3,181	3,812	4,504	5,098	5,690	6,282
Agreement Areas	PARK CITY	7,808	9,489	11,521	13,482	15,530	17,578
Agreement Areas	VALLEY CENTER	9,022	10,445	12,035	13,435	15,013	16,591
Agreement Areas Total		73,807	86,206	100,668	114,928	127,063	141,001
4MC	4MC-01	230	269	315	358	358	358
4MC	4MC-02	896	1,035	1,197	1,348	1,476	1,604
4MC	4MC-BH	767	835	965	1,142	1,169	1,197
4MC	4MC-CV	3,968	4,560	5,553	6,799	6,984	7,170
4MC	4MC-MH	2,591	3,093	3,457	3,559	3,616	3,673
4MC	4MC-SC	5,313	6,756	8,056	8,854	9,221	9,588
4MC Total		13,764	16,547	19,544	22,059	22,825	23,591
CIS Total		42,508	44,869	47,044	48,444	48,840	49,237
DRY CREEK Total		21,894	21,895	21,895	21,895	21,903	21,912
F-N	F-N-01	869	1,050	1,230	1,364	1,558	1,753
F-N	F-N-02	3,918	4,061	4,230	4,390	4,535	4,679
F-N	F-N-03A	94	191	304	410	513	617
F-N	F-N-03B	5	207	442	661	661	661
F-N	F-N-04	275	567	908	1,225	1,313	1,401
F-N Total		5,161	6,075	7,115	8,051	8,581	9,111
F-NW	F-NW-01	528	1,529	3,404	5,905	9,769	13,633
F-NW	F-NW-02	201	556	777	777	820	862
F-NW	F-NW-03	275	697	1,578	2,813	3,577	4,341
F-NW	F-NW-04A	434	852	1,975	3,698	3,827	3,956
F-NW	F-NW-04B	30	74	160	279	327	376
F-NW	F-NW-05A	73	254	379	403	518	634
F-NW	F-NW-05B	51	156	226	234	300	365
F-NW Total		1,591	4,117	8,500	14,109	19,138	24,168
F-SE	F-SE-01	1,350	1,379	1,426	1,481	1,893	2,304
F-SE	F-SE-02	1,318	1,452	1,815	2,371	3,549	4,727
F-SE Total		2,667	2,832	3,240	3,852	5,441	7,030
F-SW	F-SW-01	3,312	3,607	3,907	4,137	4,376	4,614
F-SW	F-SW-02	761	960	1,283	1,679	1,884	2,088
F-SW	F-SW-03	1,699	1,970	2,292	2,597	3,024	3,452
F-SW	F-SW-04	948	1,142	1,368	1,577	1,616	1,656
F-SW	F-SW-05	12	135	276	404	638	871
F-SW	F-SW-06	796	1,485	2,432	3,463	4,504	5,544
F-SW	F-SW-07	107	237	580	1,105	1,105	1,105
F-SW	F-SW-08	472	472	472	472	472	473
F-SW	F-SW-09	53	113	133	172	172	172
F-SW Total		8,159	10,009	12,610	15,607	17,619	19,975
F-W	F-W-01	421	789	1,106	1,282	1,348	1,414
F-W	F-W-02	583	1,134	1,576	1,770	2,407	3,045

F-W Total		1,004	1,923	2,682	3,052	3,755	4,458
NWI	NWI-01	4,540	4,816	5,000	5,023	5,154	5,285
NWI	NWI-02	953	1,059	1,126	1,126	1,154	1,182
NWI	NWI-03	670	805	890	890	890	890
NWI	NWI-04	1,236	1,718	2,121	2,323	2,377	2,431
NWI Total		7,398	8,398	9,136	9,362	9,575	9,788
SS1	SS1-01	1,827	1,827	1,827	1,827	1,827	1,827
SS1	SS1-02	4,879	4,879	4,879	4,879	4,879	4,879
SS1	SS1-03	4,748	4,650	4,536	4,430	4,473	4,516
SS1	SS1-04	9,987	10,206	10,482	10,757	11,180	11,603
SS1	SS1-05	22,058	22,672	23,394	24,073	25,109	26,145
SS1	SS1-06	5,648	5,666	5,687	5,706	5,706	5,706
SS1	SS1-07	15,378	15,536	15,728	15,914	16,094	16,273
SS1 Total		64,525	65,437	66,534	67,587	69,268	70,950
SS22	SS22-01	18,833	18,833	18,833	18,833	18,833	18,833
SS22	SS22-03	12,845	12,856	12,869	12,881	12,881	12,881
SS22	SS22-04	6,672	6,678	6,682	6,683	6,684	6,685
SS22	SS22-05	10,939	10,964	10,979	10,979	10,979	10,979
SS22 Total		49,290	49,332	49,364	49,376	49,378	49,379
SS23	SS23-01	21,107	21,108	21,110	21,112	21,112	21,112
SS23	SS23-02	13,346	13,422	13,508	13,584	13,584	13,584
SS23	SS23-03	3,114	3,356	3,511	3,519	4,031	4,543
SS23	SS23-04	485	504	516	516	516	516
SS23	SS23-05	1,942	1,994	2,026	2,026	2,026	2,026
SS23	SS23-06	4,564	4,860	5,112	5,247	5,277	5,306
SS23	SS23-07	9,587	9,920	10,128	10,128	10,128	10,128
SS23	SS23-08	4,881	5,106	5,368	5,610	5,770	5,930
SS23 Total		59,025	60,270	61,280	61,744	62,445	63,147
SWI	SWI-01	3,278	3,278	3,278	3,278	3,594	3,911
SWI	SWI-02	18,768	19,072	19,361	19,557	19,650	19,743
SWI	SWI-03	1,907	2,290	2,825	3,413	3,542	3,671
SWI	SWI-04	927	1,009	1,105	1,193	1,213	1,233
SWI	SWI-05	3,150	3,150	3,150	3,150	3,186	3,222
SWI	SWI-06	611	696	795	887	894	900
SWI	SWI-07	29	29	29	29	29	29
SWI	SWI-08	6,558	6,558	6,558	6,558	6,558	6,558
SWI	SWI-09	5,032	5,032	5,032	5,032	5,032	5,032
SWI	SWI-10	4,209	4,536	4,790	4,889	4,889	4,889
SWI	SWI-11	1,280	2,113	2,805	3,148	3,148	3,148
SWI Total		45,749	47,763	49,726	51,135	51,735	52,336
WALNUT	WALNUT-1	57	489	994	1,463	1,747	2,031
WALNUT	WALNUT-2	520	774	1,474	2,555	5,668	8,780
WALNUT	WALNUT-3A	23	438	963	1,494	1,647	1,800
WALNUT	WALNUT-3B	465	551	959	1,665	1,944	2,223
WALNUT	WALNUT-4	1,051	1,310	1,753	2,316	3,759	5,202
WALNUT Total		2,115	3,562	6,142	9,495	14,765	20,036
WIS	WIS-01	20,848	20,854	20,861	20,868	20,885	20,902
WIS	WIS-02	11,728	11,941	12,087	12,114	12,118	12,123
WIS	WIS-03	2,197	2,382	2,498	2,501	2,501	2,501
WIS	WIS-04	1,182	1,182	1,182	1,182	1,182	1,182
WIS	WIS-05	13,160	13,234	13,355	13,507	13,507	13,507
WIS	WIS-06	1,667	1,707	1,775	1,863	1,864	1,865
WIS	WIS-07	1,106	1,785	2,298	2,477	2,506	2,536
WIS Total		51,888	53,083	54,057	54,510	54,562	54,615
Grand Total		484,504	521,260	564,294	605,360	642,504	681,793

	Population 2002	Population 2010	Population 2020	Population 2030	Population 2040	Population 2050
Total City Service Area - Subbasins	376,739	396,112	418,870	440,275	459,831	479,732
Total Agreement Areas	73,807	86,206	100,668	114,928	127,063	141,001
Total Existing and Future Sewer Service	450,546	482,318	519,537	555,202	586,894	620,732
Total in TAZs outside Sewer Service Area	33,958	38,942	44,757	50,158	55,609	61,061
Total in TAZ Source Data	484,504	521,260	564,294	605,360	642,504	681,793

APPENDIX B

Treatment Facility Historical Flow Information

	Four Mile Creek Flow Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003				2.86	2.07	2.09	1.81	2.63	2.48	3.88	1.93	1.50	3.88
Daily Maximum 2004	1.50	1.94	3.07	2.88	4.52	7.80	4.07	2.28	2.20	2.30	2.38	2.40	7.80
Daily Maximum 2005	2.42	2.70	3.18	2.31	2.68	4.40	2.43	4.46	2.35	1.96	1.88		4.46
Daily Minimum 2003				1.33	1.56	1.50	1.41	1.17	1.46	1.47	1.22	1.50	1.17
Daily Minimum 2004	1.50	1.32	1.23	1.43	1.53	0.98	1.74	1.67	1.57	1.71	1.71	1.81	0.98
Daily Minimum 2005	2.42	2.70	3.18	2.31	2.68	4.40	2.43	4.46	2.35	1.96	1.88		1.88
						.							
Total 2003				52.92	54.94	50.90	49.95	49.96	53.26	56.52	46.63	46.50	461.56
Total 2004	46.50	45.34	54.78	53.68	62.39	60.02	66.27	61.49	56.39	60.95	58.88	60.97	687.65
Total 2005	64.75	63.32	65.59	62.32	66.89	82.82	63.85	71.23	63.46	54.90	52.32		711.45
Average 2003				1.76	1.77	1.70	1.61	1.61	1.78	1.82	1.55	1.50	1.68
Average 2004	1.50	1.56	1.77	1.79	2.01	2.00	2.14	1.98	1.88	1.97	1.96	1.97	1.88
Average 2005	2.09	2.26	2.12	2.08	2.16	2.76	2.06	2.30	2.12	1.77	1.74		2.13
Standard Dev. 2003				0.32	0.15	0.12	0.10	0.25	0.26	0.43	0.14	0.00	0.25
Standard Dev. 2004	0.00	0.13	0.39	0.32	0.52	1.11	0.47	0.17	0.17	0.14	0.18	0.13	0.45
Standard Dev. 2005	0.16	0.16	0.28	0.13	0.20	0.59	0.10	0.54	0.17	0.08	0.08		0.38

	CCWQRF Flow Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003					0.39	0.46	0.55	0.54	0.57	0.71	0.35	0.35	**0.71**
Daily Maximum 2004	0.35	0.66	0.73	0.65	0.74	0.73	1.10	0.75	0.81	0.78	0.88	0.63	**1.10**
Daily Maximum 2005	0.71	0.66	0.69	0.85	0.75	1.25	0.74	0.88	0.89	0.67	0.66		**1.25**
Daily Minimum 2003					0.24	0.14	0.23	0.30	0.32	0.24	0.35	0.35	**0.14**
Daily Minimum 2004	0.35	0.38	0.37	0.37	0.22	0.42	0.45	0.36	0.31	0.13	0.44	0.42	**0.13**
Daily Minimum 2005	0.44	0.42	0.13	0.41	0.42	0.13	0.44	0.46	0.44	0.42	0.41		**0.13**
Total 2003					1.57	7.00	9.97	11.10	11.71	12.32	10.50	10.85	**75.02**
Total 2004	10.85	14.20	14.58	13.84	15.98	16.81	18.28	16.00	15.02	16.48	17.27	15.49	**184.78**
Total 2005	16.02	14.04	16.76	15.75	16.85	17.07	16.25	18.10	15.77	15.90	15.06		**177.54**
Average 2003					0.31	0.32	0.36	0.36	0.39	0.40	0.35	0.35	**0.36**
Average 2004	0.35	0.49	0.47	0.46	0.52	0.56	0.59	0.52	0.50	0.53	0.58	0.50	**0.50**
Average 2005	0.52	0.50	0.54	0.52	0.54	0.57	0.52	0.58	0.54	0.51	0.50		**0.53**
Standard Dev. 2003					0.06	0.07	0.08	0.06	0.07	0.10	0.00	0.00	**0.07**
Standard Dev. 2004	0.00	0.08	0.10	0.07	0.11	0.08	0.14	0.08	0.11	0.13	0.10	0.05	**0.11**
Standard Dev. 2005	0.07	0.07	0.11	0.09	0.08	0.18	0.08	0.10	0.09	0.07	0.08		**0.10**

	Plants No. 1 & No. 2 Flow Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003	34.68	37.76	56.86	54.71	43.77	46.13	37.24	46.30	46.27	64.26	34.90	36.03	64.26
Daily Maximum 2004	41.54	37.13	56.74	47.27	55.06	49.15	52.24	40.42	35.53	40.20	40.17	34.51	56.74
Daily Maximum 2005	41.14	38.92	50.87	35.69	41.24	57.44	42.30	56.16					57.44
Daily Minimum 2003	31.89	31.11	31.82	31.35	31.26	32.08	31.15	32.16	32.38	31.54	31.05	29.09	29.09
Daily Minimum 2004	30.28	33.05	31.35	30.96	31.38	33.00	33.32	32.71	31.93	31.33	31.34	29.65	29.65
Daily Minimum 2005	28.70	33.53	31.70	31.46	29.90	23.24	8.80	30.10					8.80
Total 2003	1,030.30	937.45	1,133.11	1,086.73	1,103.33	1,077.64	1,075.63	1,111.86	1,102.08	1,128.10	996.42	1,024.19	12,806.84
Total 2004	1,045.09	1,008.34	1,135.75	1,051.86	1,159.20	1,142.11	1,253.20	1,127.42					8,922.97
Total 2005	1,101.75	995.92	1,103.03	1,030.21	1,064.82	1,163.39	1,034.70	1,198.15					8,691.97
Average 2003	33.24	33.48	36.55	36.22	35.59	35.92	34.70	35.87	36.74	36.39	33.21	33.04	35.09
Average 2004	33.71	34.77	36.64	35.06	37.39	38.07	40.43	36.37	33.96	33.71	34.32	33.35	35.66
Average 2005	35.54	35.57	35.58	34.34	34.35	38.78	33.38	38.65					35.77
Standard Dev. 2003	0.74	1.32	5.96	4.84	2.49	2.57	1.41	3.05	2.99	5.93	1.11	1.41	3.57
Standard Dev. 2004	2.02	0.96	5.14	3.41	5.06	3.88	4.79	1.77	0.96	1.92	1.93	1.04	3.75
Standard Dev. 2005	3.14	1.23	3.66	0.95	2.31	6.78	6.16	6.17					4.71

APPENDIX C

Significant Industrial Contributors

INDUSTRIAL PERMIT CATEGORIES

CATEGORY I > 200,000 GPD FLOWRATE

INDUSTRY	AVERAGE FLOW GAL/DAY
BOEING COMPANY	1,732,789
CESSNA MID-CONTINENT	804,438
RAYTHEON AIRCRAFT	717,547
McCONNELL AFB	535,773
Total Flow	3,790,547
Percent Flow	48.54%

Category II 200- 499,999	
FARMLAND FOODS	375,136
CESSNA PAWNEE	235,120
ST. JOSEPH MED CENTER	224,983
LEARJET	339,100
WESLEY MEDICAL CENTER	291,958
ST. FRANCIS MED CENTER	234,015
COASTAL REFINING CO	225,143
CARGILL I & II	204,869
TOTAL FLOW	2,130,324
PERCENT OF TOTAL FLOW	27.28%

CATEGORY II - 200K - 100K INDUSTRY	AVERAGE FLOW GAL/DAY
METAL FINISHING	129,031
HILAND DAIRY FOODS	105,791
DOLD FOODS	151,581
PEPSI - COLA	143,539
GREDE FOUNDRY	134,881
NATIONAL BY-PRODUCTS	101,436
TOTAL FLOW	766,259
PERCENT OF TOTAL FLOW	9.81%

CATEGORY III 99K - 60K

INDUSTRY	AVERAGE FLOW GAL/DAY
EVCON INDUSTRIES	72,092
SMITH FIBERGLASS	81,208
ARAMARK, INC.	76,770
AIR CAPITOL PLATING	95,315
WESTERN UNIFORM & TOWEL	91,319
COLEMAN COMPANY - NE PLANT	86,557
TOTAL FLOW	503,261
PERCENT OF TOTAL FLOW	6.44%

CATEGORY IV <60K - 30K

INDUSTRY	AVERAGE FLOW GAL/DAY
LOVE BOX, INC	50,696
KANSAS PLATING	46,220
RUS	43,628
WICHITA COCA COLA	42,686
CASE CORP	37,800
AMERIPRIDE	37,526
TWECO	35,842
CENTER INDUSTRIES	35,179
APEX ENGINEERING	32,371
TOTAL FLOW	361,948
PERCENT OF TOTAL FLOW	4.63%

CATEGORY V <30K

INDUSTRY	AVERAGE FLOW GAL/DAY
DAWSON BROS.	24,653
HARPER TRUCKS	23,077
PARAGON	21,284
SHARPLINE	21,156
REDDI-ROOT'R	19,609
B & G PLATING	18,106
WICHITA EAGLE	18,000
GLOBE ENGINEERING	13,279
UNIVERSAL LUBRICANTS	12,896
KREONITE	12,895
FILTER MEDIA	12,287
The Hayes Company	11,994
RIVERSIDE HOSPITAL	10,984
ADVANCE PRODUCTS	10,767
L&S MACHINE	7,685
BOB EISEL	6,847
TRAMCO	3,864
THERMAL TRADE	1,901
DEL PUEBLO	1,861
HUMPHREY PRODUCTS	1,557
Treatco	1,440
CHANCE INDUSTRIES	1,017
CONOCO PIPELINE	200
TOTAL FLOW	257,359
PERCENT OF TOTAL FLOW	3.30%

TOTAL INDUSTRIAL FLOW	7,809,698

APPENDIX D

Detailed Facility Flow and Population Projections by Sub-basin

		2002				2010					2020					2030					2040					2050				
Basin	**Sub-Basin**	**Population**	**R & C**	**IND/Whl**	**Basin Tot**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Popoulation**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**
Existing Service Area of City of Wichita Treatment Plants 1 and 2																														
CIS																														
	CIS-01	8,176	0.74	0.02	0.76	8,402	0.76		0.02	0.78	8,586	0.77		0.02	0.79	8,672	0.78		0.02	0.80	8,672.18	0.78		0.02	0.80	8,672	0.78		0.02	0.80
	CIS-02	698	0.06		0.06	787	0.07			0.07	866	0.08			0.08	913	0.08			0.08	990	0.09			0.09	1,067	0.10			0.10
	CIS-03	3,964	0.36		0.36	4,281	0.39			0.39	4,490	0.40			0.40	4,511	0.41			0.41	4,529	0.41			0.41	4,546	0.41			0.41
	CIS-04	975	0.09		0.09	1,197	0.11			0.11	1,338	0.12			0.12	1,344	0.12			0.12	1,344	0.12			0.12	1,344	0.12			0.12
	CIS-07	8,977	0.81		0.81	8,977	0.81			0.81	8,977	0.81			0.81	8,977	0.81			0.81	8,977	0.81			0.81	8,977	0.81			0.81
	CIS-08	7,616	0.69		0.69	7,633	0.69			0.69	7,644	0.69			0.69	7,644	0.69			0.69	7,644	0.69			0.69	7,644	0.69			0.69
	CIS-09	6,051	0.54		0.54	6,131	0.55			0.55	6,181	0.56			0.56	6,181	0.56			0.56	6,181	0.56			0.56	6,181	0.56			0.56
	CIS-10	369	0.03		0.03	490	0.04			0.04	566	0.05			0.05	566	0.05			0.05	566	0.05			0.05	566	0.05			0.05
	CIS-11	800	0.07	0.80	0.87	999	0.09	0.58	0.23	0.89	1,188	0.11	0.58	0.23	0.92	1,320	0.12	0.58	0.24	0.93	1,531.12	0.14	0.58	0.24	0.95	1,742	0.16	0.58	0.24	0.98
	CIS-12	11	0.00		0.00	11	0.00			0.00	11	0.00			0.00	12	0.00			0.00	12	0.00			0.00	12	0.00			0.00
	CIS-5A	912	0.08		0.08	1,286	0.12			0.12	1,647	0.15			0.15	1,903	0.17			0.17	1,967	0.18			0.18	2,031	0.18			0.18
	CIS-5B	229	0.02		0.02	419	0.04			0.04	641	0.06			0.06	848	0.08			0.08	848	0.08			0.08	849	0.08			0.08
	CIS-6A	3,196	0.29		0.29	3,558	0.32			0.32	3,982	0.36			0.36	4,379	0.39			0.39	4,379	0.39			0.39	4,379	0.39			0.39
	CIS-6B	532	0.05		0.05	699	0.06			0.06	927	0.08			0.08	1,176	0.11			0.11	1,202	0.11			0.11	1,228	0.11			0.11
CIS Total		**42,508**	**3.83**	**0.82**	**4.65**	**44,869**	**4.04**	**0.58**	**0.25**	**4.86**	**47,044**	**4.23**	**0.58**	**0.26**	**5.07**	**48,444**	**4.36**	**0.58**	**0.26**	**5.20**	**48,840**	**4.40**	**0.58**	**0.26**	**5.23**	**49,237**	**4.43**	**0.58**	**0.27**	**5.27**
SWI																														
	SWI-01	3,278	0.30	0.04	0.33	3,278	0.30	0.04		0.33	3,278	0.30	0.04		0.33	3,278	0.30	0.04		0.33	3,594.35	0.32	0.04		0.36	3,911	0.35	0.04		0.39
	SWI-02	18,768	1.69	0.14	1.83	19,072	1.72		0.15	1.86	19,361	1.74		0.15	1.89	19,557	1.76		0.15	1.91	19,650.12	1.77		0.15	1.92	19,743	1.78		0.16	1.93
	SWI-03	1,907	0.17		0.17	2,290	0.21			0.21	2,825	0.25			0.25	3,413	0.31			0.31	3,542	0.32			0.32	3,671	0.33			0.33
	SWI-04	927	0.08		0.08	1,009	0.09			0.09	1,105	0.10			0.10	1,193	0.11			0.11	1,213	0.11			0.11	1,233	0.11			0.11
	SWI-05	3,150	0.28	0.12	0.40	3,150	0.28		0.12	0.41	3,150	0.28		0.13	0.41	3,150	0.28		0.13	0.41	3,186.15	0.29		0.13	0.42	3,222	0.29		0.13	0.42
	SWI-06	611	0.05	1.38	1.44	696	0.06	1.34	0.05	1.44	795	0.07	1.34	0.05	1.45	887	0.08	1.34	0.05	1.46	893.60	0.08	1.34	0.05	1.46	900	0.08	1.34	0.05	1.47
	SWI-07	29	0.00	0.34	0.34	29	0.00		0.35	0.35	29	0.00		0.35	0.36	29	0.00		0.36	0.36	29.07	0.00		0.36	0.37	29	0.00		0.37	0.37
	SWI-08	6,558	0.59		0.59	6,558	0.59			0.59	6,558	0.59			0.59	6,558	0.59			0.59	6,558	0.59			0.59	6,558	0.59			0.59
	SWI-09	5,032	0.45		0.45	5,032	0.45			0.45	5,032	0.45			0.45	5,032	0.45			0.45	5,032	0.45			0.45	5,032	0.45			0.45
	SWI-10	4,209	0.38		0.38	4,536	0.41			0.41	4,790	0.43			0.43	4,889	0.44			0.44	4,889	0.44			0.44	4,889	0.44			0.44
	SWI-11	1,280	0.12		0.12	2,113	0.19			0.19	2,805	0.25			0.25	3,148	0.28			0.28	3,148	0.28			0.28	3,148	0.28			0.28
SWI Total		**45,749**	**4.12**	**2.02**	**6.14**	**47,763**	**4.30**	**1.37**	**0.66**	**6.33**	**49,726**	**4.48**	**1.37**	**0.68**	**6.53**	**51,135**	**4.60**	**1.37**	**0.69**	**6.66**	**51,735**	**4.66**	**1.37**	**0.69**	**6.72**	**52,336**	**4.71**	**1.37**	**0.70**	**6.79**
SS22																														
	SS22-01	18,833	1.70		1.70	18,833	1.70			1.70	18,833	1.70			1.70	18,833	1.70			1.70	18,833	1.70			1.70	18,833	1.70			1.70
	SS22-02	2,813	0.25		0.25	2,813	0.25		0.64	0.89	2,813	0.25		0.65	0.90	2,813	0.25		0.66	0.91	2,813	0.25		0.67	0.92	2,813	0.25		0.68	0.93
	SS22-03	10,032	0.90	0.01	0.91	10,043	0.90		0.01	0.92	10,056	0.91		0.01	0.92	10,068	0.91		0.01	0.92	10,068	0.91		0.01	0.92	10,068	0.91		0.01	0.92
	SS22-04	6,672	0.60		0.60	6,678	0.60			0.60	6,682	0.60			0.60	6,683	0.60			0.60	6,684	0.60			0.60	6,685	0.60			0.60
	SS22-05	10,939	0.98		0.98	10,964	0.99			0.99	10,979	0.99			0.99	10,979	0.99			0.99	10,979	0.99			0.99	10,979	0.99			0.99
SS22 Total		**49,290**	**4.44**	**0.01**	**4.45**	**49,332**	**4.44**	**0.00**	**0.65**	**5.09**	**49,364**	**4.44**	**0.00**	**0.66**	**5.11**	**49,376**	**4.44**	**0.00**	**0.67**	**5.12**	**49,378**	**4.44**	**0.00**	**0.68**	**5.12**	**49,379**	**4.44**	**0.00**	**0.69**	**5.13**
SS1																														
	SS1-01	1,827	0.16		0.16	1,827	0.16			0.16	1,827	0.16			0.16	1,827	0.16			0.16	1,827	0.16			0.16	1,827	0.16			0.16
	SS1-02	4,879	0.44		0.44	4,879	0.44			0.44	4,879	0.44			0.44	4,879	0.44			0.44	4,879	0.44			0.44	4,879	0.44			0.44
	SS1-03	4,748	0.43		0.43	4,650	0.42			0.42	4,536	0.41			0.41	4,430	0.40			0.40	4,473	0.40			0.40	4,516	0.41			0.41
	SS1-04	9,987	0.90	0.06	0.96	10,206	0.92		0.06	0.98	10,482	0.94		0.06	1.00	10,757	0.97		0.06	1.03	11,180	1.01		0.06	1.07	11,603	1.04		0.06	1.11
	SS1-05	22,058	1.99	0.91	2.90	22,672	2.04		0.93	2.97	23,394	2.11		0.95	3.06	24,073	2.17		0.97	3.13	25,109	2.26		0.98	3.24	26,145	2.35		0.99	3.34
	SS1-06	5,648	0.51	0.10	0.61	5,666	0.51		0.11	0.62	5,687	0.51		0.11	0.62	5,706	0.51		0.11	0.62	5,706	0.51		0.11	0.63	5,706	0.51		0.11	0.63
	SS1-07	15,378	1.38	0.21	1.59	15,536	1.40		0.21	1.61	15,728	1.42		0.21	1.63	15,914	1.43		0.22	1.65	16,094	1.45		0.22	1.67	16,273	1.46		0.22	1.69
SS1 Total		**64,525**	**5.81**	**1.28**	**7.09**	**65,437**	**5.89**	**0.00**	**1.30**	**7.19**	**66,534**	**5.99**	**0.00**	**1.33**	**7.32**	**67,587**	**6.08**	**0.00**	**1.35**	**7.44**	**69,268**	**6.23**	**0.00**	**1.37**	**7.60**	**70,950**	**6.39**	**0.00**	**1.39**	**7.77**
SS23																														
	SS23-01	21,107	1.90	0.47	2.37	21,108	1.90		0.48	2.38	21,110	1.90		0.49	2.39	21,112	1.90		0.50	2.40	21,112	1.90		0.50	2.40	21,112	1.90		0.51	2.41
	SS23-02	13,346	1.20		1.20	13,422	1.21			1.21	13,508	1.22			1.22	13,584	1.22			1.22	13,584	1.22			1.22	13,584	1.22			1.22
	SS23-03	3,114	0.28		0.28	3,356	0.30			0.30	3,511	0.32			0.32	3,519	0.32			0.32	4,031	0.36			0.36	4,543	0.41			0.41
	SS23-04	485	0.04		0.04	504	0.05			0.05	516	0.05			0.05	516	0.05			0.05	516	0.05			0.05	516	0.05			0.05
	SS23-05	1,942	0.17		0.17	1,994	0.18			0.18	2,026	0.18			0.18	2,026	0.18			0.18	2,026	0.18			0.18	2,026	0.18			0.18
	SS23-06	4,564	0.41		0.41	4,860	0.44			0.44	5,112	0.46			0.46	5,247	0.47			0.47	5,277	0.47			0.47	5,306	0.48			0.48
	SS23-07	9,587	0.86		0.86	9,920	0.89			0.89	10,128	0.91			0.91	10,128	0.91			0.91	10,128	0.91			0.91	10,128	0.91			0.91
	SS23-08	4,371	0.39	0.61	1.00	4,490	0.40		0.62	1.03	4,628	0.42		0.64	1.05	4,756	0.43		0.65	1.07	4,858	0.44		0.65	1.09	4,959	0.45		0.66	1.11
	SS23-09	510	0.05		0.05	616	0.06			0.06	740	0.07			0.07	854	0.08			0.08	913	0.08			0.08	971	0.09			0.09
SS23 Total		**59,025**	**5.31**	**1.08**	**6.39**	**60,270**	**5.42**	**0.00**	**1.10**	**6.52**	**61,280**	**5.52**	**0.00**	**1.13**	**6.64**	**61,744**	**5.56**	**0.00**	**1.14**	**6.70**	**62,445**	**5.62**	**0.00**	**1.16**	**6.78**	**63,147**	**5.68**	**0.00**	**1.17**	**6.85**
Dry Creek																														
	DRY CREEK	21,894	1.97		1.97	21,895	1.97			1.97	21,895	1.97			1.97	21,895	1.97			1.97	21,903	1.97			1.97	21,912	1.97			1.97
Dry Creek Total		**21,894**	**1.97**	**0.00**	**1.97**	**21,895**	**1.97**	**0.00**	**0.00**	**1.97**	**21,895**	**1.97**	**0.00**	**0.00**	**1.97**	**21,895**	**1.97**	**0.00**	**0.00**	**1.97**	**21,903**	**1.97**	**0.00**	**0.00**	**1.97**	**21,912**	**1.97**	**0.00**	**0.00**	**1.97**
WIS																														
	WIS-01	20,848	1.88	0.77	2.65	20,854	1.88	0.54	0.24	2.65	20,861	1.88	0.54	0.25	2.66	20,868	1.88	0.54	0.25	2.66	20,885	1.88	0.54	0.25	3	20,902	1.88	0.54	0.25	2.67
	WIS-02	11,728	1.06		1.06	11,941	1.07			1.07	12,087	1.09			1.09	12,114	1.09			1.09	12,118	1.09			1.09	12,123	1.09			1.09
	WIS-03	2,197	0.20	0.39	0.59	2,382	0.21	0.39		0.61	2,498	0.22	0.39		0.62	2,501	0.23	0.39		0.62	2,501	0	0.39		1	2,501	0	0.39		0.62
	WIS-04	1,182	0.11		0.11	1,182	0.11			0.11	1,182	0.11			0.11	1,182	0.11			0.11	1,182	0.11			0.11	1,182	0.11			0.11

		2002				2010					2020					2030					2040					2050				
Basin	**Sub-Basin**	**Population**	**R & C**	**IND/Whl**	**Basin Tot**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Popoulation**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**
	WIS-05	13,160	1.18	0.00	1.18	13,234	1.19		0.00	1.19	13,355	1.20		0.00	1.20	13,507	1.22		0.00	1.22	13,507	1.22		0.00	1.22	13,507	1.22		0.00	1.22
	WIS-06	1,667	0.15	1.73	1.88	1,707	0.15	1.73		1.89	1,775	0.16	1.73		1.89	1,863	0.17	1.73		1.90	1,864	0.17	1.73		2	1,865	0.17	1.73		1.90
	WIS-07	1,106	0.10		0.10	1,785	0.16			0.16	2,298	0.21			0.21	2,477	0.22			0.22	2,506	0.23			0.23	2,536	0.23			0.23
WIS Total		**51,888**	**4.67**	**2.89**	**7.56**	**53,083**	**4.78**	**2.66**	**0.24**	**7.68**	**54,057**	**4.87**	**2.66**	**0.25**	**7.77**	**54,510**	**4.91**	**2.66**	**0.25**	**7.81**	**54,562**	**4.91**	**2.66**	**0.25**	**8**	**54,615**	**4.92**	**2.66**	**0.25**	**7.83**
Kechi																														
	KECHI	2,000	0.18		0.18	2,427	0.22			0.22	3,111	0.28			0.28	3,947	0.36			0.36	4,583	0.41			0.41	5,220	0.47			0.47
Kechi Total		**2,000**	**0.18**	**0.00**	**0.18**	**2,427**	**0.22**	**0.00**	**0.00**	**0.22**	**3,111**	**0.28**	**0.00**	**0.00**	**0.28**	**3,947**	**0.36**	**0.00**	**0.00**	**0.36**	**4,583**	**0.41**	**0.00**	**0.00**	**0.41**	**5,220**	**0.47**	**0.00**	**0.00**	**0.47**
NWI																														
	NWI-03	670	0.06		0.06	0	0.00			0.00		0.00			0.00		0.00			0.00		0.00			0.00		0.00			0.00
	NWI-04	1,236	0.11		0.11	0	0.00			0.00		0.00			0.00		0.00			0.00		0.00			0.00		0.00			0.00
NWI Total		**1,906**	**0.17**	**0.00**	**0.17**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Existing Service Area of City of Wichita Treatment Plants 1 and 2 Total		**338,785**	**30.49**	**8.11**	**38.60**	**345,076**	**31.06**	**4.61**	**4.20**	**39.87**	**353,011**	**31.77**	**4.61**	**4.30**	**40.68**	**358,636**	**32.28**	**4.61**	**4.37**	**41.25**	**362,716**	**32.64**	**4.61**	**4.42**	**41.67**	**366,795**	**33.01**	**4.61**	**4.47**	**42.09**
Existing Service Area of City of Wichita's Four Mile Creek																														
4MC																														
	4MC-01	230	0.03		0.03	269	0.03			0.03	315	0.04			0.04	358	0.04			0.04	358	0.04			0.04	358	0.04			0.04
	4MC-02	896	0.12		0.12	1,035	0.13			0.13	1,197	0.15			0.15	1,348	0.16			0.16	1,476	0.17			0.17	1,604	0.18			0.18
	4MC-BH	767	0.10		0.10	835	0.11			0.11	965	0.12			0.12	1,142	0.14			0.14	1,169	0.13			0.13	1,197	0.13			0.13
	4MC-CV	3,968	0.52		0.52	4,560	0.59			0.59	5,553	0.69			0.69	6,799	0.82			0.82	6,984	0.80			0.80	7,170	0.79			0.79
	4MC-MH	2,591	0.34		0.34	3,093	0.40			0.40	3,457	0.43			0.43	3,559	0.43			0.43	3,616	0.42			0.42	3,673	0.40			0.40
	4MC-SC	5,313	0.69		0.69	6,756	0.88			0.88	8,056	1.01			1.01	8,854	1.06			1.06	9,221	1.06			1.06	9,588	1.05			1.05
4MC Total		**13,764**	**1.79**	**0.00**	**1.79**	**16,547**	**2.15**	**0.00**	**0.00**	**2.15**	**19,544**	**2.44**	**0.00**	**0.00**	**2.44**	**22,059**	**2.65**	**0.00**	**0.00**	**2.65**	**22,825**	**2.62**	**0.00**	**0.00**	**2.62**	**23,591**	**2.60**	**0.00**	**0.00**	**2.60**
Existing Service Area of City of Wichita's Four Mile Creek Total		**13,764**	**1.79**	**0.00**	**1.79**	**16,547**	**2.15**	**0.00**	**0.00**	**2.15**	**19,544**	**2.44**	**0.00**	**0.00**	**2.44**	**22,059**	**2.65**	**0.00**	**0.00**	**2.65**	**22,825**	**2.62**	**0.00**	**0.00**	**2.62**	**23,591**	**2.60**	**0.00**	**0.00**	**2.60**
Existing Service Area of City of Wichita CCWQRF																														
NWI																														
	NWI-01	4,540	0.41		0.41	4,816	0.43			0.43	5,000	0.45			0.45	5,023	0.45			0.45	5,154	0.46			0.46	5,285	0.48			0.48
	NWI-02	953	0.09		0.09	1,059	0.10			0.10	1,126	0.10			0.10	1,126	0.10			0.10	1,154	0.10			0.10	1,182	0.11			0.11
	NWI-03	0	0.00		0.00	805	0.07			0.07	890	0.08			0.08	890	0.08			0.08	890	0.08			0.08	890	0.08			0.08
	NWI-04	0	0.00		0.00	1,718	0.15			0.15	2,121	0.19			0.19	2,323	0.21			0.21	2,377	0.21			0.21	2,431	0.22			0.22
NWI Total		**5,492**	**0.49**	**0.00**	**0.49**	**8,398**	**0.76**	**0.00**	**0.00**	**0.76**	**9,136**	**0.82**	**0.00**	**0.00**	**0.82**	**9,362**	**0.84**	**0.00**	**0.00**	**0.84**	**9,575**	**0.86**	**0.00**	**0.00**	**0.86**	**9,788**	**0.88**	**0.00**	**0.00**	**0.88**
Existing Service Area of City of Wichita CCWQRF Total		**5,492**	**0.49**	**0.00**	**0.49**	**8,398**	**0.76**	**0.00**	**0.00**	**0.76**	**9,136**	**0.82**	**0.00**	**0.00**	**0.82**	**9,362**	**0.84**	**0.00**	**0.00**	**0.84**	**9,575**	**0.86**	**0.00**	**0.00**	**0.86**	**9,788**	**0.88**	**0.00**	**0.00**	**0.88**
Potential Service Area of City of Wichita																														
Walnut																														
	WALNUT-1	57	0.01		0.01	489	0.04			0.04	994	0.09			0.09	1,463	0.13			0.13	1,747	0.16			0.16	2,031	0.18			0.18
	WALNUT-2	520	0.05		0.05	774	0.07			0.07	1,474	0.13			0.13	2,555	0.23			0.23	5,668	0.51			0.51	8,780	0.79			0.79
	WALNUT-3A	23	0.00		0.00	438	0.04			0.04	963	0.09			0.09	1,494	0.13			0.13	1,647	0.15			0.15	1,800	0.16			0.16
	WALNUT-3B	465	0.04		0.04	551	0.05			0.05	959	0.09			0.09	1,665	0.15			0.15	1,944	0.17			0.17	2,223	0.20			0.20
	WALNUT-4	1,051	0.09		0.09	1,310	0.12			0.12	1,753	0.16			0.16	2,316	0.21			0.21	3,759	0.34			0.34	5,202	0.47			0.47
Walnut Total		**2,115.40**	**0.19**	**0.00**	**0.19**	**3,562**	**0.32**	**0.00**	**0.00**	**0.32**	**6,142**	**0.55**	**0.00**	**0.00**	**0.55**	**9,495**	**0.85**	**0.00**	**0.00**	**0.85**	**14,765**	**1.33**	**0.00**	**0.00**	**1.33**	**20,036**	**1.80**	**0.00**	**0.00**	**1.80**
F-SE																														
	F-SE-01	1,350	0.12		0.12	1,379	0.12			0.12	1,426	0.13			0.13	1,481	0.13			0.13	1,893	0.17			0.17	2,304	0.21			0.21
	F-SE-02	1,318	0.12		0.12	1,452	0.13			0.13	1,815	0.16			0.16	2,371	0.21			0.21	3,549	0.32			0.32	4,727	0.43			0.43
F-SE Total		**2,667**	**0.24**	**0.00**	**0.24**	**2,832**	**0.25**	**0.00**	**0.00**	**0.25**	**3,240**	**0.29**	**0.00**	**0.00**	**0.29**	**3,852**	**0.35**	**0.00**	**0.00**	**0.35**	**5,441**	**0.49**	**0.00**	**0.00**	**0.49**	**7,030**	**0.63**	**0.00**	**0.00**	**0.63**
F-N																														
	F-N-01	869	0.08		0.08	1,050	0.09			0.09	1,230	0.11			0.11	1,364	0.12			0.12	1,558	0.14			0.14	1,753	0.16			0.16
	F-N-02	3,918	0.35		0.35	4,061	0.37			0.37	4,230	0.38			0.38	4,390	0.40			0.40	4,535	0.41			0.41	4,679	0.42			0.42
	F-N-03A	94	0.01		0.01	191	0.02			0.02	304	0.03			0.03	410	0.04			0.04	513	0.05			0.05	617	0.06			0.06
	F-N-03B	5	0.00		0.00	207	0.02			0.02	442	0.04			0.04	661	0.06			0.06	661	0.06			0.06	661	0.06			0.06
	F-N-04	239	0.02		0.02	239	0.02			0.02	240	0.02			0.02	240	0.02			0.02	240	0.02			0.02	240	0.02			0.02
F-N Total		**5,125**	**0.46**	**0.00**	**0.46**	**5,748**	**0.52**	**0.00**	**0.00**	**0.52**	**6,447**	**0.58**	**0.00**	**0.00**	**0.58**	**7,065**	**0.64**	**0.00**	**0.00**	**0.64**	**7,507**	**0.68**	**0.00**	**0.00**	**0.68**	**7,950**	**0.72**	**0.00**	**0.00**	**0.72**
F-W																														

		2002				2010					2020					2030					2040					2050				
Basin	**Sub-Basin**	**Population**	**R & C**	**IND/Whl**	**Basin Tot**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Popoulation**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**	**Population**	**R & C**	**Top 4 IND**	**IND**	**TOT**
	F-W-01	421	0.04		0.04	789	0.07			0.07	1,106	0.10			0.10	1,282	0.12			0.12	1,348	0.12			0.12	1,414	0.13			0.13
	F-W-02	583	0.05		0.05	1,134	0.10			0.10	1,576	0.14			0.14	1,770	0.16			0.16	2,407	0.22			0.22	3,045	0.27			0.27
F-W Total		**1,004**	**0.09**	**0.00**	**0.09**	**1,923**	**0.17**	**0.00**	**0.00**	**0.17**	**2,682**	**0.24**	**0.00**	**0.00**	**0.24**	**3,052**	**0.27**	**0.00**	**0.00**	**0.27**	**3,755**	**0.34**	**0.00**	**0.00**	**0.34**	**4,458**	**0.40**	**0.00**	**0.00**	**0.40**
F-NW																														
	F-NW-01	528	0.05		0.05	1,529	0.14			0.14	3,404	0.31			0.31	5,905	0.53			0.53	9,769	0.88			0.88	13,633	1.23			1.23
	F-NW-02	201	0.02		0.02	556	0.05			0.05	777	0.07			0.07	777	0.07			0.07	820	0.07			0.07	862	0.08			0.08
	F-NW-03	275	0.02		0.02	697	0.06			0.06	1,578	0.14			0.14	2,813	0.25			0.25	3,577	0.32			0.32	4,341	0.39			0.39
	F-NW-04A	434	0.04		0.04	852	0.08			0.08	1,975	0.18			0.18	3,698	0.33			0.33	3,827	0.34			0.34	3,956	0.36			0.36
	F-NW-04B	30	0.00		0.00	74	0.01			0.01	160	0.01			0.01	279	0.03			0.03	327	0.03			0.03	376	0.03			0.03
	F-NW-05A	73	0.01		0.01	254	0.02			0.02	379	0.03			0.03	403	0.04			0.04	518	0.05			0.05	634	0.06			0.06
	F-NW-05B	51	0.00		0.00	156	0.01			0.01	226	0.02			0.02	234	0.02			0.02	300	0.03			0.03	365	0.03			0.03
F-NW Total		**1,591**	**0.14**	**0.00**	**0.14**	**4,117**	**0.37**	**0.00**	**0.00**	**0.37**	**8,500**	**0.76**	**0.00**	**0.00**	**0.76**	**14,109**	**1.27**	**0.00**	**0.00**	**1.27**	**19,138**	**1.72**	**0.00**	**0.00**	**1.72**	**24,168**	**2.18**	**0.00**	**0.00**	**2.18**
F-SW																														
	F-SW-01	3,312	0.30		0.30	3,607	0.32			0.32	3,907	0.35			0.35	4,137	0.37			0.37	4,376	0.39			0.39	4,614	0.42			0.42
	F-SW-02	761	0.07		0.07	960	0.09			0.09	1,283	0.12			0.12	1,679	0.15			0.15	1,884	0.17			0.17	2,088	0.19			0.19
	F-SW-03	1,699	0.15		0.15	1,970	0.18			0.18	2,292	0.21			0.21	2,597	0.23			0.23	3,024	0.27			0.27	3,452	0.31			0.31
	F-SW-04	948	0.09		0.09	1,142	0.10			0.10	1,368	0.12			0.12	1,577	0.14			0.14	1,616	0.15			0.15	1,656	0.15			0.15
	F-SW-05	12	0.00		0.00	135	0.01			0.01	276	0.02			0.02	404	0.04			0.04	638	0.06			0.06	871	0.08			0.08
	F-SW-06	796	0.07		0.07	1,485	0.13			0.13	2,432	0.22			0.22	3,463	0.31			0.31	4,504	0.41			0.41	5,544	0.50			0.50
	F-SW-07	107	0.01		0.01	237	0.02			0.02	580	0.05			0.05	1,105	0.10			0.10	1,105	0.10			0.10	1,105	0.10			0.10
	F-SW-08	472	0.04		0.04	472	0.04			0.04	472	0.04			0.04	472	0.04			0.04	472	0.04			0.04	473	0.04			0.04
	F-SW-09	53	0.00		0.00	90	0.01			0.01	133	0.01			0.01	172	0.02			0.02	172	0.02			0.02	172	0.02			0.02
F-SW Total		**8,159**	**0.73**	**0.00**	**0.73**	**10,099**	**0.91**	**0.00**	**0.00**	**0.91**	**12,743**	**1.15**	**0.00**	**0.00**	**1.15**	**15,607**	**1.40**	**0.00**	**0.00**	**1.40**	**17,791**	**1.60**	**0.00**	**0.00**	**1.60**	**19,975**	**1.80**	**0.00**	**0.00**	**1.80**
					0.65					0.73					0.84					0.94					1.02					1.11
Potential Service Area of City of Wichita Total		**20,662**	**1.86**	**0.00**	**1.86**	**28,279**	**2.55**	**0.00**	**0.00**	**2.55**	**39,754**	**3.58**	**0.00**	**0.00**	**3.58**	**53,179**	**4.79**	**0.00**	**0.00**	**4.79**	**68,398**	**6.16**	**0.00**	**0.00**	**6.16**	**83,617**	**7.53**	**0.00**	**0.00**	**7.53**
Surrounding Communities																														
Bel Aire																														
	BEL AIRE-01	2,215	0.20		0.20	2,270	0.20			0.20	2,328	0.21			0.21	2,375	0.21			0.21	2,375	0.21			0.21	2,375	0.21			0.21
	BEL AIRE-02	2,174	0.20		0.20	2,394	0.22			0.22	2,608	0.23			0.23	2,759	0.25			0.25	2,759	0.25			0.25	2,759	0.25			0.25
	BEL AIRE-03	718	0.06		0.06	1,283	0.12			0.12	1,776	0.16			0.16	2,058	0.19			0.19	2,077	0.19			0.19	2,096	0.19			0.19
	BEL AIRE-04	274	0.02		0.02	325	0.03			0.03	429	0.04			0.04	571	0.05			0.05	859	0.08			0.08	1,146	0.10			0.10
	BEL AIRE-05	36	0.00		0.00	327	0.03			0.03	668	0.06			0.06	985	0.09			0.09	1,073	0.10			0.10	1,161	0.10			0.10
Bel Aire Total		**5,417**	**0.49**	**0.00**	**0.49**	**6,599**	**0.59**	**0.00**	**0.00**	**0.59**	**7,809**	**0.70**	**0.00**	**0.00**	**0.70**	**8,749**	**0.79**	**0.00**	**0.00**	**0.79**	**9,144**	**0.82**	**0.00**	**0.00**	**0.82**	**9,538**	**0.86**	**0.00**	**0.00**	**0.86**
Colwich																														
	COLWICH	1,682	0.15		0.15	1,839	0.17			0.17	2,022	0.18			0.18	2,192	0.20			0.20	2,637	0.24			0.24	3,081	0.28			0.28
Colwich Total		**1,682**	**0.15**	**0.00**	**0.15**	**1,839**	**0.17**	**0.00**	**0.00**	**0.17**	**2,022**	**0.18**	**0.00**	**0.00**	**0.18**	**2,192**	**0.20**	**0.00**	**0.00**	**0.20**	**2,637**	**0.24**	**0.00**	**0.00**	**0.24**	**3,081**	**0.28**	**0.00**	**0.00**	**0.28**
Derby																														
	DERBY	23,845	2.15		2.15	27,972	2.52			2.52	32,788	2.95			2.95	37,259	3.35			3.35	41,053	3.69			3.69	44,847	4.04			4.04
Derby Total		**23,845**	**2.15**	**0.00**	**2.15**	**27,972**	**2.52**	**0.00**	**0.00**	**2.52**	**32,788**	**2.95**	**0.00**	**0.00**	**2.95**	**37,259**	**3.35**	**0.00**	**0.00**	**3.35**	**41,053**	**3.69**	**0.00**	**0.00**	**3.69**	**44,847**	**4.04**	**0.00**	**0.00**	**4.04**
Goddard																														
	GODDARD	7,030	0.63		0.63	7,871	0.71			0.71	8,964	0.81			0.81	10,099	0.91			0.91	11,452	1.03			1.03	12,805	1.15			1.15
Goddard Total		**7,030**	**0.63**	**0.00**	**0.63**	**7,871**	**0.71**	**0.00**	**0.00**	**0.71**	**8,964**	**0.81**	**0.00**	**0.00**	**0.81**	**10,099**	**0.91**	**0.00**	**0.00**	**0.91**	**11,452**	**1.03**	**0.00**	**0.00**	**1.03**	**12,805**	**1.15**	**0.00**	**0.00**	**1.15**
Haysville																														
	HAYSVILLE	13,823	1.24		1.24	15,988	1.44			1.44	18,450	1.66			1.66	20,666	1.86			1.86	22,863	2.06			2.06	25,059	2.26			2.26
Haysville Total		**13,823**	**1.24**	**0.00**	**1.24**	**15,988**	**1.44**	**0.00**	**0.00**	**1.44**	**18,450**	**1.66**	**0.00**	**0.00**	**1.66**	**20,666**	**1.86**	**0.00**	**0.00**	**1.86**	**22,863**	**2.06**	**0.00**	**0.00**	**2.06**	**25,059**	**2.26**	**0.00**	**0.00**	**2.26**
Maize																														
	MAIZE	3,181	0.29		0.29	3,812	0.34			0.34	4,504	0.41			0.41	5,098	0.46			0.46	5,690	0.51			0.51	6,282	0.57			0.57
Maize Total		**3,181**	**0.29**	**0.00**	**0.29**	**3,812**	**0.34**	**0.00**	**0.00**	**0.34**	**4,504**	**0.41**	**0.00**	**0.00**	**0.41**	**5,098**	**0.46**	**0.00**	**0.00**	**0.46**	**5,690**	**0.51**	**0.00**	**0.00**	**0.51**	**6,282**	**0.57**	**0.00**	**0.00**	**0.57**
Park City																														
	PARK CITY	7,808	0.70		0.70	9,489	0.85			0.85	11,521	1.04			1.04	13,482	1.21			1.21	15,530	1.40			1.40	17,578	1.58			1.58
Park City Total		**7,808**	**0.70**	**0.00**	**0.70**	**9,489**	**0.85**	**0.00**	**0.00**	**0.85**	**11,521**	**1.04**	**0.00**	**0.00**	**1.04**	**13,482**	**1.21**	**0.00**	**0.00**	**1.21**	**15,530**	**1.40**	**0.00**	**0.00**	**1.40**	**17,578**	**1.58**	**0.00**	**0.00**	**1.58**
Valley Center																														
	VALLEY CENTER	9,022	0.81		0.81	10,445	0.94			0.94	12,035	1.08			1.08	13,435	1.21			1.21	15,013	1.35			1.35	16,591	1.49			1.49
Valley Center Total		**9,022**	**0.81**	**0.00**	**0.81**	**10,445**	**0.94**	**0.00**	**0.00**	**0.94**	**12,035**	**1.08**	**0.00**	**0.00**	**1.08**	**13,435**	**1.21**	**0.00**	**0.00**	**1.21**	**15,013**	**1.35**	**0.00**	**0.00**	**1.35**	**16,591**	**1.49**	**0.00**	**0.00**	**1.49**
Surrounding Communities Total		**71,807**	**6.46**	**0.00**	**6.46**	**84,016**	**7.56**	**0.00**	**0.00**	**7.56**	**98,092**	**8.83**	**0.00**	**0.00**	**8.83**	**110,981**	**9.99**	**0.00**	**0.00**	**9.99**	**123,381**	**11.10**	**0.00**	**0.00**	**11.10**	**135,781**	**12.22**	**0.00**	**0.00**	**12.22**

APPENDIX E

Treatment Facility Historical Biological and Nutrient Loading Information

	4 Mile NH_3 Data for 2004 and 2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2004								17.70	20.20	22.90	25.50		25.50
Daily Maximum 2005	24.70	19.70	20.60	22.10		21.80	23.60	22.50	19.20	26.80	26.60		26.80
Daily Minimum 2004								15.50	18.40	20.20	20.40		15.50
Daily Minimum 2005	19.40	14.60	10.20	16.60		12.90	18.40	8.58	15.10	20.30	24.40		8.58
Average 2004								16.47	19.28	21.40	23.20		20.33
Average 2005	22.18	16.98	17.43	19.45		17.40	20.53	17.77	17.08	23.08	25.47		19.59
Standard Dev. 2004								1.12	0.86	1.12	2.11		2.79
Standard Dev. 2005	2.57	2.25	4.85	2.41		3.64	2.24	6.26	2.13	2.71	1.10		4.04

	4 Mile BOD (mg/L) Data for 2004-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2004								113	198	234	248		248
Daily Maximum 2005	336	199	212	332		225	255	170	290	266	339		339
Daily Minimum 2004								97	150	177	121		97
Daily Minimum 2005	232	117	61	186		119	228	115	266	222	169		61
Average 2004								104	177	204	177		170
Average 2005	285	158	147	235		185	237	146	279	244	236		215
Standard Dev 2004								8	22	29	61		49
Standard Dev 2005	43	35	65	67		46	12	28	12	25	73		64

	4 Mile BOD (ppd) Data for 2004-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2004								1874	3329	3989	4430		4430
Daily Maximum 2005	6737	3311	3220	5654.05		4787	4341	2941	5444	4325	4860		6737
Daily Minimum 2004								1490	2326	2851	1945		1490
Daily Minimum 2005	4077	2156	1281	3454.61		2531	3750	2093	4499	3434	2476		1281
Average 2004								1659	2812	3421	2829		2748
Average 2005	5124	2850	2382	4221.74		3965	4090	2487	4936	3825	3450		3734
Standard Dev 2004								196	474	591	1170		899
Standard Dev 2005	1138	537	865	1009.70		994	250	427	477	420	1018		1125

	4 Mile TSS (mg/L) Data for 2004-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2004								101	217	274	248		274
Daily Maximum 2005	286	192	238	295		226	261	318	387	254	275		387
Daily Minimum 2004								32	190	210	124		32
Daily Minimum 2005	250	67	14	139		88	196	71	206	178	56		14
Average 2004								66	203	240	192		183
Average 2005	274	139	117	206		175	228	143	324	213	182		200
Standard Dev 2004								34	11	26	52		70
Standard Dev 2005	17	54	109	66		60	27	118	82	34	101		90

	4 Mile TSS (ppd) Data for 2004-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2004								1691	3687	4033	4281		4281
Daily Maximum 2005	5494	3195	3615	5023.93		4808	4443	8089	7265	3834	3943		8089
Daily Minimum 2004								547	2906	3485	1792		547
Daily Minimum 2005	4393	1233	303	2581.67		1871	3510	1122	3637	2729	819		303
Average 2004								1068	3225	3812	3078		2911
Average 2005	4898	2511	1859	3699.15		3749	3938	3118	5736	3325	2692		3552
Standard Dev 2004								579	329	236	1031		1143
Standard Dev 2005	520	912	1661	1051.41		1300	483	3331	1533	511	1521		1722

	CCWQRF BOD (mg/L) Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003			144	517	332	590	263	286	301	338	310	317	590
Daily Maximum 2004	350	293	281	313	451	278	198	201	268	292	246	310	451
Daily Maximum 2005	291	344	305	383		307	332	382	282	296	327		383
Daily Minimum 2003			144	224	200	298	117	176	236	224	232	208	117
Daily Minimum 2004	292	256	281	303	246	238	198	201	268	226	211	234	198
Daily Minimum 2005	264	230	253	241		201	284	239	225	217	253		201
Average 2003			144	347	262	375	198	222	268	270	260	243	266
Average 2004	316	270	0	308	349	258	198	201	268	259	226	267	272
Average 2005	280	279	279	307		268	304	299	261	258	292		282
Standard Dev 2003				131	57	144	68	51	24	53	37	51	87
Standard Dev 2004	30	16		7	145	28				47	18	39	
Standard Dev 2005	12	49	22	71		40	24	61	31	33	37		39

	CCWQRF BOD (ppd) Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003					860	1,041	932	1,066	994	1,192	905	925	1,192
Daily Maximum 2004	1,798	1,542	1,427	1,436	1,749	1,088	789	808	1,464	1,098	1,124	1,228	1,798
Daily Maximum 2005	1,716	1,266	383	1,757		2,884	1,495	1,889	1,502	1,483	1,504		2,884
Daily Minimum 2003					860	790		465	733	440	677	607	440
Daily Minimum 2004	1,287	927	1,427	1,185	1,194	1,085	789	808	1,464	839	903	942	789
Daily Minimum 2005	993	929	241	1,103		215	1,132	1,074	873	816	874		215
Average 2003					860	941	474	697	827	870	760	709	744
Average 2004	1,467	1,220	1,427	1,310	1,472	1,086	789	808	1,464	969	996	1,123	1,192
Average 2005	280	279	279	307		268	304	299	261	258	292		1,237
Standard Dev 2003						133	350	279	99	315	107	148	413
Standard Dev 2004	287	301		177		2				184	115	158	277
Standard Dev 2005	12	49	22	71		40	24	61	31	33	37		430

CCWQRF NH_3 Data for 2003 and 2005

	Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Daily Maximum 2003			13.30			37.00	39.40	41.60	32.60	32.70	31.60		41.60
Daily Maximum 2005	29.90	31.60	28.20			26.90	29.50	29.70	33.30	30.70	32.60		33.30
Daily Minimum 2003			13.30			27.70	21.80	35.90	29.90	29.20	26.80		13.30
Daily Minimum 2005	26.20	27.80	21.60			21.40	22.20	25.40	22.40	20.90	27.30		20.90
Average 2003			13.30			31.95	30.68	37.63	31.02	30.83	29.00		30.06
Average 2005	27.97	29.25	25.03			24.68	24.55	26.80	26.56	23.93	30.00		26.34
Standard Dev. 2003						4.17	6.81	2.67	1.13	1.76	2.22		1.27
Standard Dev. 2005	1.86	1.71	2.91			2.42	3.34	1.99	4.04	4.55	2.65		0.43

	CCWQRF PO_4 Data for 2003 and 2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003					7.84	12.20	10.10	8.48	7.36	6.91	7.60	7.60	12.20
Daily Maximum 2005	6.70	7.44											7.44
Daily Minimum 2003					6.64	7.40	5.86	6.00	6.38	6.66	7.48	7.06	5.86
Daily Minimum 2005	6.69	7.44											6.69
Average 2003					7.24	8.81	7.74	6.89	6.97	6.77	7.54	7.33	7.45
Average 2005	6.70	7.44											6.94
Standard Dev. 2003					0.85	2.27	1.68	1.38	0.36	0.13	0.08	0.23	1.27
Standard Dev. 2005	0.01	0.00											0.43

	CCWQRF TSS (mg/L) Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003			98	381	500	436	360	370	275	338	250	317	500
Daily Maximum 2005	322	412	352	408		274	336	324	288	411	329		412
Daily Minimum 2003			98	57	41	41	32	42	201	66	160	208	32
Daily Minimum 2005	277	270	238	252		204	214	244	234	84	136		84
Average 2003			98	177	169	162	162	199	244	207	199	243	188
Average 2005	300	308	314	309		232	255	269	261	259	213		271
Standard Dev 2003				146	221	184	132	174	29	112	46	51	126
Standard Dev 2005	22	69	52	86		26	55	37	22	136	102		67

	CCWQRF TSS (ppd) Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003					500	436	360	370	275	338	250	317	500
Daily Maximum 2005	322	412	352	408		274	336	324	288	411	329		412
Daily Minimum 2003					41	41	32	42	201	66	160	208	32
Daily Minimum 2005	277	270	238	252		204	214	244	234	84	136		84
Average 2003					169	162	162	199	244	207	199	243	606
Average 2005	300	308	314	309		232	255	269	261	259	213		1177
Standard Dev 2003					221	184	132	174	29	112	46	51	323
Standard Dev 2005	22	69	52	86		26	55	37	22	136	102		434

	Plant 2 PO_4 Data for 2003-2005												
	Jan	**Feb.**	**March**	**April**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
Daily Maximum 2003	7.08	6.48	6.55	6.18	6.39	6.94	7.29	5.74	5.52	7.38	6.52	6.22	7.38
Daily Maximum 2004	6.28	6.05	7.74	6.28	6.42	5.84	4.54	5.64	5.89	5.52	5.96	5.54	7.74
Daily Maximum 2005	5.84	6.14	7.57	5.39	5.94	5.99	7.72	6.32	5.66	5.18	5.75	6.26	7.72
Daily Minimum 2003	7.08	6.48	6.55	6.18	6.39	6.94	7.29	5.74	5.52	7.38	6.52	6.22	5.52
Daily Minimum 2004	6.28	6.05	7.74	6.28	6.42	5.84	4.54	5.64	5.89	5.52	5.96	5.54	4.54
Daily Minimum 2005	5.84	6.14	7.57	5.39	5.94	5.99	7.72	6.32	5.66	5.18	5.75	6.26	5.18
Average 2003	7.08	6.48	6.55	6.18	6.39	6.94	7.29	5.74	5.52	7.38	6.52	6.22	6.52
Average 2004	6.28	6.05	7.74	6.28	6.42	5.84	4.54	5.64	5.89	5.52	5.96	5.54	5.98
Average 2005	5.84	6.14	7.57	5.39	5.94	5.99	7.72	6.32	5.66	5.18	5.75	6.26	6.15
Standard Dev. 2003													0.58
Standard Dev. 2004													0.74
Standard Dev. 2005													0.77

		Plant No. 1 and No. 2 BOD (mg/L) Data for 2003-2005												
		Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Daily Maximum 2003	**Plant 1**	464	418	576	368	899	500	418	338	340	276	284	304	899
Daily Maximum 2003	**Plant 2**	340	294	292	268	285	307	260	471	340	238	281	276	471
Daily Maximum 2004	**Plant 1**	506	348	604	383	899	738	309	350	365	324	387	352	899
Daily Maximum 2004	**Plant 2**	376	298	326	287	291	280	290	269	276	273	264	276	376
Daily Maximum 2005	**Plant 1**	410	349	360	385	411	377	439	396					439
Daily Maximum 2005	**Plant 2**	395	351	387	310	313	339	310	272					395
Daily Minimum 2003	**Plant 1**	250	243	123	166	49	176	186	119	138	117	162	204	49
Daily Minimum 2003	**Plant 2**	231	200	185	188	153	180	145	178	138	175	164	182	138
Daily Minimum 2004	**Plant 1**	175	242	245	175	49	226	184	222	222	223	203	230	49
Daily Minimum 2004	**Plant 2**	170	164	150	211	216	181	148	166	180	136	144	219	136
Daily Minimum 2005	**Plant 1**	296	222	232	254	197	204	233	254					197
Daily Minimum 2005	**Plant 2**	238	220	224	212	206	214	228	204					204
Average 2003	**Plant 1**	342	318	285	262	244	262	251	254	203	196	217	234	256
Average 2003	**Plant 2**	268	250	247	240	233	230	206	235	203	205	235	239	233
Average 2004	**Plant 1**	285	291	317	289	289	317	249	281	302	279	283	309	291
Average 2004	**Plant 2**	257	247	261	251	244	223	217	222	216	215	216	261	236
Average 2005	**Plant 1**	331	299	312	324	345	298	328	343					323
Average 2005	**Plant 2**	286	283	283	260	266	273	257	242					269
Standard Dev. 2003	**Plant 1**	66	58	108	70	188	85	62	61	51	43	35	29	91
Standard Dev. 2003	**Plant 2**	31	28	29	26	36	32	34	74	51	20	35	26	41
Standard Dev. 2004	**Plant 1**	86	30	90	57	183	136	35	35	40	33	59	32	83
Standard Dev. 2004	**Plant 2**	51	35	48	21	23	28	39	31	32	46	36	27	40
Standard Dev. 2005	**Plant 1**	35	42	43	38	50	58	59	37					48
Standard Dev. 2005	**Plant 2**	45	31	46	26	33	38	21	22					48

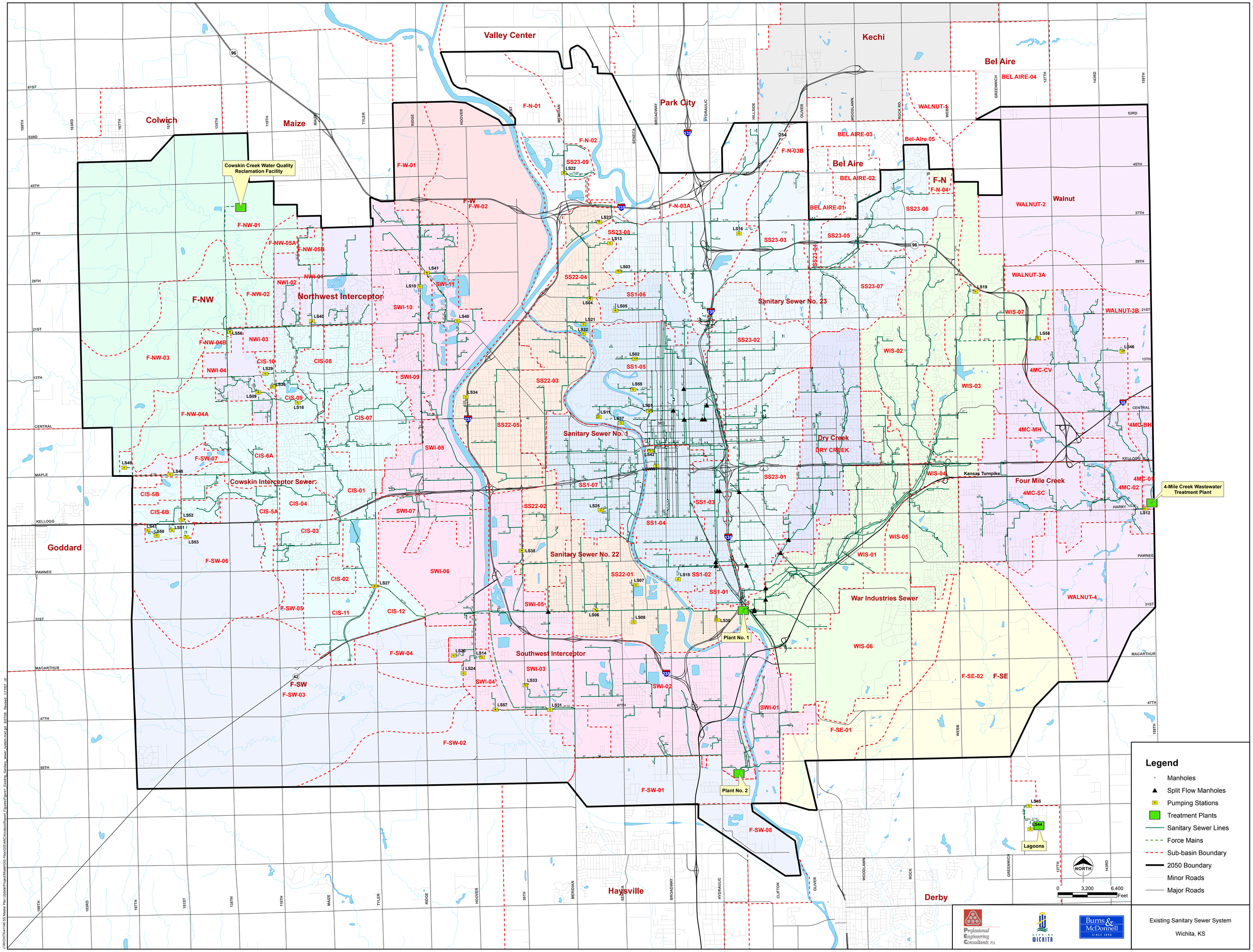
		Plant No. 1 and No. 2 BOD (PPD) Data for 2003-2005												
		Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Daily Maximum 2003	**Plant 1**	92,681	87,048	116,733	99,071	59,907	116,593	87,781	82,740	71,599	58,835	57,817	59,911	116,733
Daily Maximum 2003	**Plant 2**	92,681	87,048	116,733	99,071	59,907	116,593	87,781	82,740	71,599	58,835	57,817	59,911	116,733
Daily Maximum 2004	**Plant 1**	99,635	72,819	127,697	77,045	68,398	144,887	96,743	74,532	76,742	63,393	87,874	68,607	144,887
Daily Maximum 2004	**Plant 2**	99,635	72,819	127,697	77,045	68,398	144,887	96,743	74,532	76,742	63,393	87,874	68,607	144,887
Daily Maximum 2005	**Plant 1**	80,154	79,385	73,537	78,988	80,774	92,235	115,989	112,771					115,989
Daily Maximum 2005	**Plant 2**	32,548	28,542	31,275	24,794	24,825	28,605	25,311	27,382					32,548
Daily Minimum 2003	**Plant 1**	48,048	44,856	34,242	39,181	35,120	37,122	36,299	32,364	28,444	28,419	31,426	39,835	28,419
Daily Minimum 2003	**Plant 2**	18,167	16,280	15,506	14,111	11,599	14,612	11,476	14,675	11,037	13,500	13,404	14,526	11,037
Daily Minimum 2004	**Plant 1**	42,731	49,847	57,639	41,289	37,540	53,255	47,172	46,176	45,565	41,429	37,196	46,862	37,196
Daily Minimum 2004	**Plant 2**	14,773	12,912	16,843	16,630	17,229	14,914	13,800	14,772	15,222	11,422	11,805	17,333	11,422
Daily Minimum 2005	**Plant 1**	58,637	44,676	47,579	50,205	42,208	56,010	42,421	67,513					42,208
Daily Minimum 2005	**Plant 2**	19,909	18,403	17,673	17,504	15,940	18,080	13,805	18,163					13,805
Average 2003	**Plant 1**	66,520	62,907	61,082	57,295	45,521	58,262	52,033	54,753	44,476	42,241	42,997	45,729	52,839
Average 2003	**Plant 2**	21,899	20,429	21,016	19,023	17,645	17,912	16,288	19,796	16,422	16,029	17,872	18,771	18,674
Average 2004	**Plant 1**	58,714	60,759	70,260	60,466	59,237	72,138	62,391	59,448	60,561	55,720	57,818	60,532	61,572
Average 2004	**Plant 2**	20,553	20,132	21,185	19,448	19,517	19,231	19,915	19,073	18,038	17,645	18,076	21,081	19,486
Average 2005	**Plant 1**	69,510	64,104	65,084	65,697	69,291	70,690	64,798	79,177					68,550
Average 2005	**Plant 2**	24,137	23,180	22,861	21,034	20,849	23,057	21,077	22,460					22,323
Standard Dev. 2003	**Plant 1**	13,707	12,589	21,051	16,205	8,289	20,563	13,319	13,481	11,248	9,146	7,628	5,955	15,420
Standard Dev. 2003	**Plant 2**	13,707	2,235	4,837	1,950	2,473	2,702	2,600	6,806	4,023	1,748	2,547	2,079	3,771
Standard Dev. 2004	**Plant 1**	16,899	7,488	18,813	10,436	8,039	24,287	12,609	6,774	9,208	6,620	14,123	6,006	13,218
Standard Dev. 2004	**Plant 2**	16,899	2,856	3,133	1,536	1,741	2,555	4,398	2,554	2,756	3,747	3,788	2,165	3,154
Standard Dev. 2005	**Plant 1**	6,778	9,607	6,625	7,863	10,159	12,768	19,027	12,481					12,007
Standard Dev. 2005	**Plant 2**	6,778	2,603	3,737	1,868	2,701	3,493	2,709	2,561					3,061

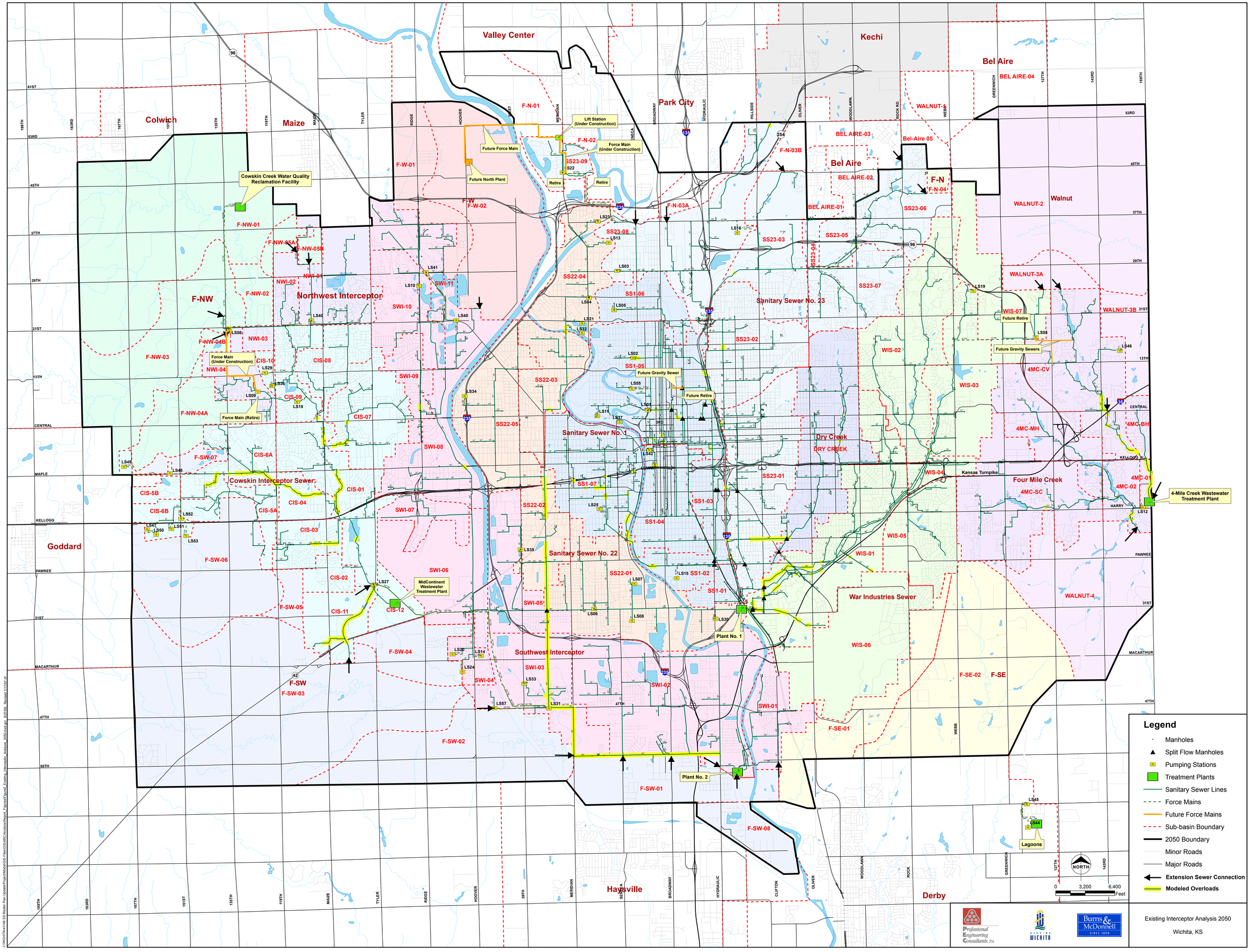
		Plant No. 1 and No. 2 TSS (mg/L) Data for 2003-2005												
		Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Daily Maximum 2003	**Plant 1**	634	500	492	537	326	621	498	450	530	264	173	136	634
Daily Maximum 2003	**Plant 2**	610	458	368	300	387	957	820	2,237	254	1,378	290	278	2,237
Daily Maximum 2004	**Plant 1**	594	294	406	417	569	1,125	360	506	370	477	427	466	1,125
Daily Maximum 2004	**Plant 2**	1,466	280	378	305	512	322	349	392	378	596	332	318	1,466
Daily Maximum 2005	**Plant 1**	469	232	290	318	538	380	478	375					538
Daily Maximum 2005	**Plant 2**	323	1,881	1,034	420	476	834	274	291					1,881
Daily Minimum 2003	**Plant 1**	120	62	85	55	75	64	48	57	63	46	39	41	39
Daily Minimum 2003	**Plant 2**	200	186	146	88	155	192	141	128	164	104	51	110	51
Daily Minimum 2004	**Plant 1**	43	86	179	204	128	234	180	147	189	224	222	186	43
Daily Minimum 2004	**Plant 2**	106	38	140	190	139	168	42	10	144	38	128	161	10
Daily Minimum 2005	**Plant 1**	210	126	160	146	222	129	56	178					56
Daily Minimum 2005	**Plant 2**	163	131	171	134	70	107	135	162					70
Average 2003	**Plant 1**	369	259	216	201	125	160	152	194	167	134	83	84	179
Average 2003	**Plant 2**	306	274	254	211	285	293	268	376	211	298	194	199	266
Average 2004	**Plant 1**	203	196	240	269	307	380	261	273	291	316	296	297	278
Average 2004	**Plant 2**	309	195	229	232	234	223	200	217	232	221	223	214	227
Average 2005	**Plant 1**	304	191	225	231	330	249	236	290					257
Average 2005	**Plant 2**	226	485	312	237	217	297	209	208					271
Standard Dev. 2003	**Plant 1**	160	118	125	146	68	144	122	129	156	68	39	27	137
Standard Dev. 2003	**Plant 2**	125	81	57	62	64	202	178	542	25	317	62	41	210
Standard Dev. 2004	**Plant 1**	174	59	59	54	123	243	55	95	55	66	55	67	112
Standard Dev. 2004	**Plant 2**	356	57	73	33	91	47	72	90	59	121	51	36	122
Standard Dev. 2005	**Plant 1**	65	33	40	45	89	73	117	63					81
Standard Dev. 2005	**Plant 2**	43	532	238	71	96	170	43	38					223

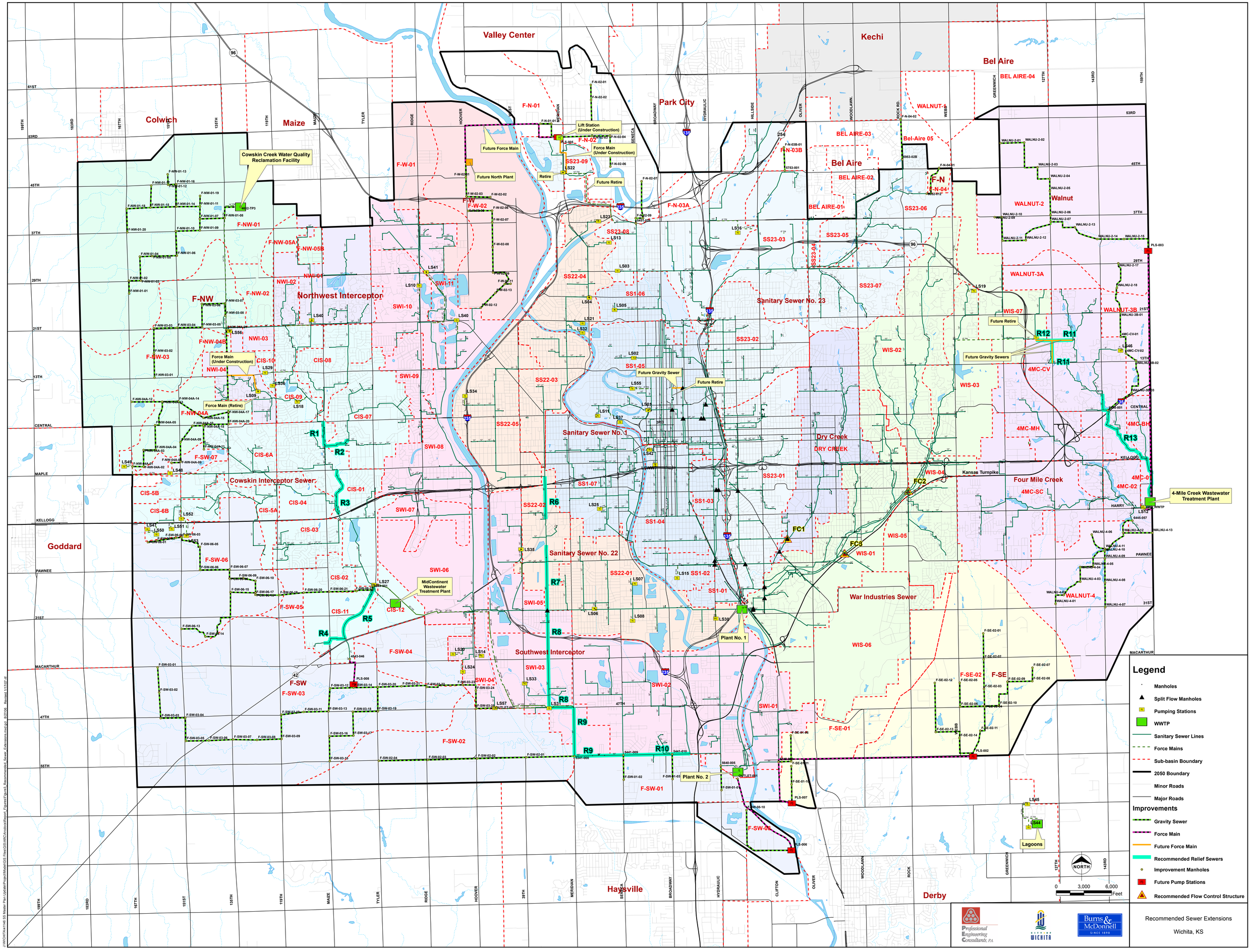
		Plant No. 1 and No. 2 TSS (PPD) Data for 2003-2005												
		Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Daily Maximum 2003	**Plant 1**	126,637	104,125	100,120	144,569	72,022	144,809	104,581	93,112	129,998	56,791	35,219	26,802	144,809
Daily Maximum 2003	**Plant 2**	126,637	104,125	100,120	144,569	72,022	144,809	104,581	93,112	129,998	56,791	35,219	26,802	144,809
Daily Maximum 2004	**Plant 1**	116,963	66,988	97,744	83,884	172,213	220,864	91,678	111,156	70,634	94,880	82,121	88,689	220,864
Daily Maximum 2004	**Plant 2**	116,963	66,988	97,744	83,884	172,213	220,864	91,678	111,156	70,634	94,880	82,121	88,689	220,864
Daily Maximum 2005	**Plant 1**	106,353	52,463	66,678	65,242	118,410	88,896	126,293	109,354					126,293
Daily Maximum 2005	**Plant 2**	25,861	152,954	83,562	34,818	37,872	70,112	126,293	109,354					152,954
Daily Minimum 2003	**Plant 1**	22,898	12,233	16,738	12,494	15,602	14,119	9,956	11,273	12,190	9,055	7,781	7,643	7,643
Daily Minimum 2003	**Plant 2**	16,914	15,233	12,091	6,620	11,673	14,716	9,956	11,273	12,190	9,055	7,781	7,643	6,620
Daily Minimum 2004	**Plant 1**	7,603	18,181	35,428	41,479	27,425	52,182	44,502	31,573	39,343	42,295	40,677	37,478	7,603
Daily Minimum 2004	**Plant 2**	9,212	3,007	10,917	15,341	11,117	13,843	44,502	31,573	39,343	42,295	40,677	37,478	3,007
Daily Minimum 2005	**Plant 1**	46,350	25,357	32,613	29,954	41,344	29,974	10,429	35,554					10,429
Daily Minimum 2005	**Plant 2**	13,159	10,958	13,577	10,997	5,361	9,040	10,429	35,554					5,361
Average 2003	**Plant 1**	71,791	51,944	47,284	44,980	27,232	36,255	31,557	41,647	37,243	29,695	16,498	16,477	37,821
Average 2003	**Plant 2**	24,934	22,378	21,844	16,759	21,573	22,800	31,557	41,647	37,243	29,695	16,498	16,477	21,454
Average 2004	**Plant 1**	40,671	40,946	54,209	56,477	74,054	85,727	64,653	57,997	57,729	62,268	60,421	58,092	59,523
Average 2004	**Plant 2**	24,825	15,921	18,673	17,898	18,769	19,303	64,653	57,997	57,729	62,268	60,421	58,092	18,833
Average 2005	**Plant 1**	64,315	40,909	47,511	46,856	67,038	59,943	47,350	69,016					55,429
Average 2005	**Plant 2**	19,071	39,374	25,770	19,235	17,144	25,176	47,350	69,016					22,625
Standard Dev. 2003	**Plant 1**	32,108	26,286	27,042	36,069	15,082	34,149	25,516	28,019	36,875	16,274	8,020	5,641	29,421
Standard Dev. 2003	**Plant 2**	32,108	6,606	7,951	4,900	4,821	15,477	13,485	48,461	1,820	29,550	4,818	3,204	18,610
Standard Dev. 2004	**Plant 1**	34,667	13,347	18,153	10,440	45,268	45,200	12,868	21,153	10,698	14,173	12,403	12,488	25,881
Standard Dev. 2004	**Plant 2**	34,667	4,589	6,052	2,240	7,926	4,279	6,303	7,602	5,234	14,173	5,735	2,948	10,004
Standard Dev. 2005	**Plant 1**	16,735	7,862	11,026	9,565	21,557	18,746	29,517	24,564					21,044
Standard Dev. 2005	**Plant 2**	16,735	42,962	20,068	5,972	7,869	14,523	3,625	4,655					18,289

APPENDIX F

Sanitary Sewer Maps


Valley Center
Kechi
Bel Aire
Park City
Colwich
Maize
Goddard
Haysville
Derby
Walnut
F-NW
F-W
F-N
F-SW
F-SE
Northwest Interceptor
Cowskin Interceptor Sewer
Southwest Interceptor
Sanitary Sewer No. 1
Sanitary Sewer No. 22
Sanitary Sewer No. 23
Dry Creek
DRY CREEK
Four Mile Creek
War Industries Sewer
Kansas Turnpike
Cowskin Creek Water Quality Reclamation Facility
4-Mile Creek Wastewater Treatment Plant
Plant No. 1
Plant No. 2
Lagoons
Legend
Manholes
Split Flow Manholes
Pumping Stations
Treatment Plants
Sanitary Sewer Lines
Force Mains
Sub-basin Boundary
2050 Boundary
Minor Roads
Major Roads
NORTH
0
3,200
6,400
Feet
Professional Engineering Consultants, P.A.
Burns & McDonnell
Existing Sanitary Sewer System
Wichita, KS


Valley Center
Kechi
Bel Aire
Colwich
Maize
Park City
Goddard
Haysville
Derby
Walnut
Northwest Interceptor
Cowskin Interceptor Sewer
Southwest Interceptor
Sanitary Sewer No. 1
Sanitary Sewer No. 22
Sanitary Sewer No. 23
Dry Creek
Four Mile Creek
War Industries Sewer
Cowskin Creek Water Quality Reclamation Facility
Lift Station (Under Construction)
Force Main (Under Construction)
Future Force Main
Future North Plant
Retire
Force Main (Retire)
Future Gravity Sewer
Future Retire
MidContinent Wastewater Treatment Plant
4-Mile Creek Wastewater Treatment Plant
Plant No. 1
Plant No. 2
Lagoons
Kansas Turnpike
F-N
F-NW
F-W
F-SW
F-SE
Legend
Manholes
Split Flow Manholes
Pumping Stations
Treatment Plants
Sanitary Sewer Lines
Force Mains
Future Force Mains
Sub-basin Boundary
2050 Boundary
Minor Roads
Major Roads
Extension Sewer Connection
Modeled Overloads
NORTH
0 3,200 6,400 Feet
Professional Engineering Consultants, P.A.
City of Wichita
Burns & McDonnell Since 1898
Existing Interceptor Analysis 2050
Wichita, KS


Valley Center
Kechi
Bel Aire
Park City
Colwich
Maize
Goddard
Haysville
Derby
Cowskin Creek Water Quality Reclamation Facility
Lift Station (Under Construction)
Force Main (Under Construction)
Future Force Main
Future North Plant
Retire
Future Retire
Force Main (Under Construction)
Force Main (Retire)
Future Gravity Sewer
Future Gravity Sewers
Northwest Interceptor
Cowskin Interceptor Sewer
Sanitary Sewer No. 23
Sanitary Sewer No. 1
Sanitary Sewer No. 22
Dry Creek
DRY CREEK
Four Mile Creek
Walnut
War Industries Sewer
Southwest Interceptor
MidContinent Wastewater Treatment Plant
Plant No. 1
Plant No. 2
4-Mile Creek Wastewater Treatment Plant
Lagoons
Kansas Turnpike
F-N
F-NW
F-W
F-SW
F-SE
CIS-
SWI-
NWI-
SS1-
SS22-
SS23-
WIS-
WALNUT-
4MC-
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
FC1
FC2
FC3
NORTH
0
3,000
6,000
Feet
Legend
Manholes
Split Flow Manholes
Pumping Stations
WWTP
Sanitary Sewer Lines
Force Mains
Sub-basin Boundary
2050 Boundary
Minor Roads
Major Roads
Improvements
Gravity Sewer
Force Main
Future Force Main
Recommended Relief Sewers
Improvement Manholes
Future Pump Stations
Recommended Flow Control Structure
Professional Engineering Consultants, P.A.
Burns & McDonnell
SINCE 1898
Recommended Sewer Extensions
Wichita, KS

APPENDIX G

Sanitary Sewer Model Conversion

APPENDIX G

Existing Dynamic Model Conversion to H20MAP Sewer

INTRODUCTION

The model consists of two programs and the associated data files: CAPE (created by Brown & Caldwell), and SewerCAT (created by Reid Crowther Consulting, Inc. and now owned by EarthTech). The model approach was to analyze the meter data, both rain gauge and flow meter, with CAPE and use the analysis results in the SewerCat model.

Information sources provided to PEC/Burns & McDonnell included:

- Report titled City of Wichita Sanitary Sewer Collection System Modeling Project – Project Report and Summary of Results, March 2003.
- 2000 Master Plan Update.
- CAPE model training guide.
- SewerCAT model user's manual.
- Installation CD's as delivered to the City in 2003 for the CAPE program and data, and the SewerCAT program and data. This is the same information presently installed on the City network.
- CD delivered to the City in 2003 labeled "SewerCAT export for updating GIS", which contained GIS files for sewer pipes and manholes that were later confirmed to match the data in the SewerCAT CD.
- Copy of City's sewer Geographical Information System (GIS) files.

2003 REPORT & MODELS (CAPE & SEWERCAT)

The 2003 Report documenting the hydraulic model was reviewed. The system was modeled as seven separate areas (one separate model per area). In the report is the following:

- Population and wastewater generation by flow meter basin (tabulated form)
- Calibration results by model area (tabulated)

- Data Gap Resolution and Assumptions (tabulated)
- Future flow monitoring recommendations (tabulated)
- I&I Input parameters by model area (tabulated)
- Location of injection nodes, modeled manholes, and lift stations (graphical)

The existing dynamic model utilized two software packages named CAPE and SewerCat.

CAPE

CAPE stands for **C**apacity **A**ssurance **P**lanning **E**nvironment and is a software package developed by Brown & Caldwell, which prepared the existing dynamic model. CAPE was used to analyze rain gauge and flow meter data, land use and population data, and hydrologic data to prepare flow hydrograph files that are the flow inputs to the SewerCat program.

CAPE used many proprietary file extensions only readable within the program. The program modules and file formats are listed in Table 1.

Table 1. CAPE Modules and Associated File Extensions

Module	*File Extension*	*Contents and Comments*
Wastewater Forecasting	.wwg, .tmv, .iii, .iip, .pts, .nsa, .ses, .grd, .gri, .rlt,	The geographical files used in this module were not delivered to the City.
I&I Workbench	.wkb, .inq	I&I Input Parameters[1] Output flow hydrographs in *.inq files are the inflow hydrographs assigned to injection nodes in SewerCAT
Time Series Data Manager	.dat, .ts2	Raw Flow Meter Data.
Geographic Information	.spp, .grd, .gri, .bmp, .bpw, .gbp	The geographical files used in this module were not delivered to the City.
Capacity Planning	Module was not used in the existing model	

[1] The CAPE model I&I input parameters found on the CAPE model input screens for each model area in nearly all cases matched the data listed in the 2003 Report Appendix E.

Wastewater Forecasting

The Wastewater Forecasting module has three subdirectories: Resource Library, Sessions, and Simulation Results. The simulated sessions reference the Resource Library data and stores the output files in the Simulation Results module.

I&I Workbench

The I&I Workbench uses necessary parameters to calculate the I&I flow contribution from precipitation. The model uses the BCRDII Model theory to simulate the hydrologic cycle to develop the flow. The resulting flow is a combination between the base flow and the I&I flow.

Time Series Data Manager

The Time Series Manager stores rain gauge and flow meter data in the two subdirectories, flow meters and rain gauges. The I&I Workbench references this data.

Geographic Information Module

The Geographic Information Module stores the geographic information used by CAPE in developing flows such as flow meter area boundaries, study area boundaries, grids used for population allocation, the sewer network, and other data in GIS file formats. The referenced GIS files in the existing model are in unknown file paths and were not included in the data made available by the City.

SewerCat

SewerCat is a modeling package meant to simulate flows through a pipe network. To start a simulation four objects must be present:

1 Solution Engine parameters object,
2 Inflow locations object,
3 Sewer Network Object, and
4 Downstream Boundary conditions object.

There are also additional objects that may be added: Inflow files, Control Strategy settings, and Output Results files.

In the existing model, the sewer network is separated into seven areas. For each area, the model simulated flows for years 2000 (present), 10, 30 and 50. The available data sources are listed in Table 2.

Table 2. Available Data, Source, and Information from SewerCat

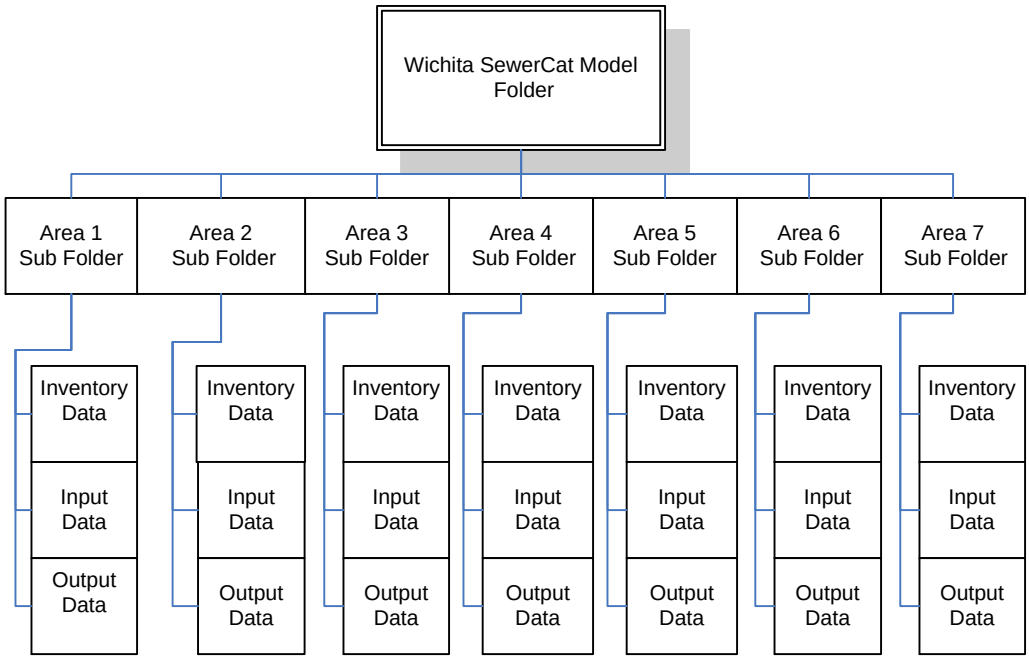
Data Type	*Source*	*Information*
Sewer Network Information	Export from model	Northing, easting, ground surface elevation, invert elevation, node id, and head and depth in feet
Injection data	.inq input files[1]	Flows verses time for the injection nodes for each network area
Downstream Boundary Information	.xls files previously prepared by other	Network flow at the most downstream manhole of the network area for different simulation years
Storage Basins[2]	Export from model	Volume
Pump Station[3]	Export from model	Number of pumps, flow

1. The .inq file data correspond to inflow.
2. SewerCat requires storage basins upstream of pump stations whether they exist or not.
3. The model developer inserted ideal pump stations as well as physical pump stations.

Summary Description of SewerCat

The City provided the program and related files to Burns & McDonnell. The structure is described in Figure 1.

Figure 1. SewerCat File Structure



The SewerCat Model accesses each area sub folder separately in separate windows. For certain output data, the model could occupy eight windows to view it.

Understanding the overall model in the program is difficult and made the conversion process quite time consuming. The 2003 model approach and general model term descriptions are below.

- Historical model storms: dry weather, 5 year, and 10 year storms
- Simulated years: 2000, 2010, 2030, and 2050.
- The seven areas are treated as individual collection systems: Areas one through six discharge to assumed boundary outlets which are input flows into Area seven, and Area seven terminates at wastewater treatment plants No. 1 and 2.
- The seven area boundaries in the SewerCat model are geographic regions defined by sewer basins in the City's GIS. It is made of the components below:
    - Model elements:
    - Nodes represent manholes from the sewer network collection system.
    - Links represent pipe sewers connecting manholes.
- Injection nodes are nodes which have a diurnal load into the node (output from CAPE).
- Weirs are used to control flow at nodes with multiple outlets.
- Boundary outlets (both assumed and actual) represent the most downstream nodes to which all flow from an area discharge.
- Pump Stations, both ideal and actual, with wet wells are in locations of limited head.
- The input files (.inq extensions) can be viewed with Microsoft Excel. The result files (.dat extensions) can be viewed with the SewerCat program.
- The available GIS shape files are incomplete.

Current Wichita Sewer GIS and Facility Data

Table 3.1 below compares the number of elements in the GIS to the number of elements modeled.

Table 3. Comparison of GIS and SewerCat Network Elements

Element	*GIS*	*SewerCat*	*Percent Modeled*
Nodes (manholes)	48,775	2,780	5.7%
Links (sewers)	48,850	2,803	5.7%

Element	*GIS*	*SewerCat*	*Percent Modeled*
Lift Stations	63	14	22%

The 2003 report emphasized sewer pipe with diameters greater than 8 inches, which excluded more than forty thousand links (sewers) from the GIS sewer network. Large diameter sewer trunks were also missing from the model. The large diameter sewer and the overall network layout in the model were updated with the GIS.

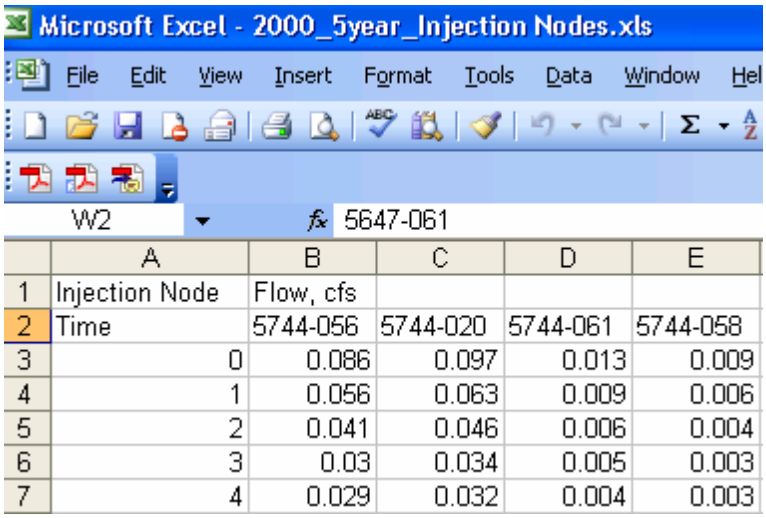
For pump control data, the City provided a separate resource from the GIS. This reference, in pdf, was more valuable than SewerCat. Its information was more consistent with the control methods in H20MAP than the SewerCat information. In the old model, pump stations had only a single point pump capacity or had pump curve data with pump flow as a function of wet well water depth. The H20MAP model required more information in the former method and could not simulate the latter.

Model Conversion Process from 2003 Report to H2OMAP

This section describes the conversion process from SewerCat to the selected MWH Soft© program, H2OMAP Sewer for the 2000, 5 year storm event.

- ASCII text files representing the manholes were exported from the SewerCAT model
- The ASCII text file of the manholes were imported into ArcGIS and a spatial query was run on the City's existing Sanitary Sewer Network (pipes) to create the existing Sanitary Sewer Network
- Once the existing system was identified in GIS, pre-processing and analysis was performed to fill in data gaps in the SewerCAT model data that would be required by H2OMap.
- After all data anomalies were complete, manholes, pipes and other facilities were imported into H2OMap through the GIS Import Manager
- Necessary data fields were mapped to standard H2OMap databases to build the hydraulic model with proper information
- The SewerCAT injection node files (.inq extension) were located and reviewed using Excel.
- The injection node files were then organized into a spreadsheet with node ids as column headings and time steps as row headings, as illustrated below. The orientation is incompatible with the H20MAP import manager. Each of the areas had to be put into separate tabs because they existed as separate files.

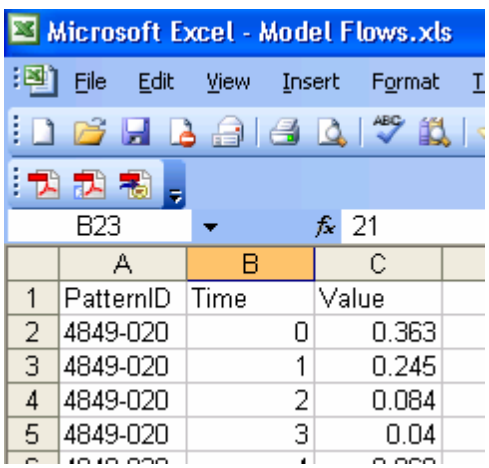
Figure 2. Injection Node File



	A	B	C	D	E
1	Injection Node	Flow, cfs			
2	Time	5744-056	5744-020	5744-061	5744-058
3	0	0.086	0.097	0.013	0.009
4	1	0.056	0.063	0.009	0.006
5	2	0.041	0.046	0.006	0.004
6	3	0.03	0.034	0.005	0.003
7	4	0.029	0.032	0.004	0.003

- Then, the data order was manipulated to be able to import all the injection nodes and inflow patterns in one step into H2OMAP. The manipulated file structure is illustrated below:

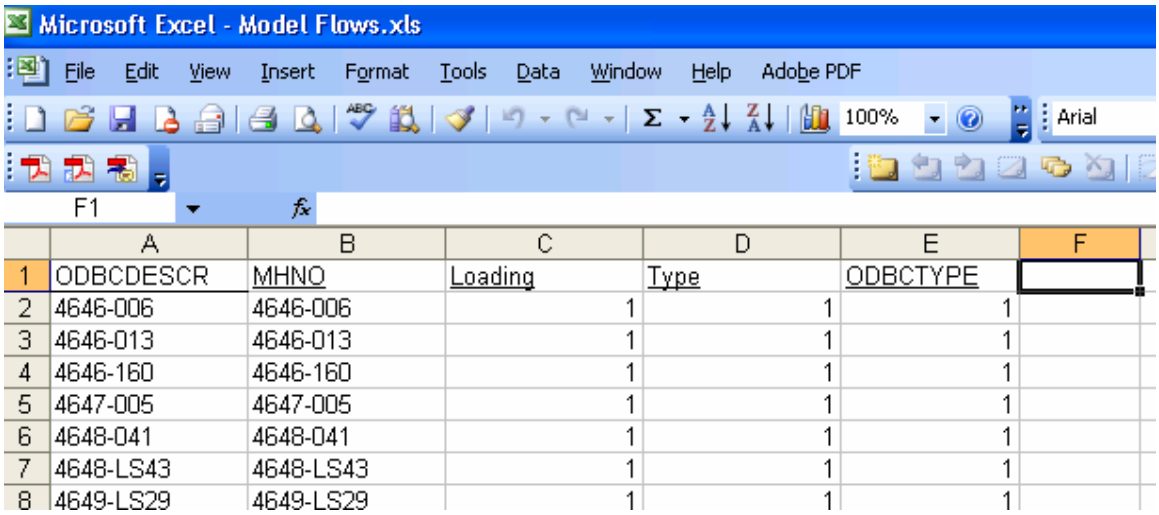
Figure 3. Manipulated Injection Node Information



	A	B	C
1	PatternID	Time	Value
2	4849-020	0	0.363
3	4849-020	1	0.245
4	4849-020	2	0.084
5	4849-020	3	0.04

- This last step was laborious because injection node's hydrograph has 97 time steps and there were over 450 injection nodes, totaling over 43,000 rows of injection node flow data for one storm event.
- The next step is to match correctly the pattern ID's to the manhole ID's. The required import ODBC mapping information is below:

Figure 4. ODBC Mapping Excel Information



	A	B	C	D	E	F
1	ODBCDESCR	MHNO	Loading	Type	ODBCTYPE	
2	4646-006	4646-006	1	1	1	
3	4646-013	4646-013	1	1	1	
4	4646-160	4646-160	1	1	1	
5	4647-005	4647-005	1	1	1	
6	4648-041	4648-041	1	1	1	
7	4648-LS43	4648-LS43	1	1	1	
8	4649-LS29	4649-LS29	1	1	1	

The manhole ID appears in two columns: one used for an H20MAP required id field and the second for mapping to the H20MAP database. The load type tells the model which peaking formula is required in the run. All of these columns must be present for a successful data import.

The inventory data for the wet wells and the pumps were manually placed into the model. Below is a description of the steps to set up lit stations in H20MAP.

- Both models required data depicting a wet well, a pump(s), and a force main.
- H20MAP also required a chamber node to mark the separation between the pump and the force main.
- Unlike SewerCat, H20MAP requires multiple pumps be shown graphically if multiple pumps exist.
- The SewerCat model allows wet wells to be in the same location as injection nodes. To keep the injection node data, in H20MAP a wet well was inserted between the upstream injection node and the chamber node. Invert data from the connecting sewer pipes was copied for the wet well.
- In most cases, the SewerCat wet well was not in the same location as an injection node. In this case, the upstream node was deleted and the invert data copied for the wet well.
- The SewerCat model uses control weirs to split flow between two pipes exiting a junction. The H20MAP program uses either exiting pipe slopes or programmed flow curves to control flow splits. The flow curves represent the flow out of the node as a function of the flow in. The City visually verified, in the field, the flow split condition to update the model.

Model Run Results

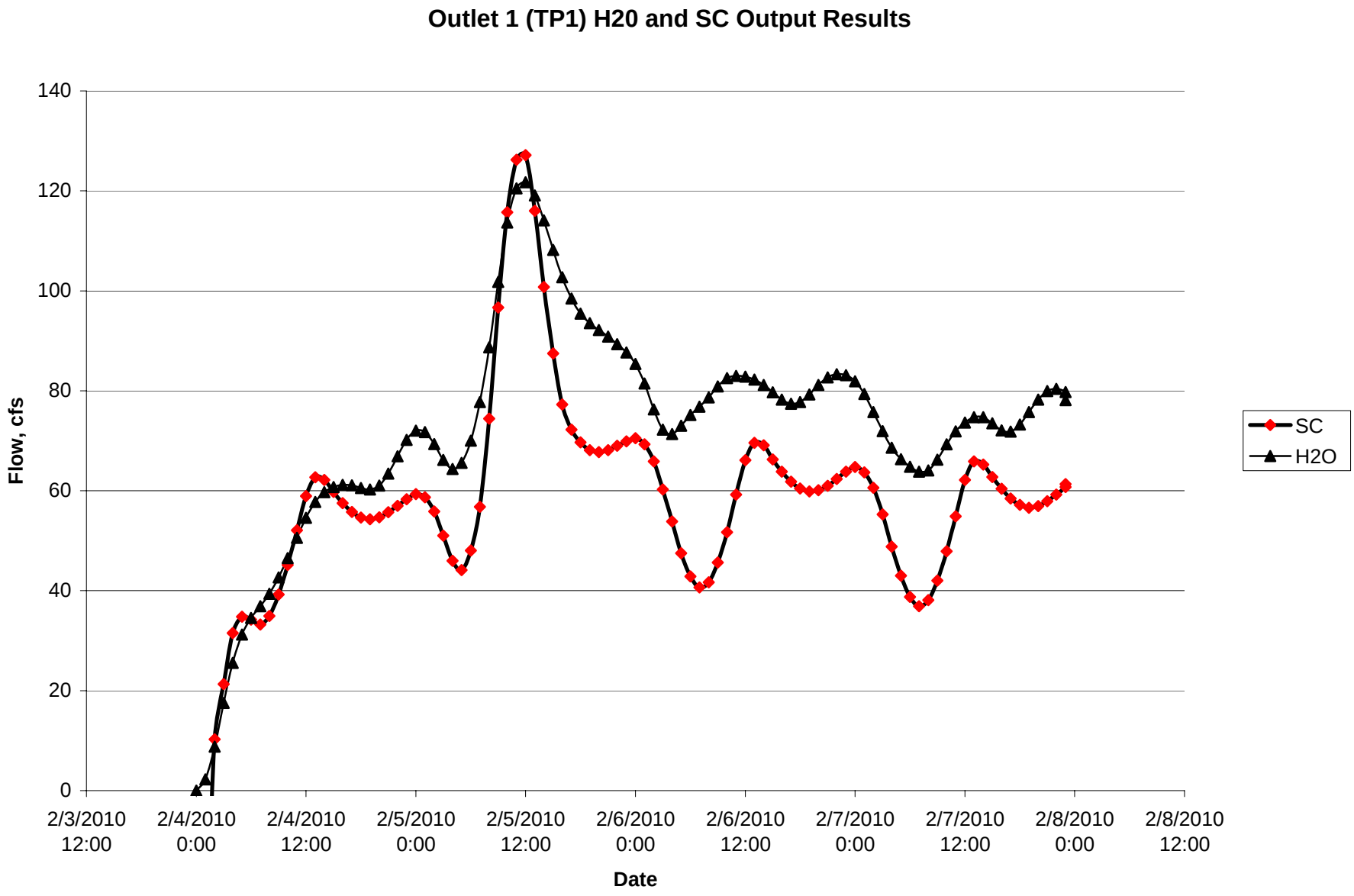
Initial attempts to run the program were unsuccessful for reasons primarily related to the pump station controls. The pump station controls have been discussed in a previous section. All other input data needs to be input correctly in order for the model to run. H20MAP has several tools and utilities on its menu to help locate network errors. In debugging the H2OMAP model the runs that ended with an error exit generated an output file that needed to be manually deleted after correcting the model. Also, the database packing and re-index menu selections in H20MAP needed to be run periodically to help avoid a simulation error exit.

The modeled flow hydrographs by SewerCAT and H20MAP were compared at SewerCAT's calibration manholes to confirm the model was correctly converted. The comparison hydrographs for the successful run are included in the Appendix. Table 1 summarizes the percentage differences between the SewerCAT and H20MAP modeled flow hydrographs.

Table 4. Percent Difference Between SewerCat and H20MAP Sewer Results

Manhole ID	*Difference in Flow Volume*	*Difference in Peak Flow*
4845-005	1%	1%
4748-106	1%	9%
4748-007	1%	0%
4748-114	1%	11%
4749-002	1%	3%
4748-005	1%	5%
4749-001	9%	5%
4748-329	32%	31%
4845-004	1%	0%
5144-001	3%	1%
5244-014	1%	9%
5647-137	6%	10%
5646-047	10%	2%
5645-303	8%	37%
5644-404	253%	47%
5745-003	82%	93%
5744-063	3%	10%

Manhole ID	*Difference in Flow Volume*	*Difference in Peak Flow*
5744-020	7%	13%
4748-113	7%	29%
4847-002	2%	2%
4845-004	1%	2%
5049-002	0%	7%
5144-001	3%	1%
5149-139	0%	1%
5146-020	0%	2%
5351-013	0%	8%
5249-002	2%	40%
5247-003	1%	23%
5244-016	2%	6%
550-007	22%	12%
5650-018	5%	10%
5646-048	9%	2%
5647-137	6%	10%
5848-105	1%	13%
5846-025	1%	8%
5745-034	1%	5%
5645-302	9%	37%
5644-404	55%	89%
5745-003	81%	93%
6047-002	4%	8%
6047-059	4%	1%
6046-038	7%	2%
5845-019	0%	6%
5744-021	11%	21%



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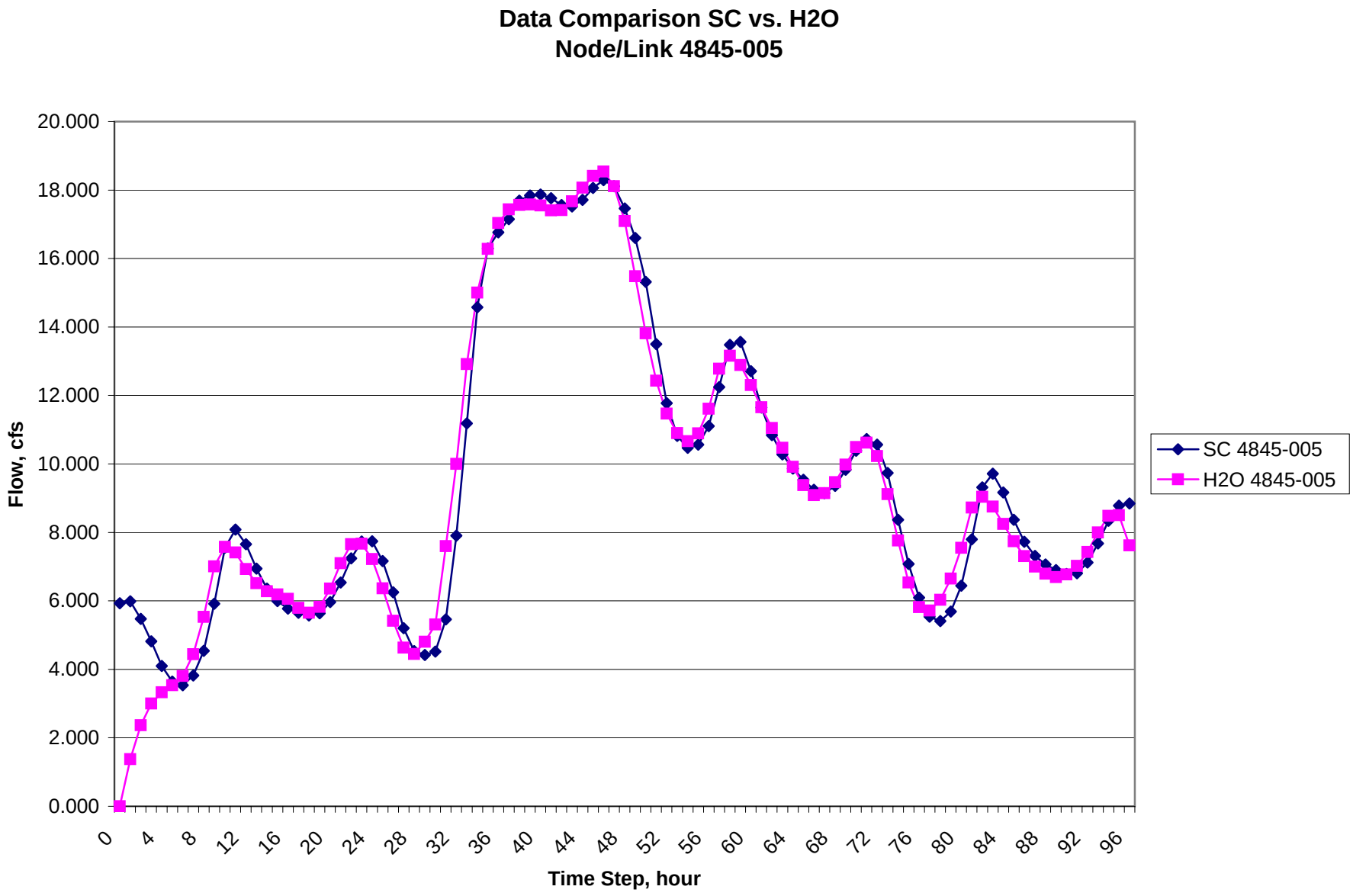

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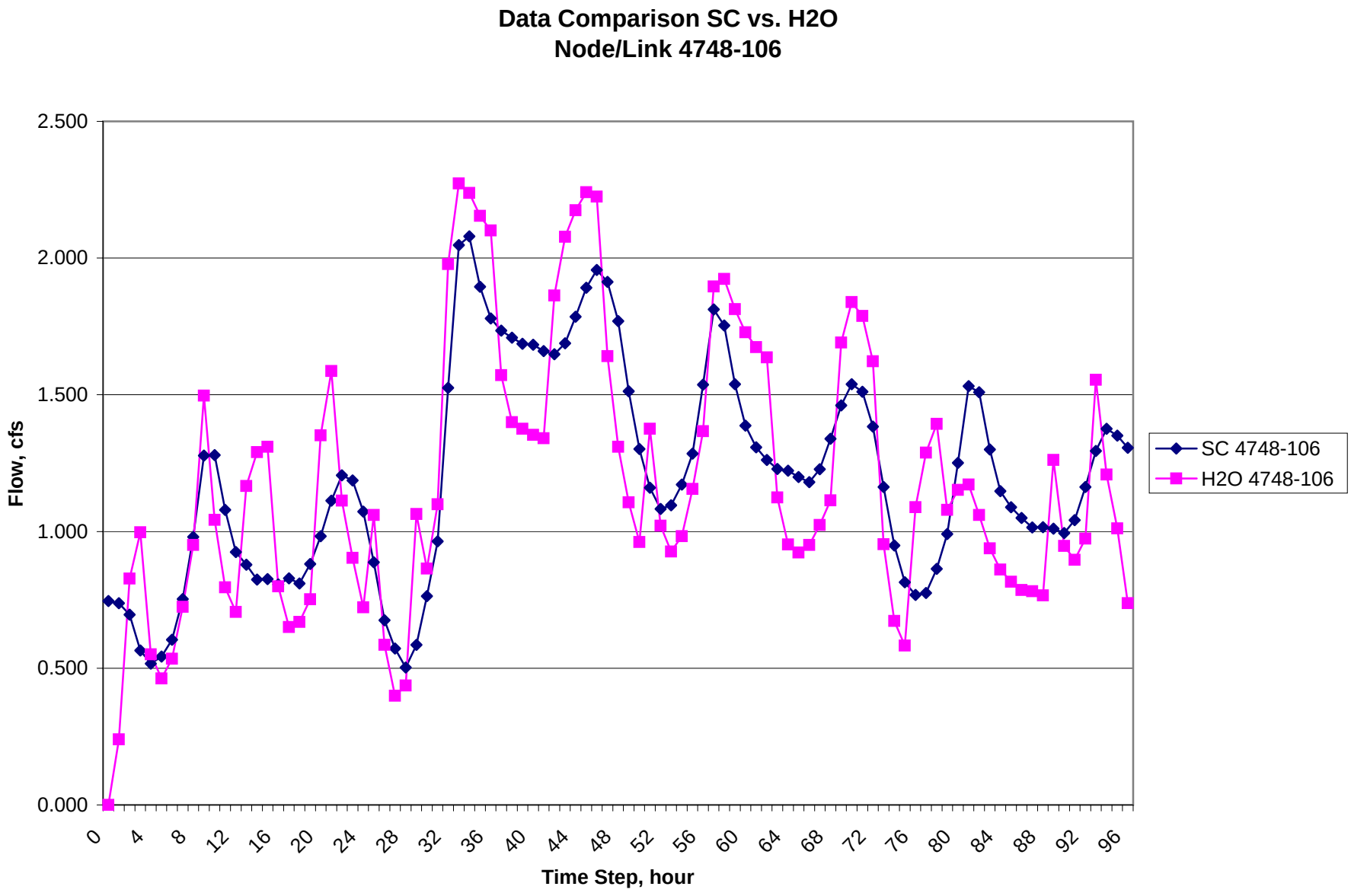

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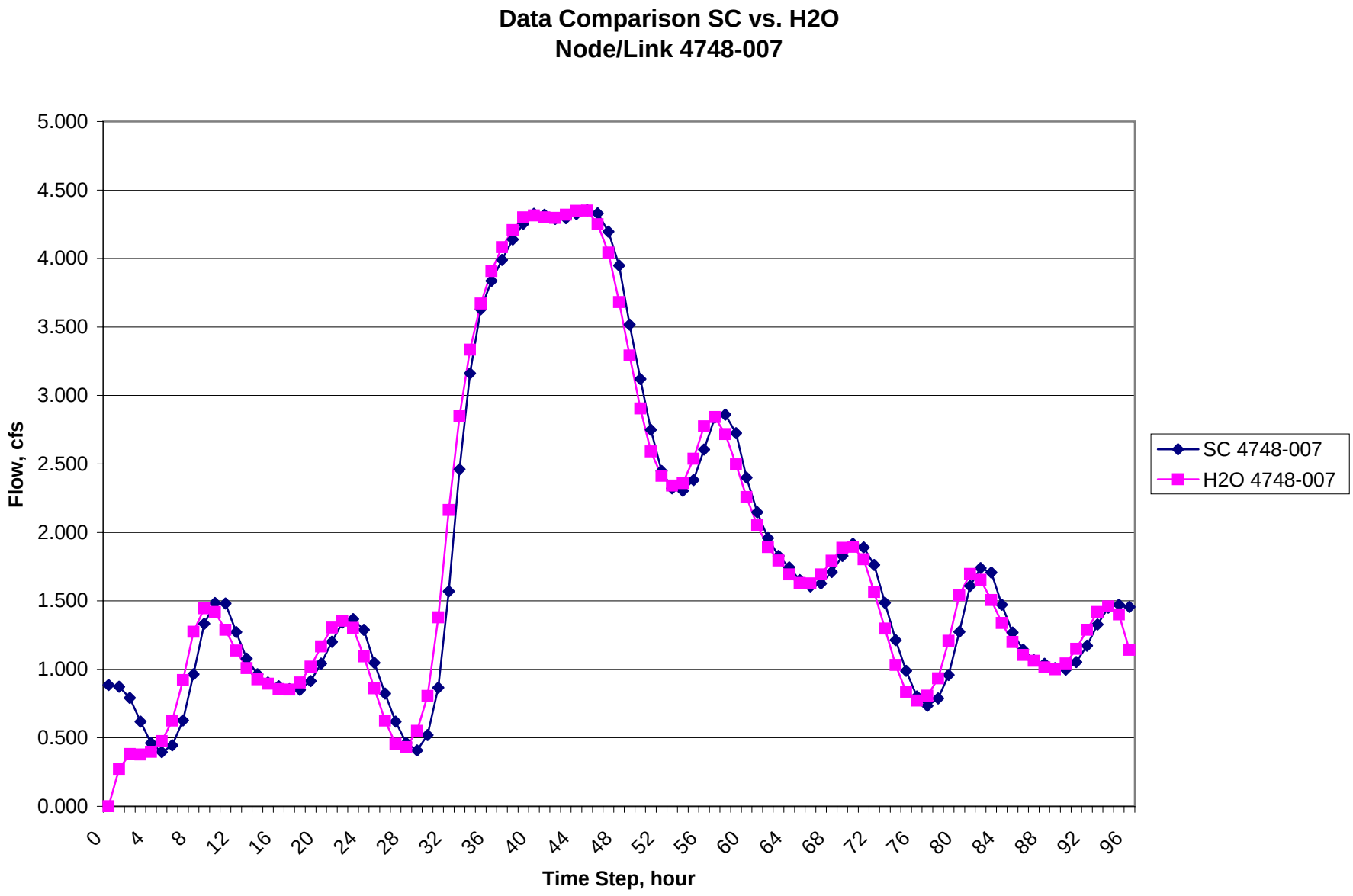

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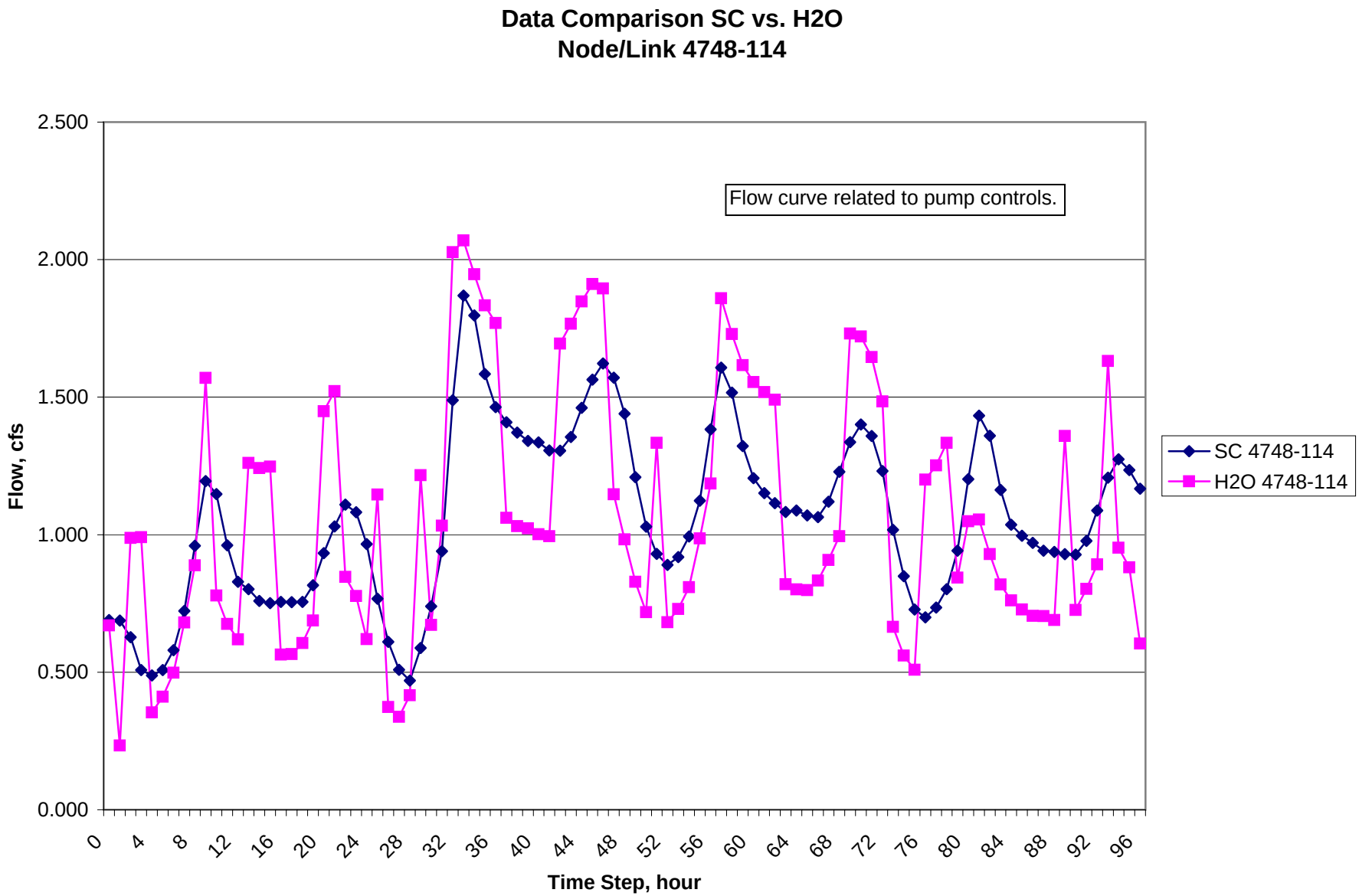

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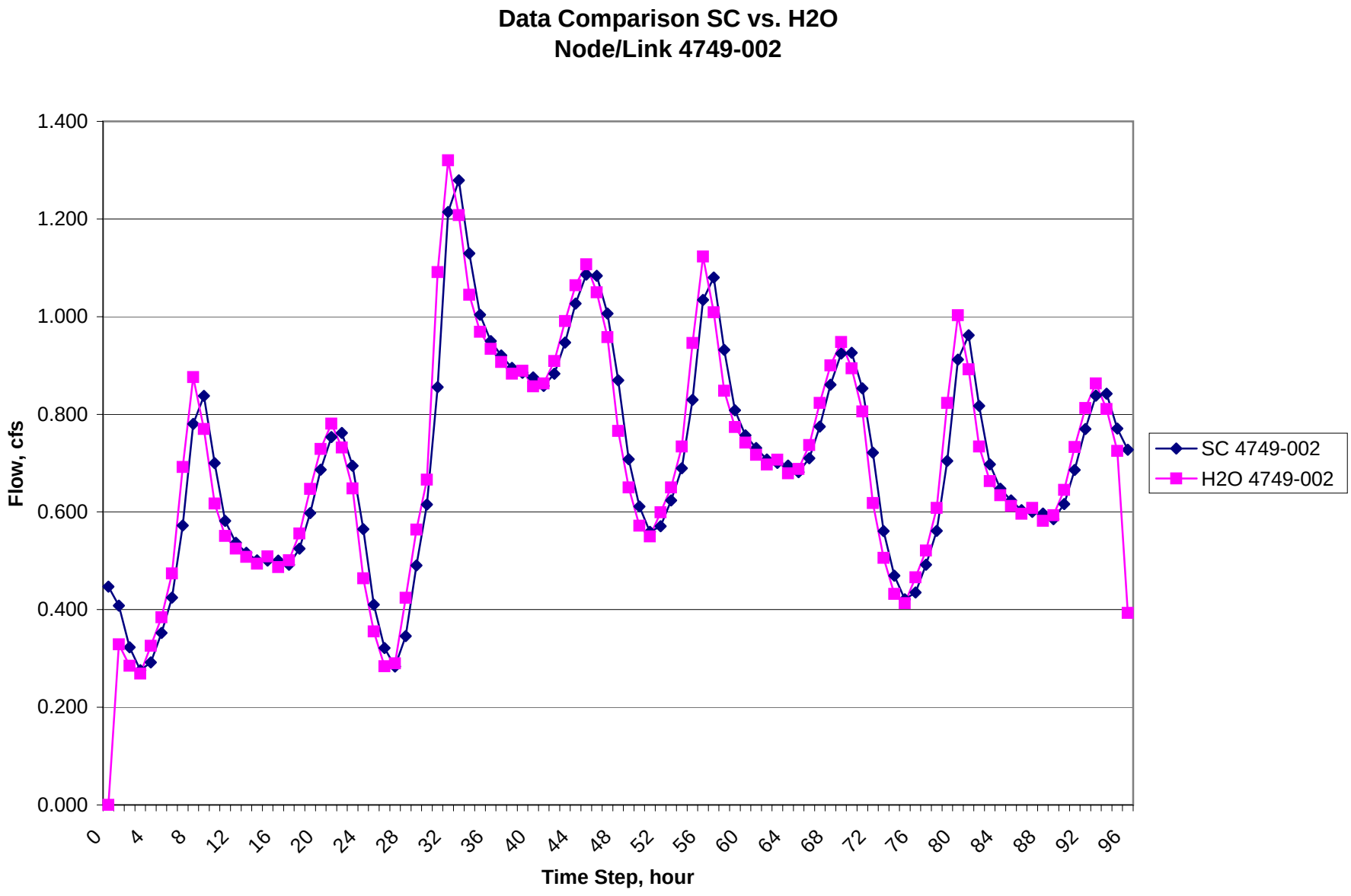

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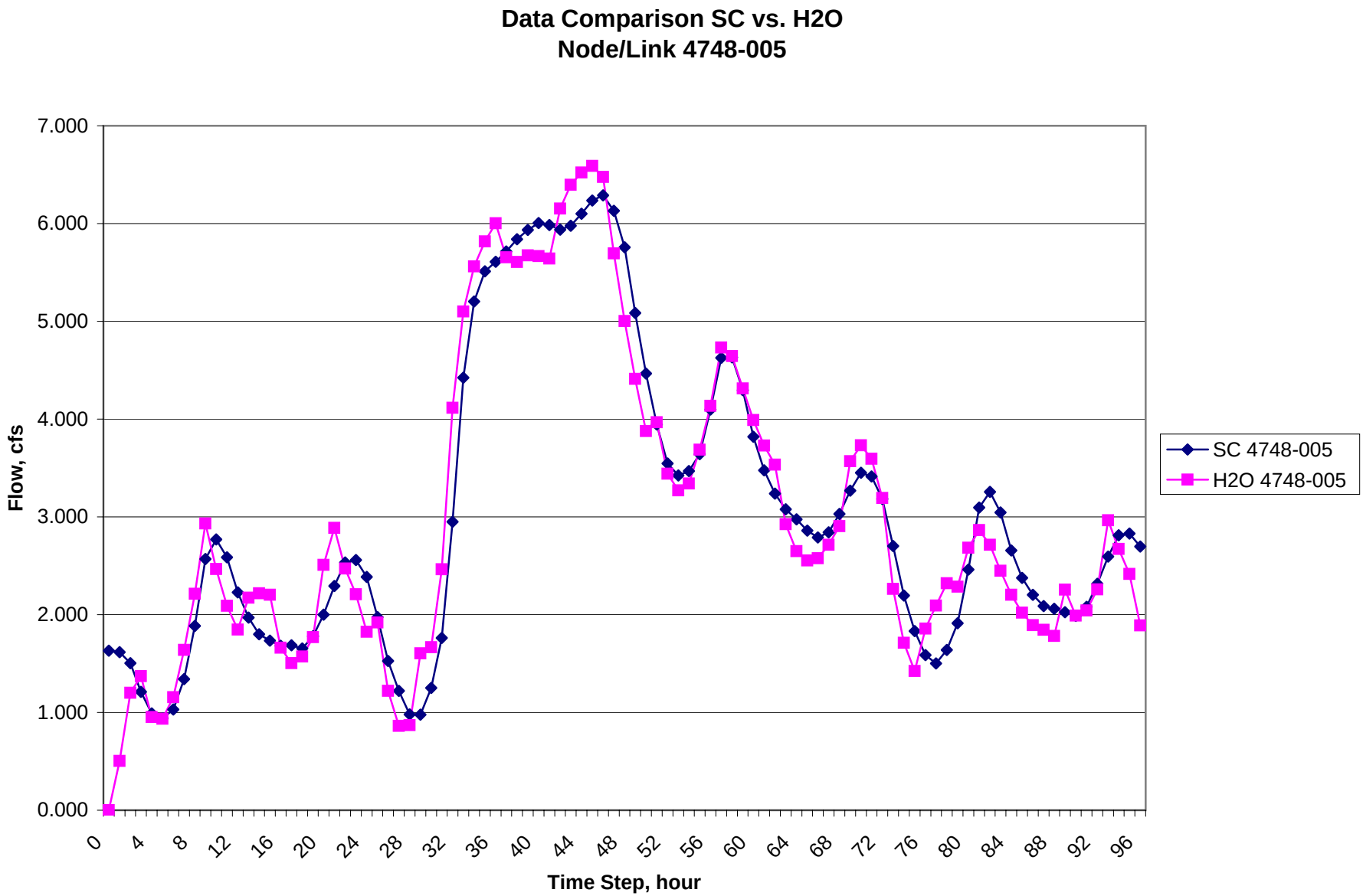

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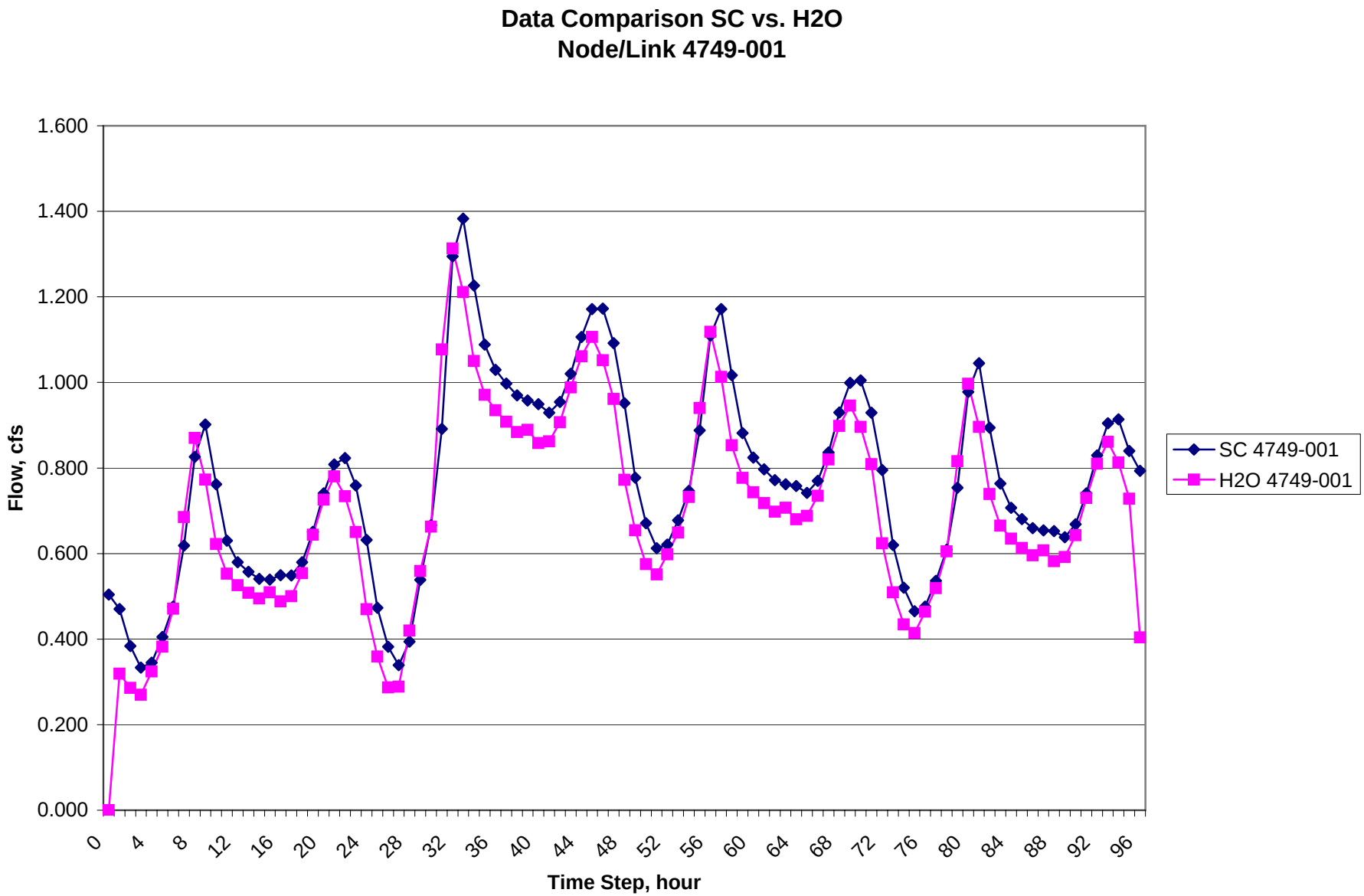

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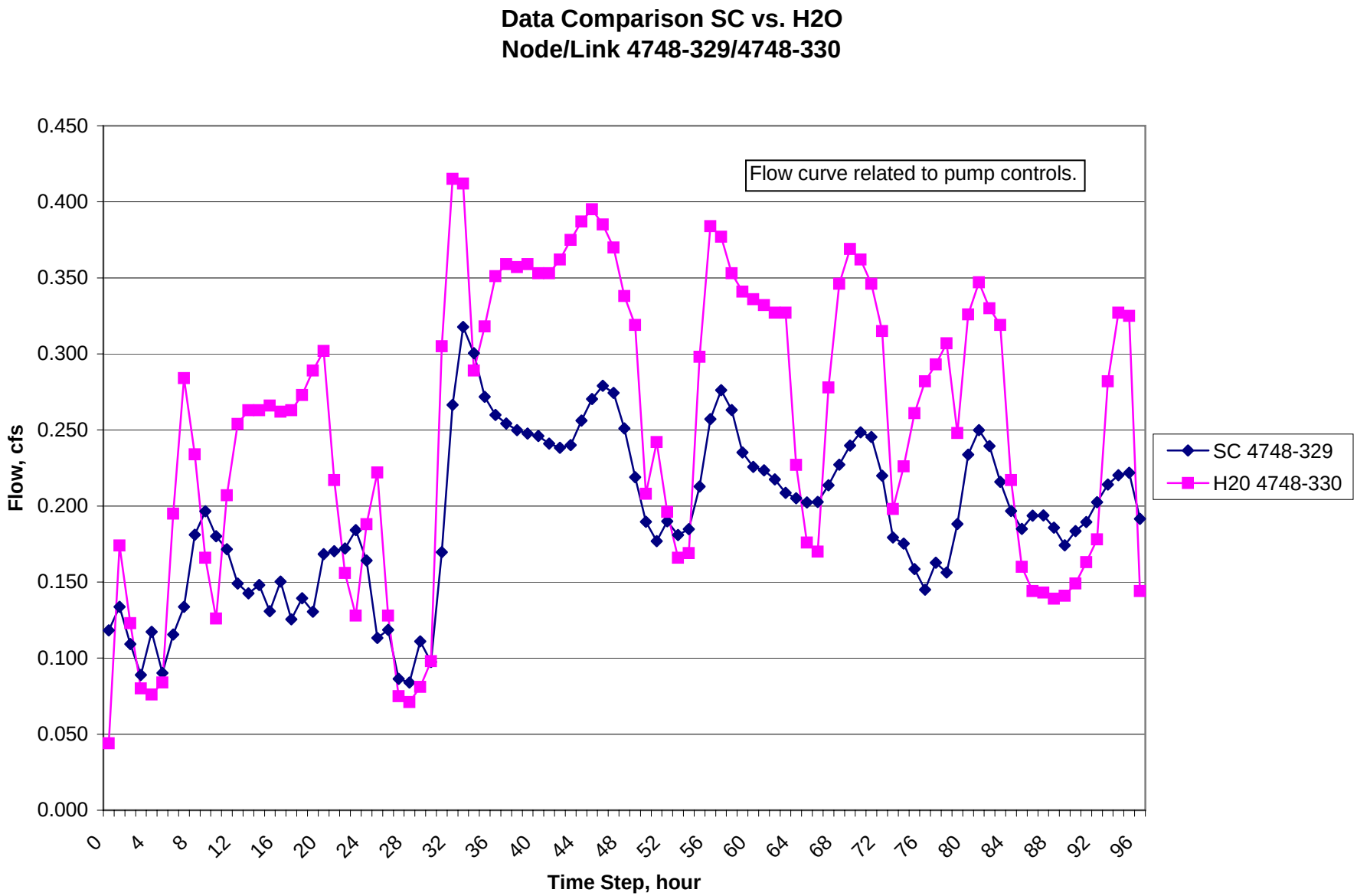

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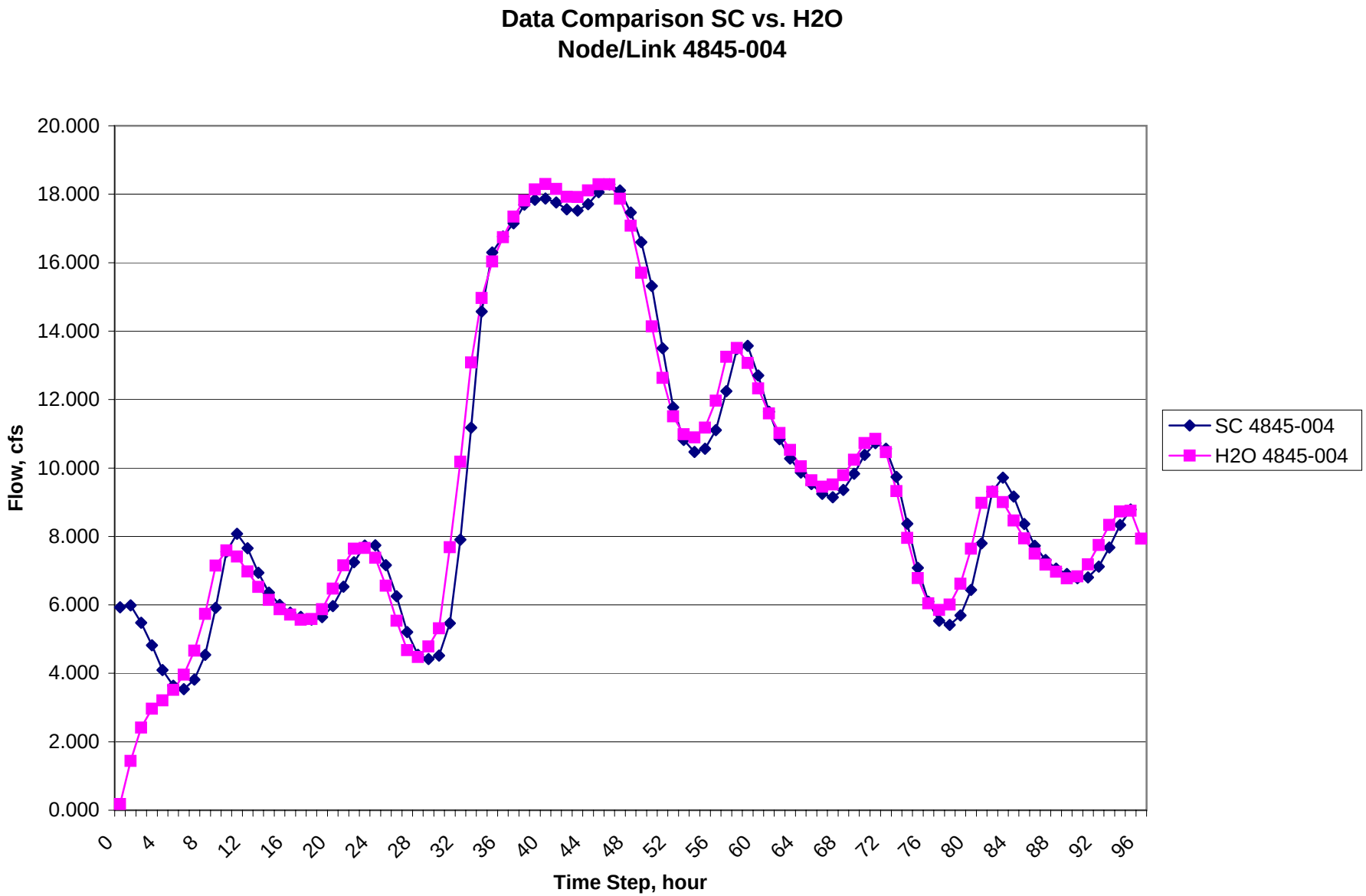

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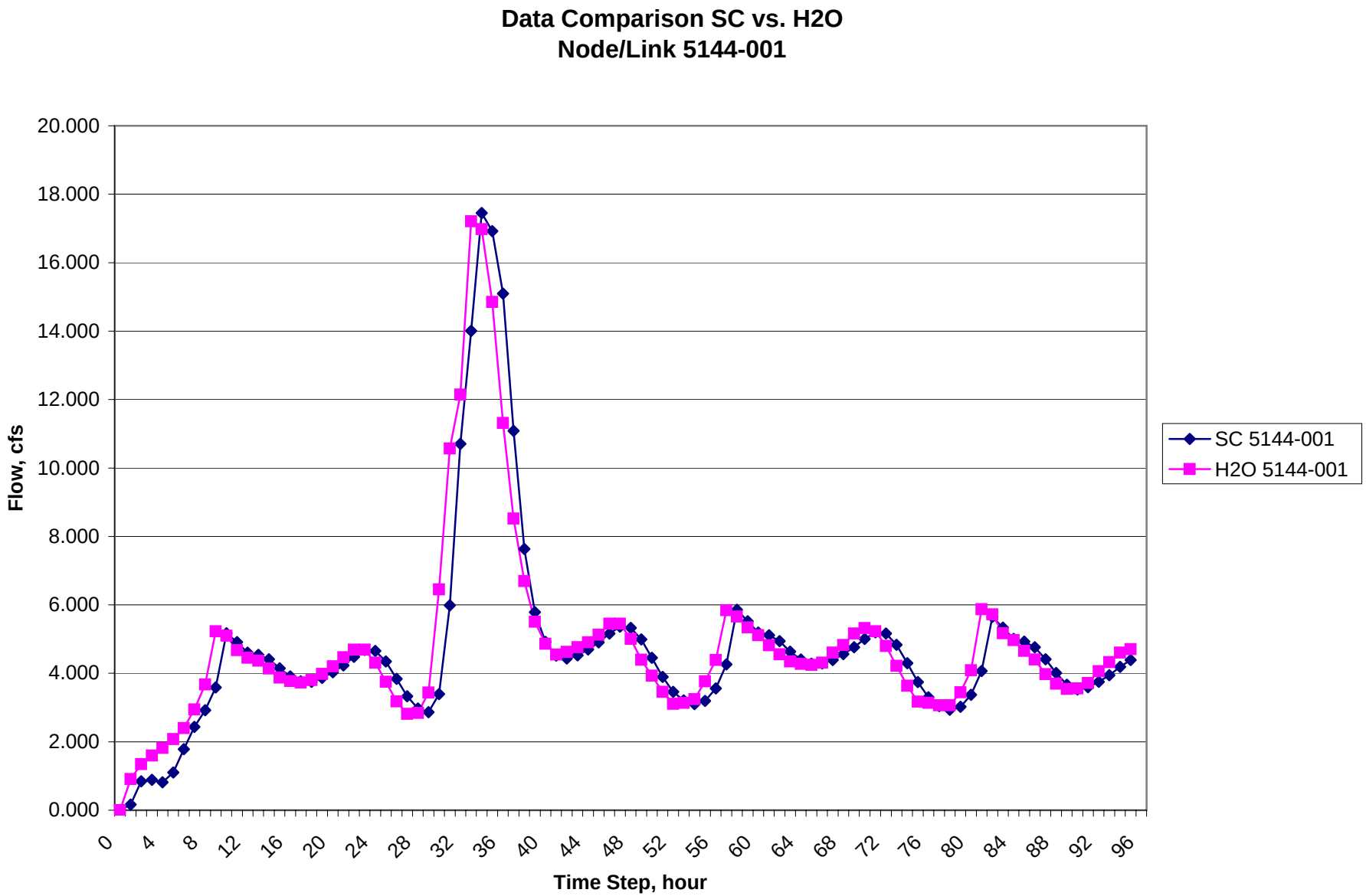

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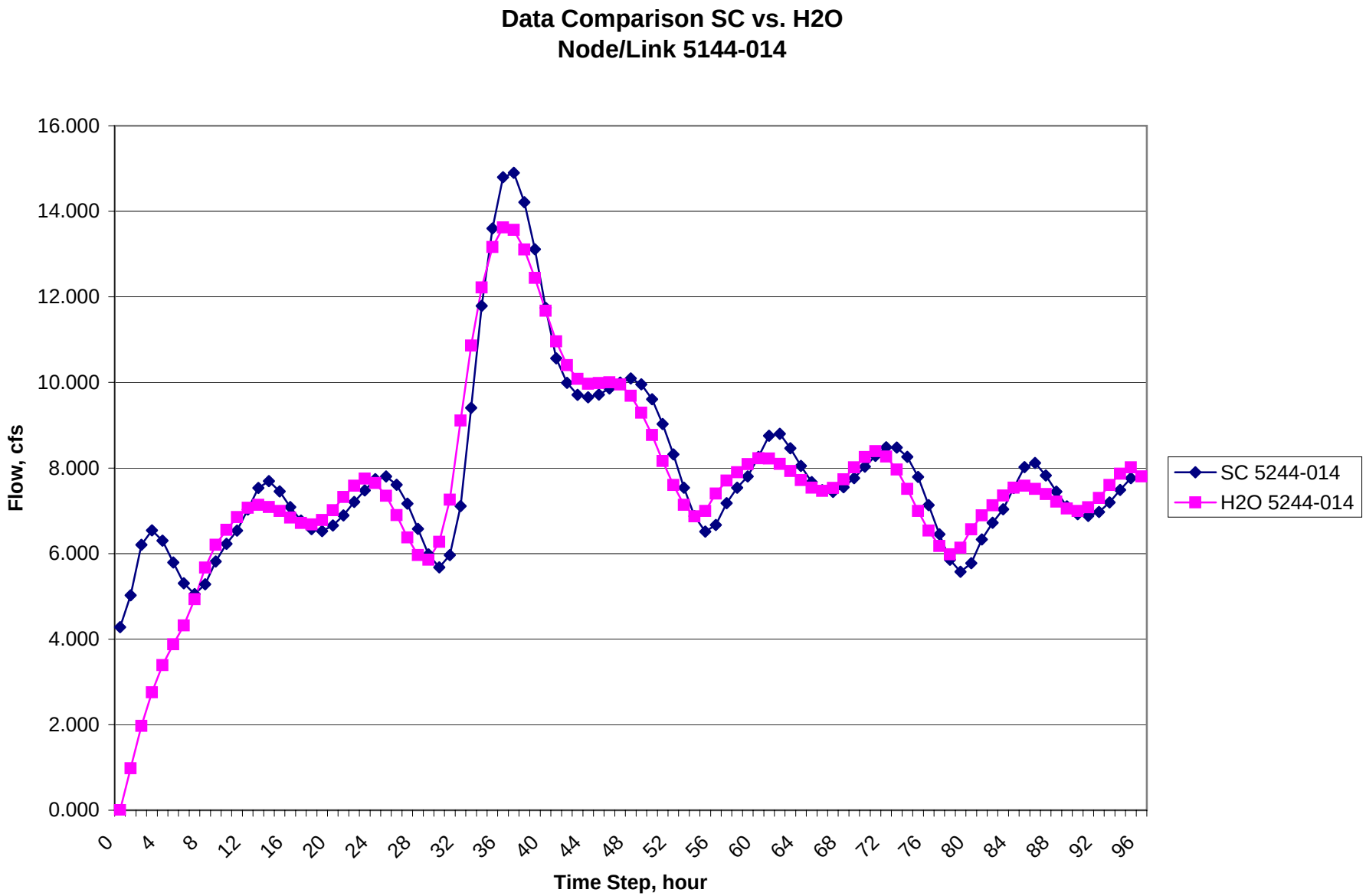

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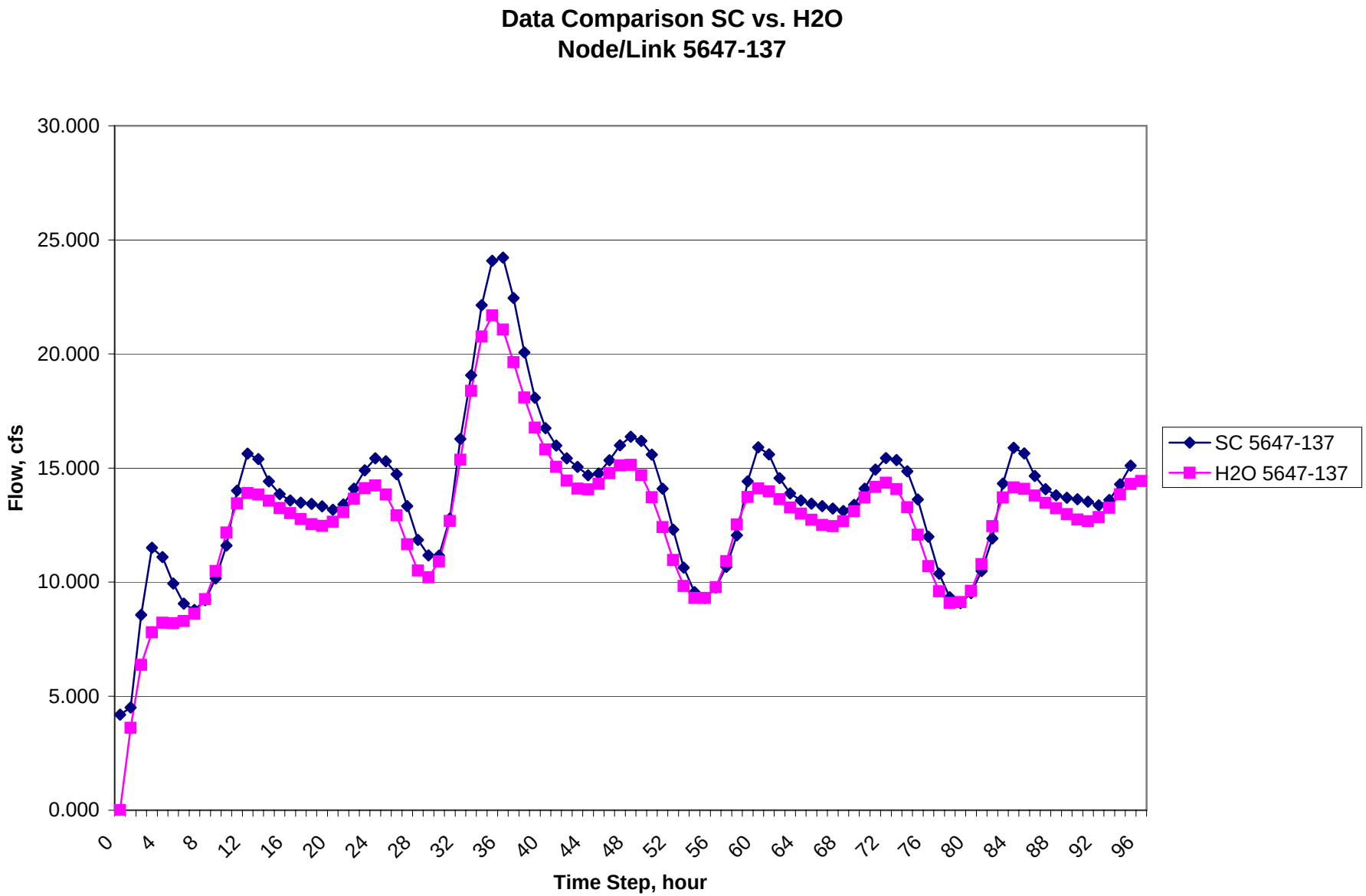

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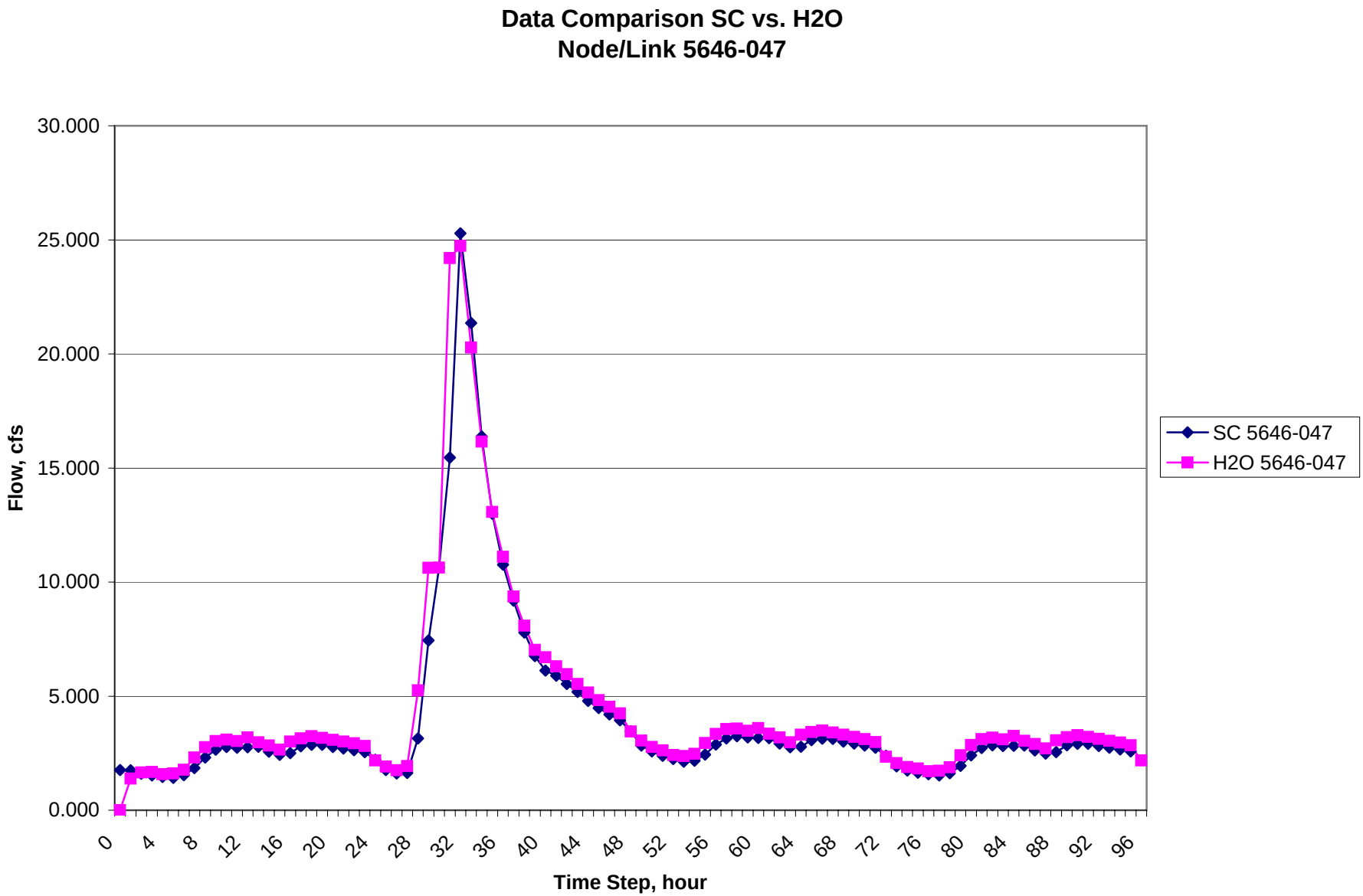

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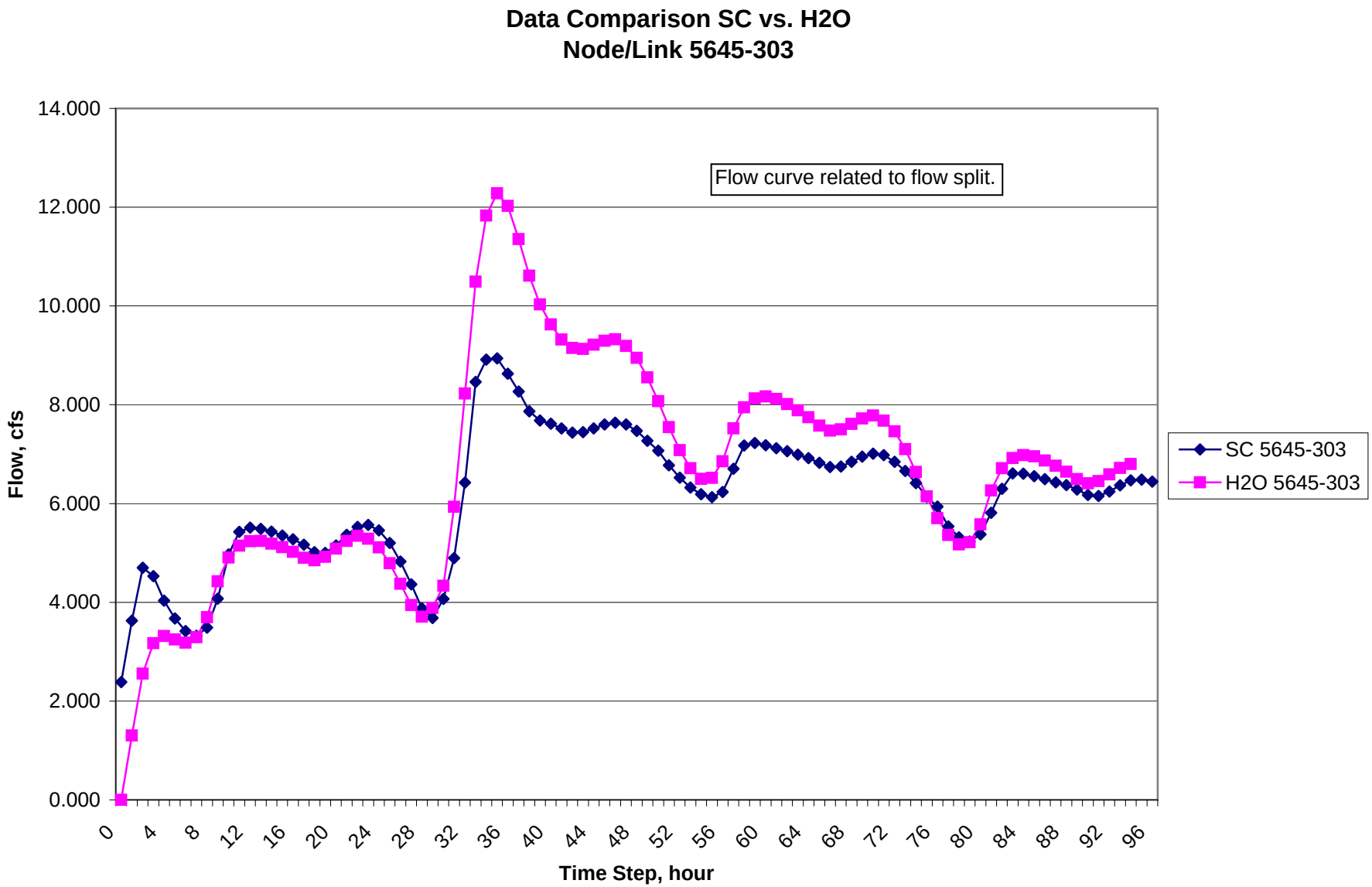

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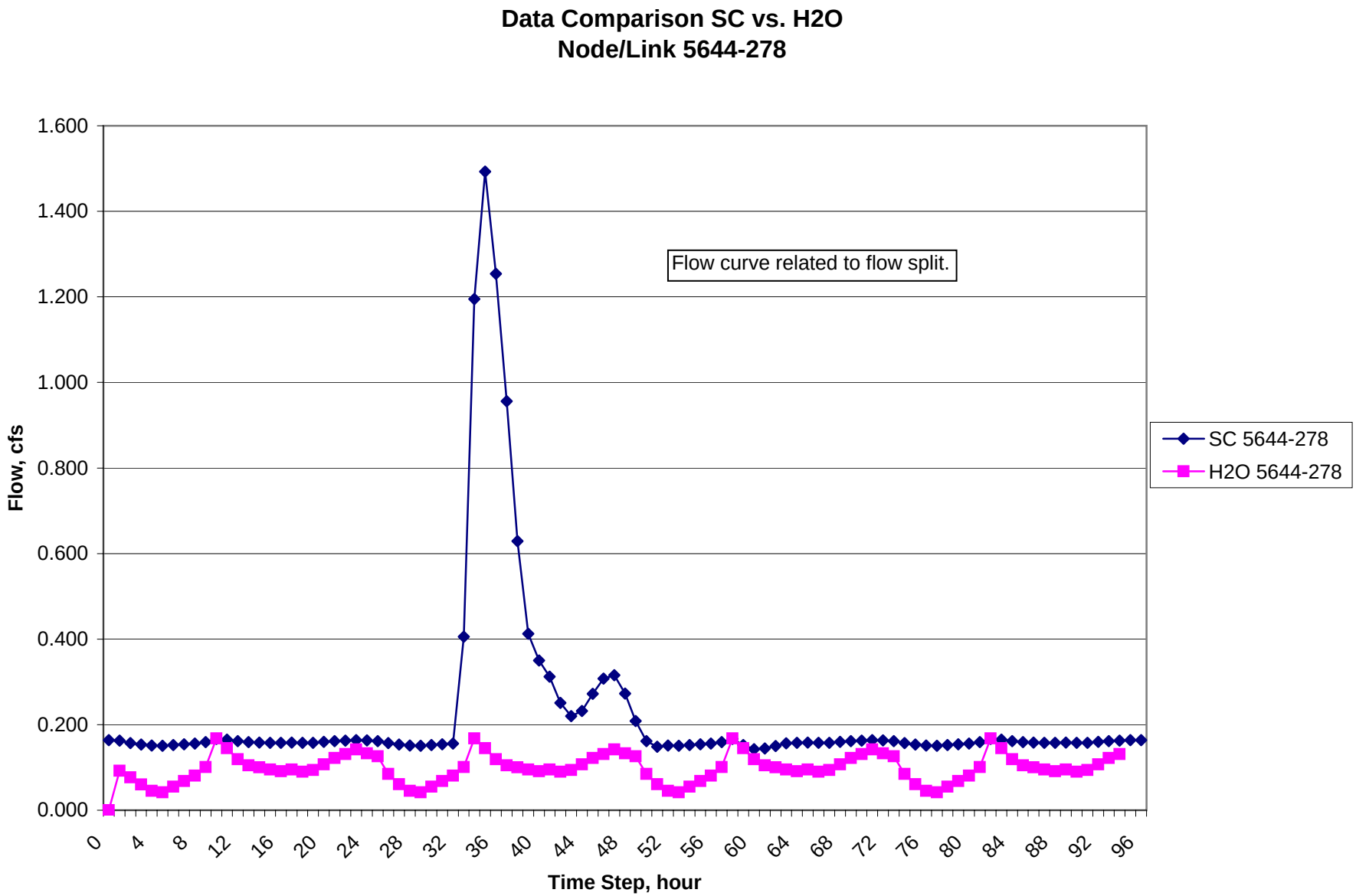

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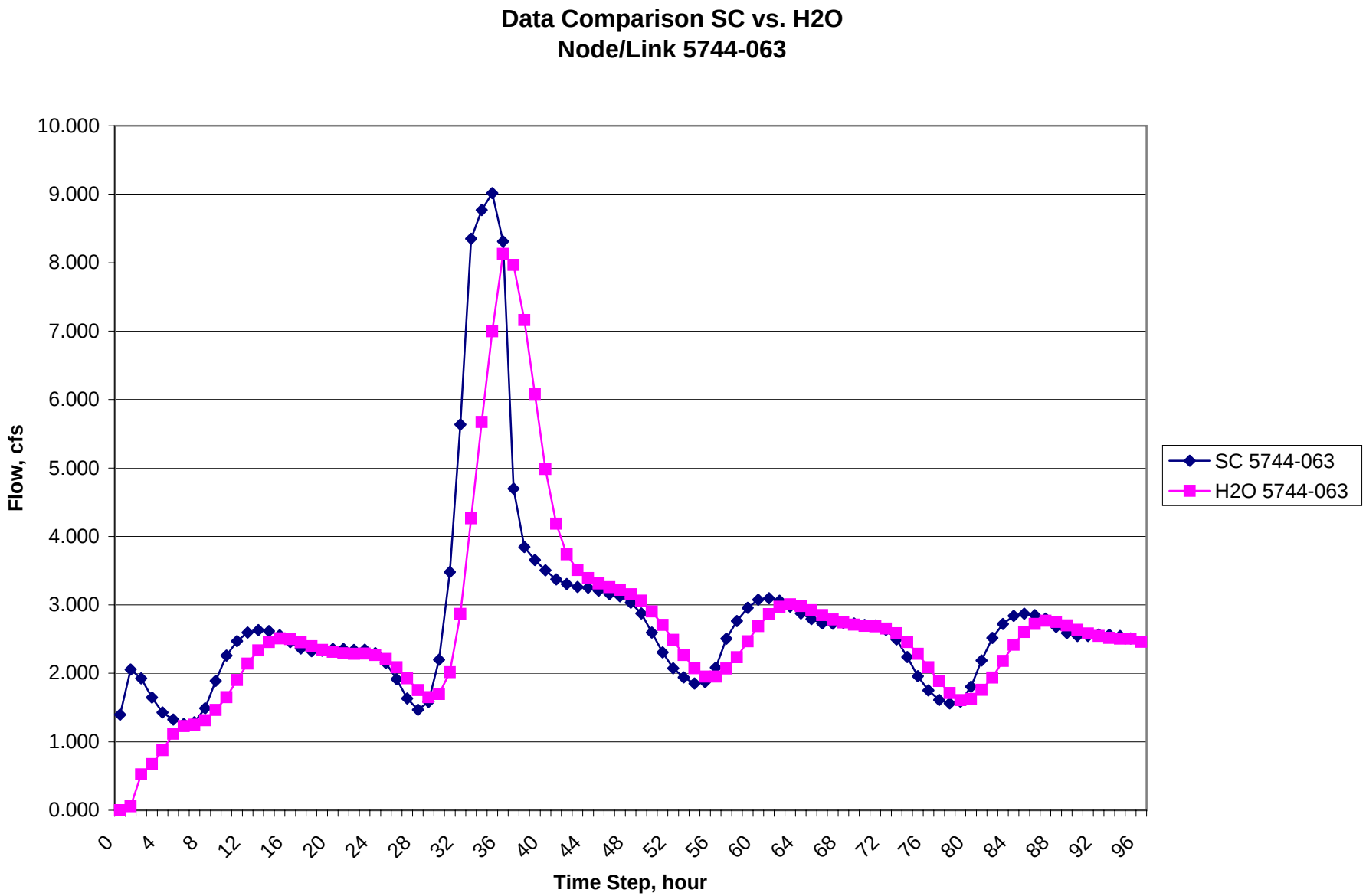

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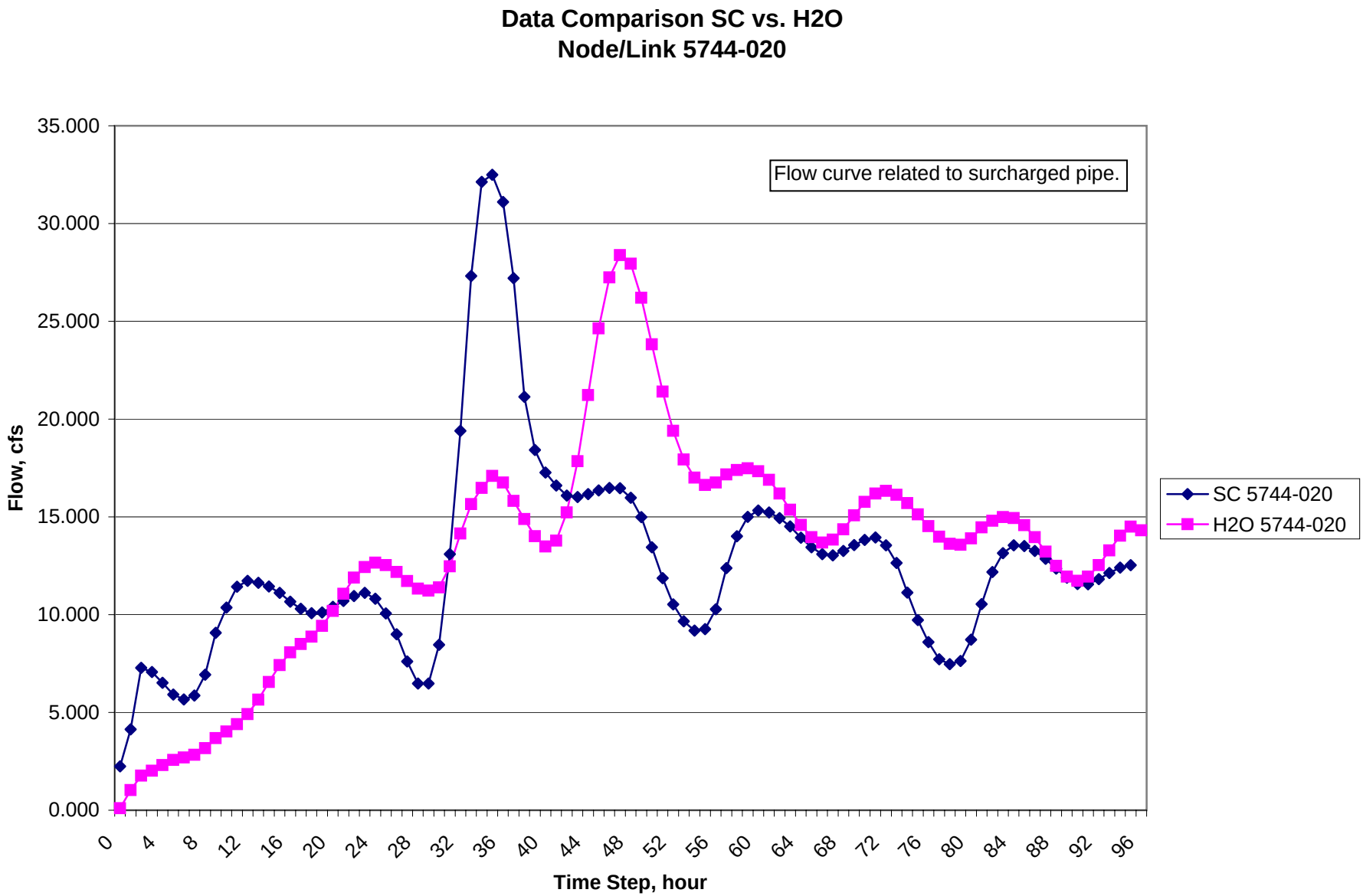

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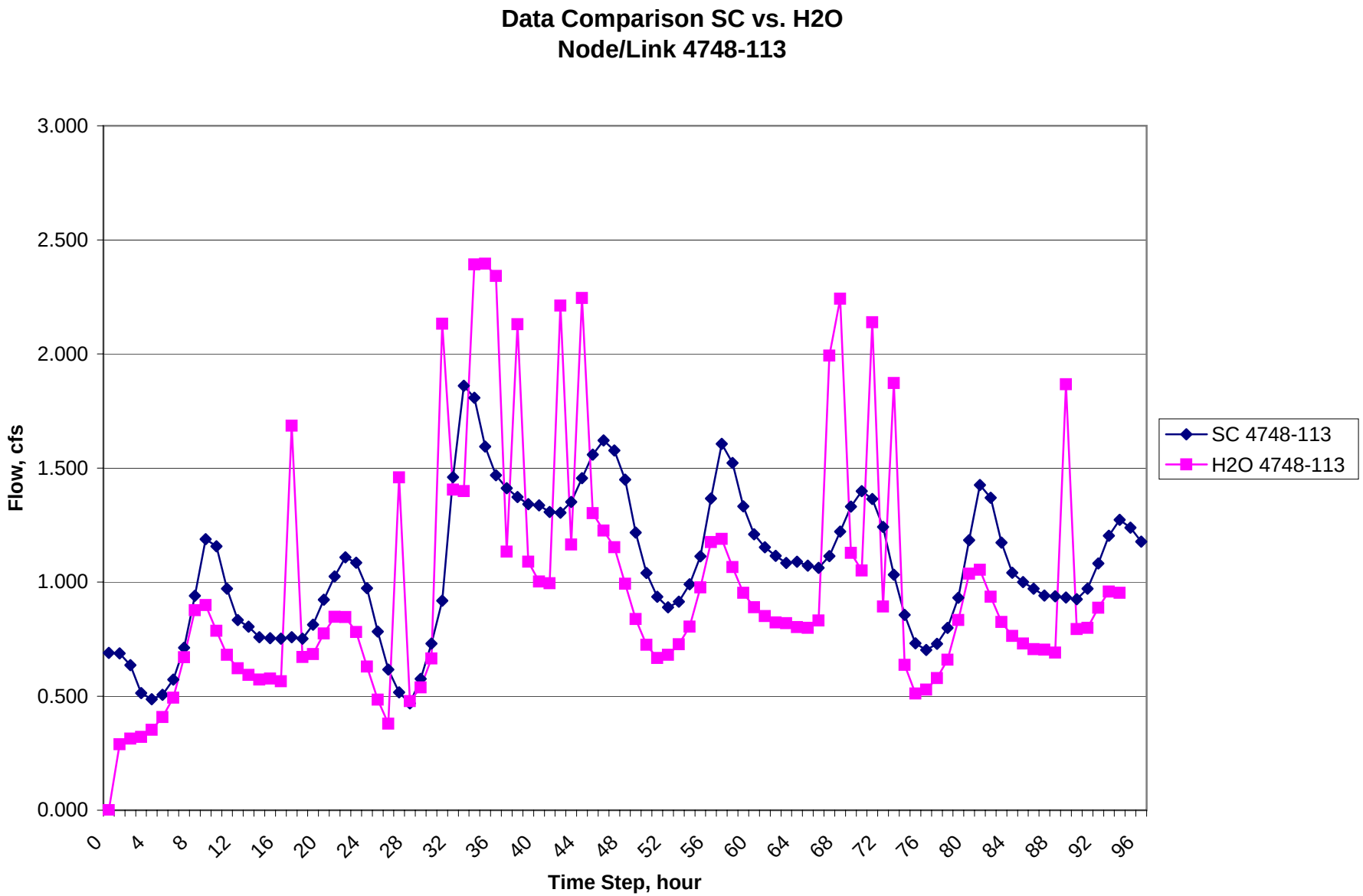

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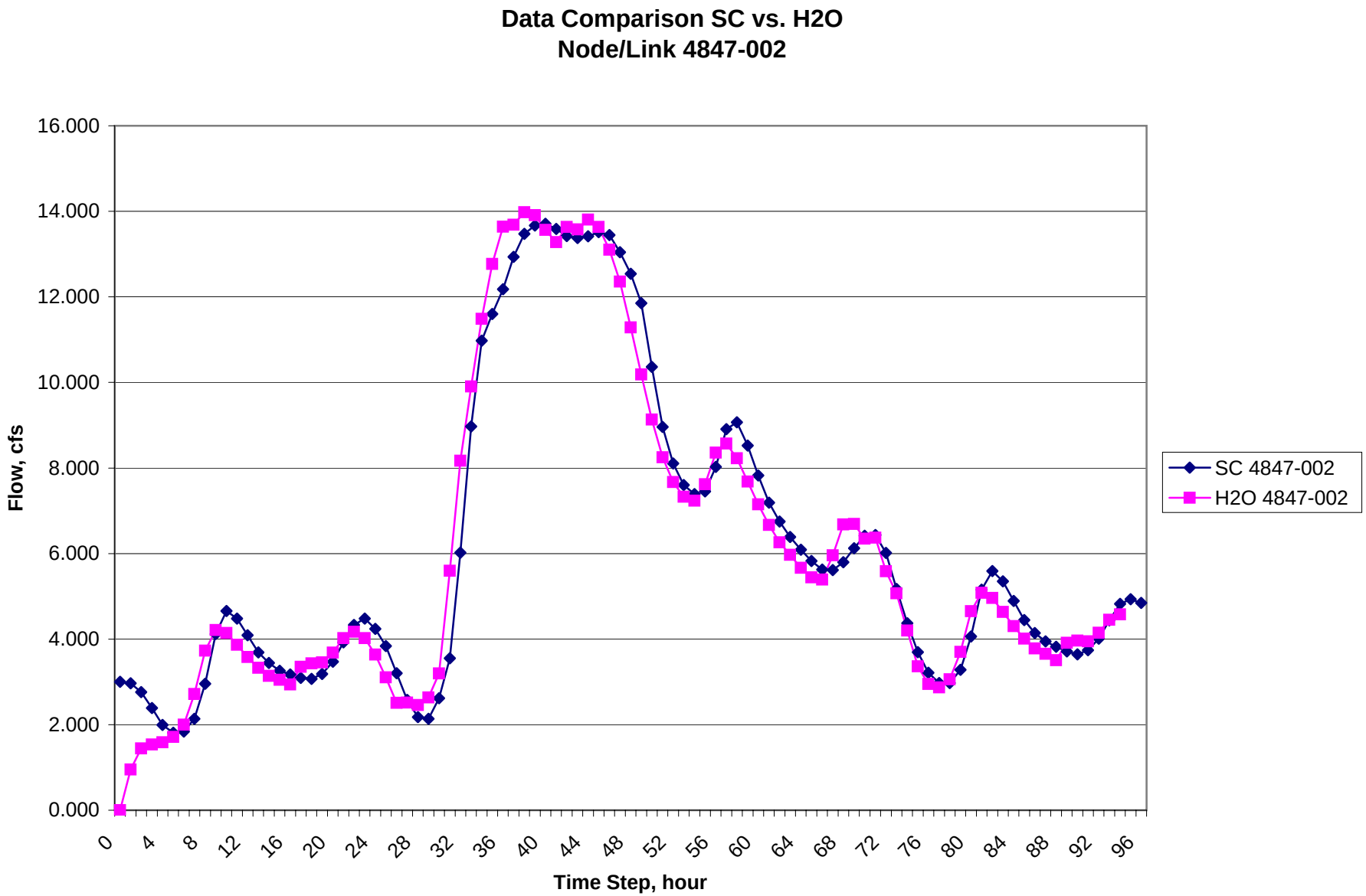

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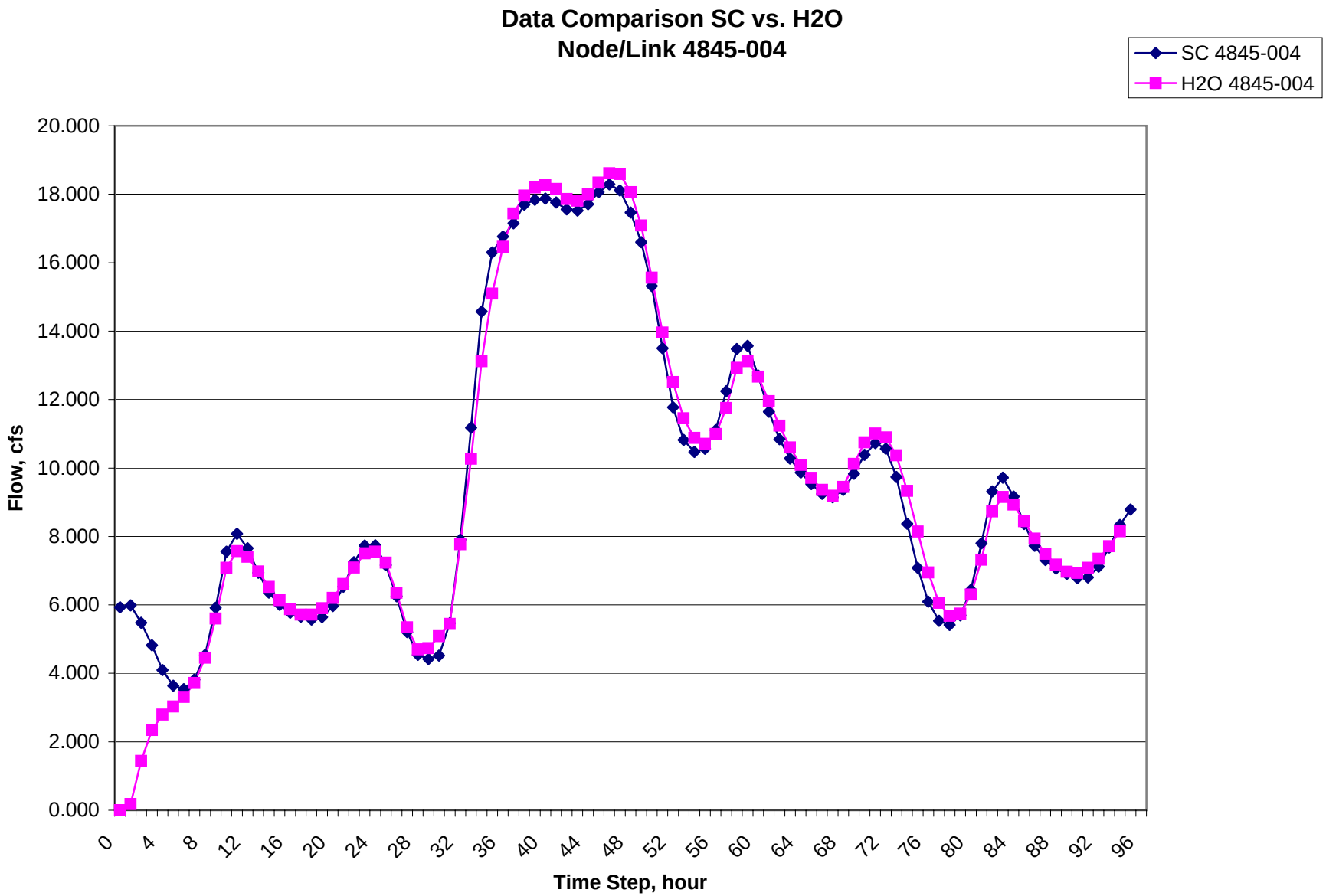

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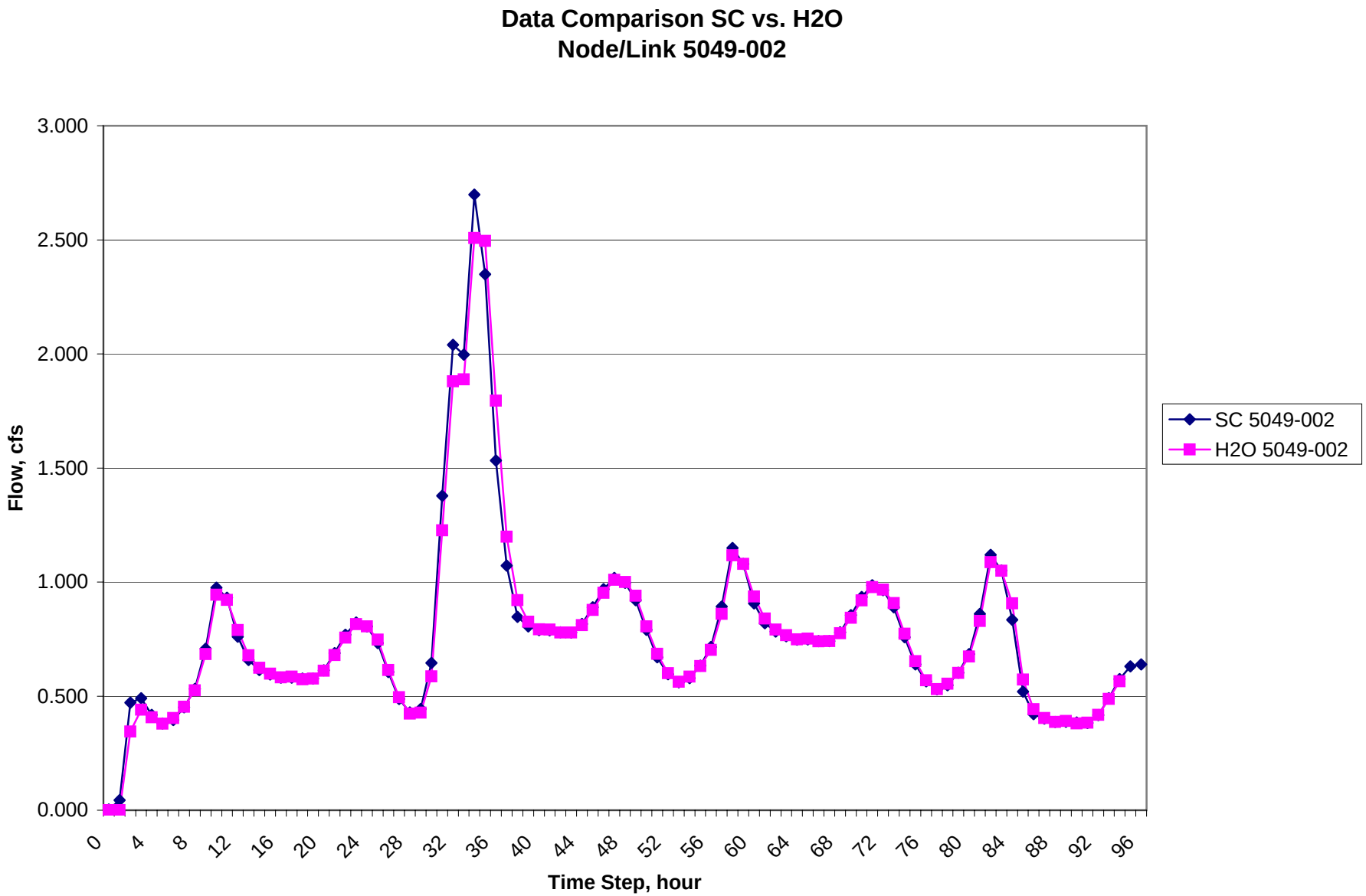

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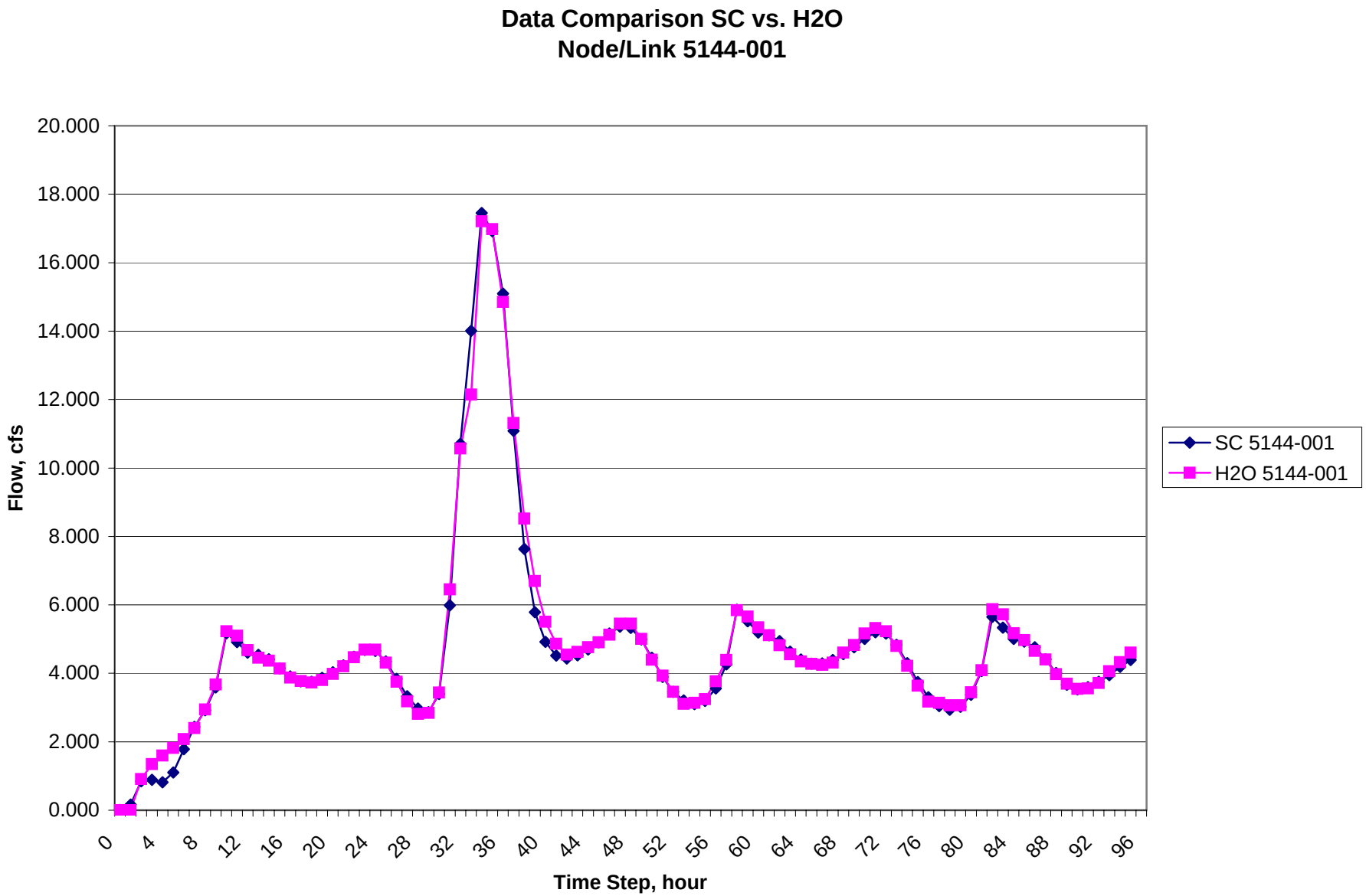

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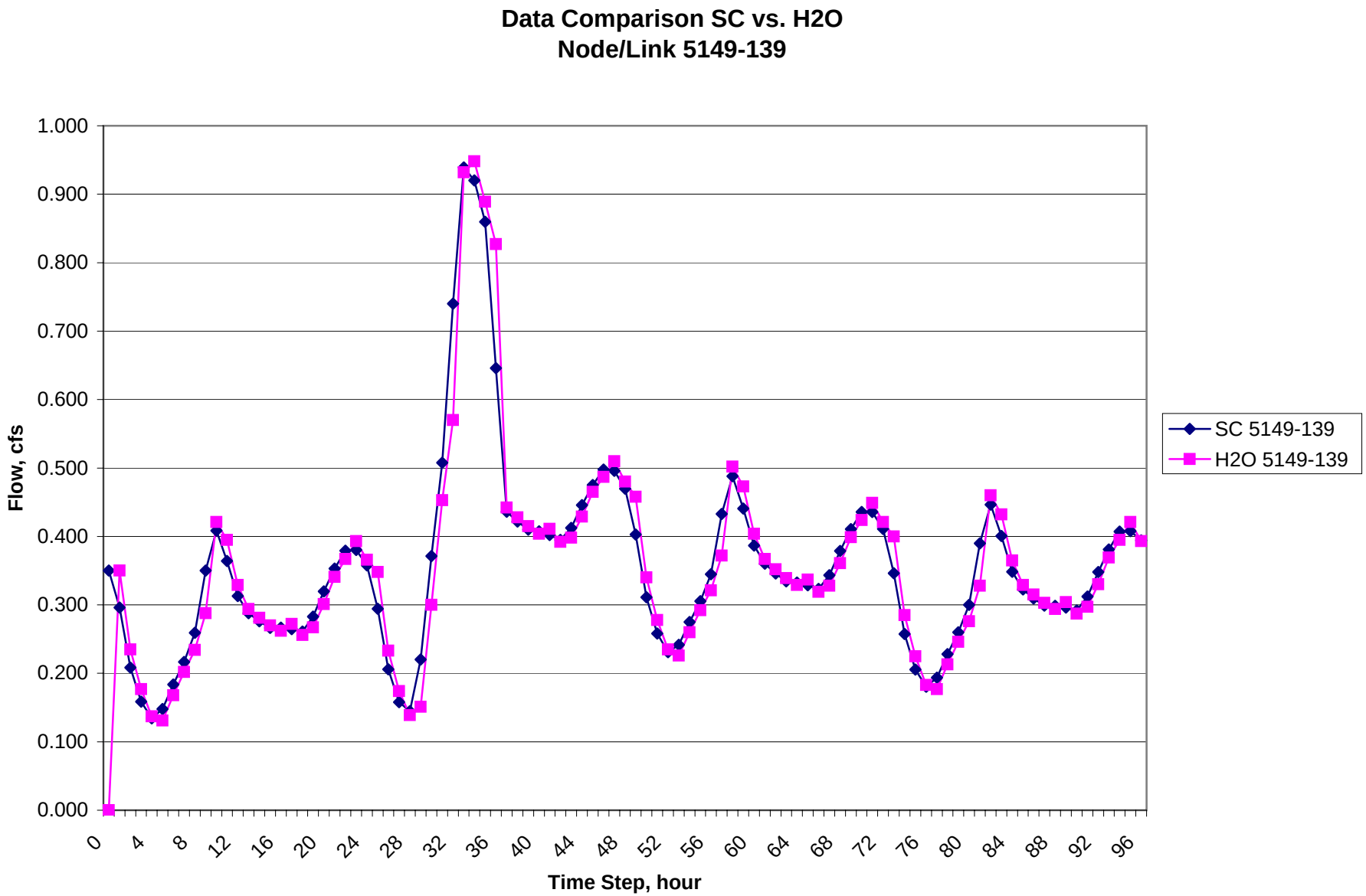

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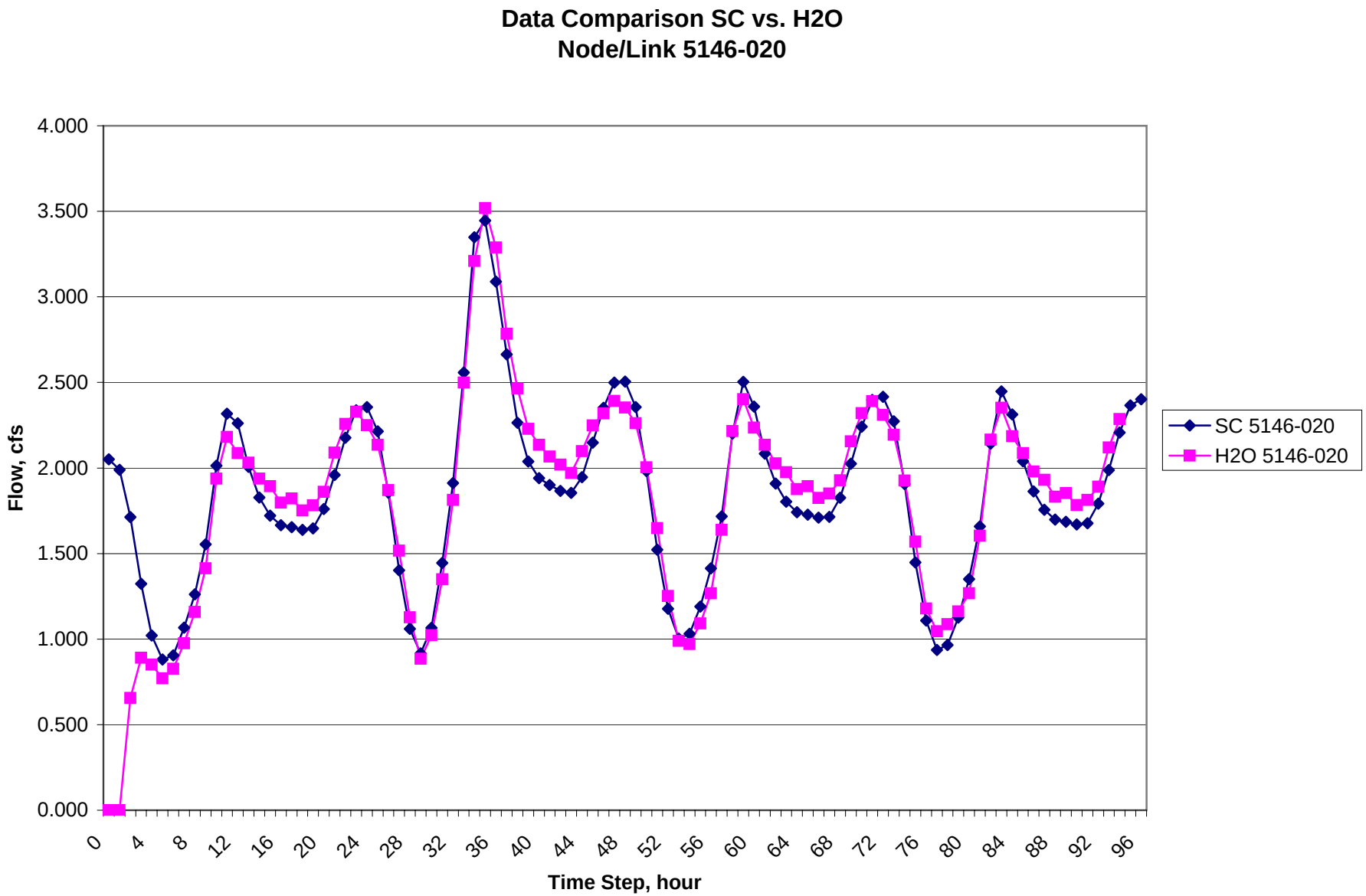

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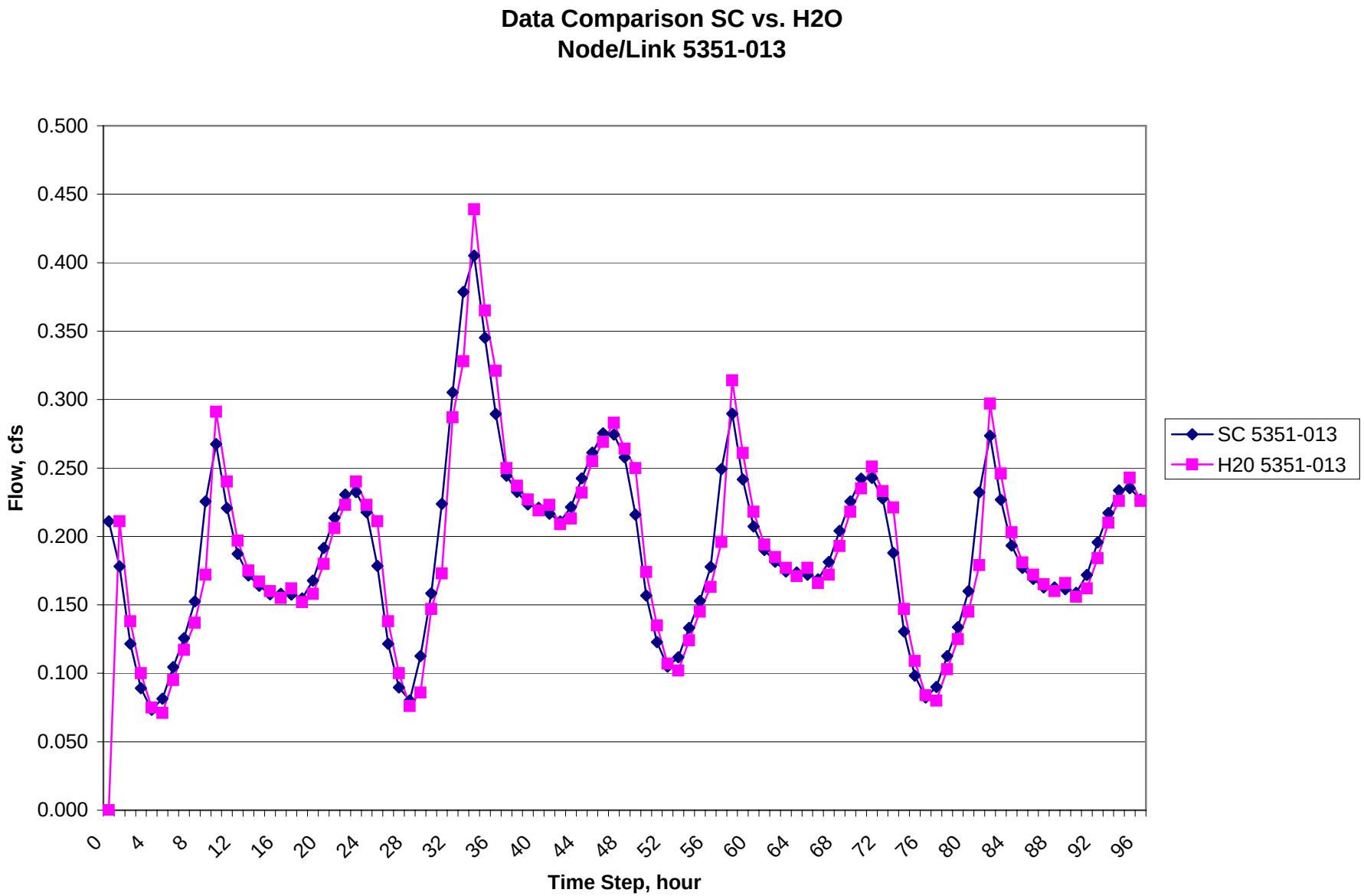

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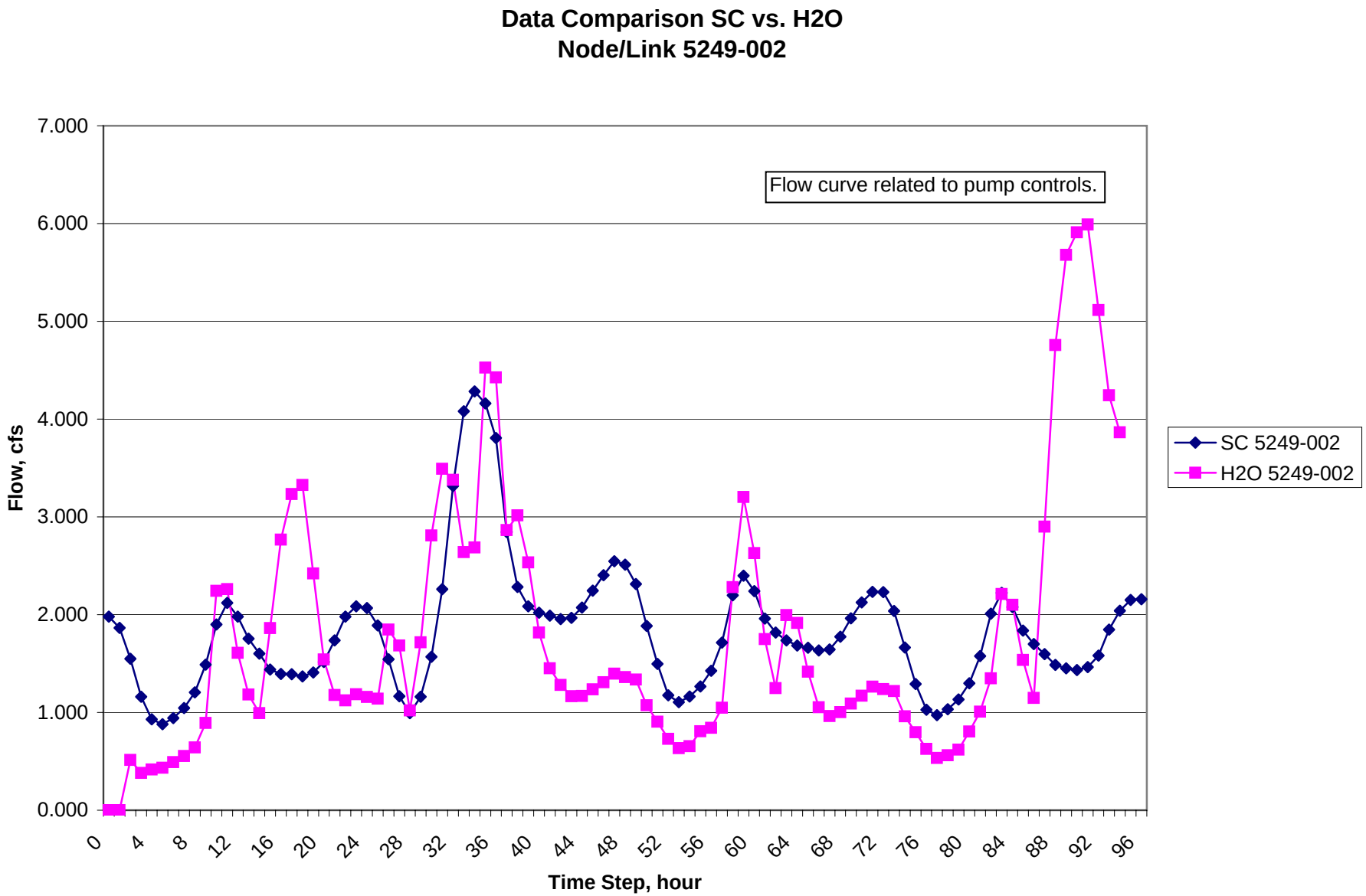

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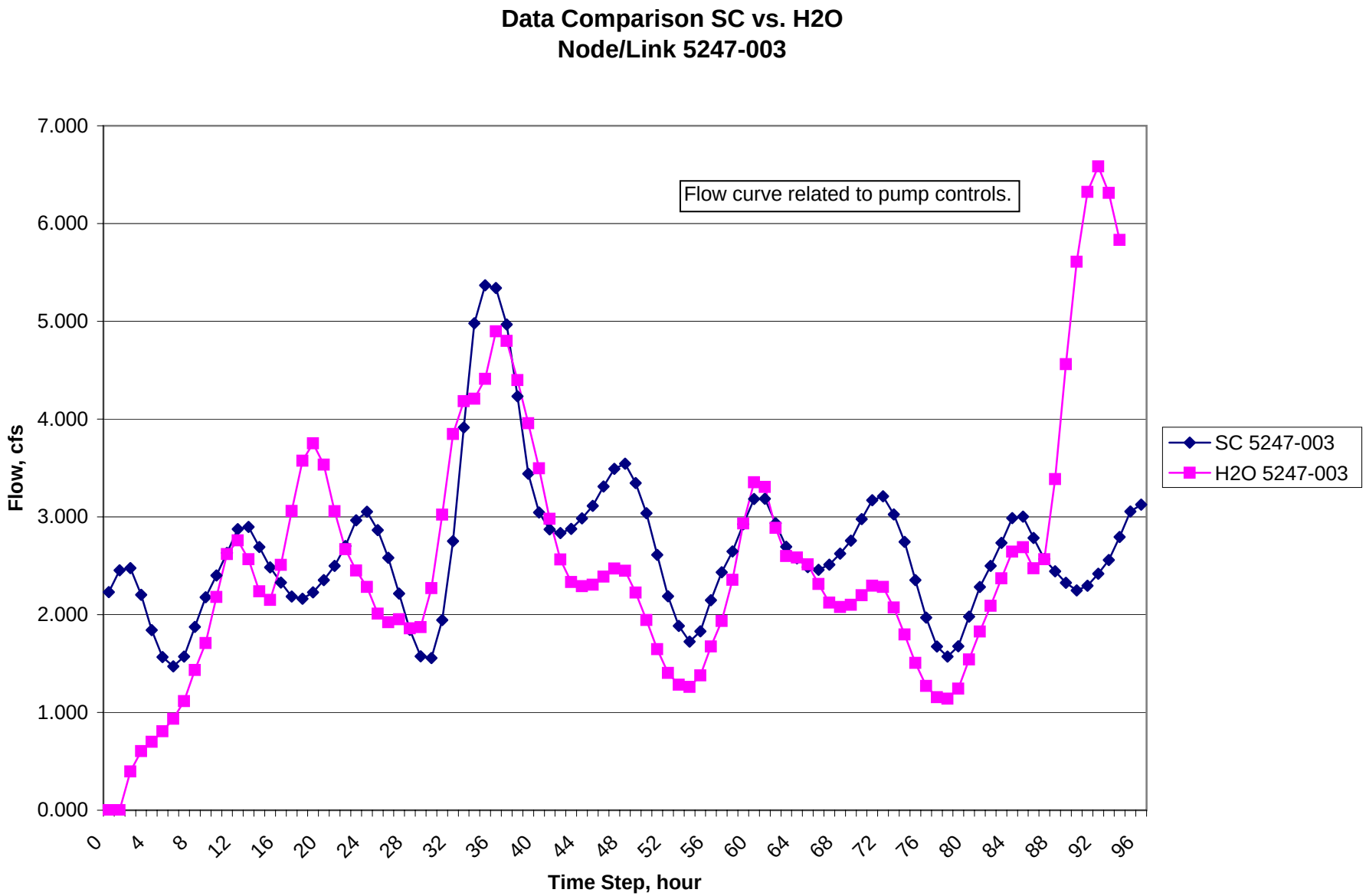

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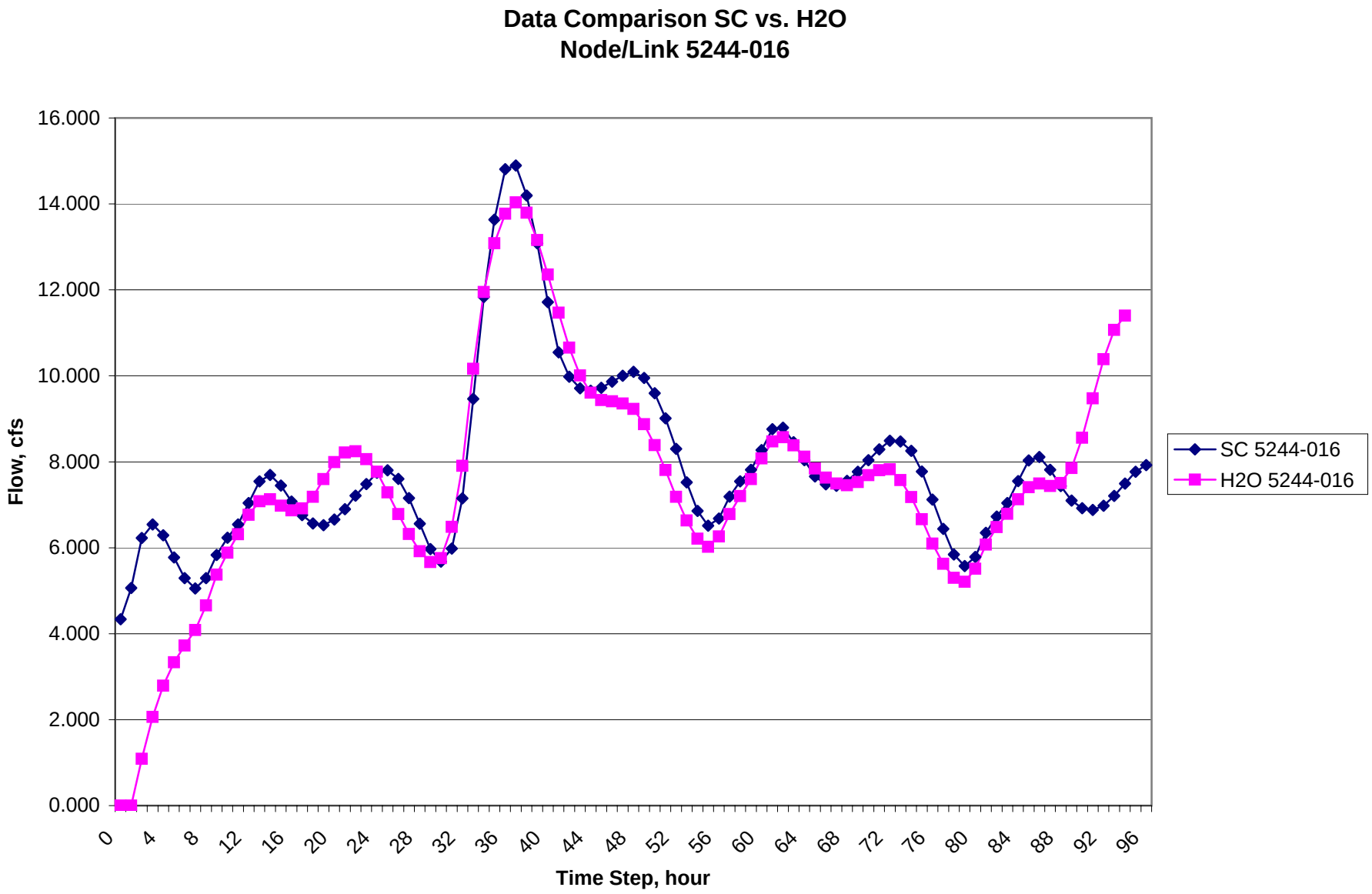

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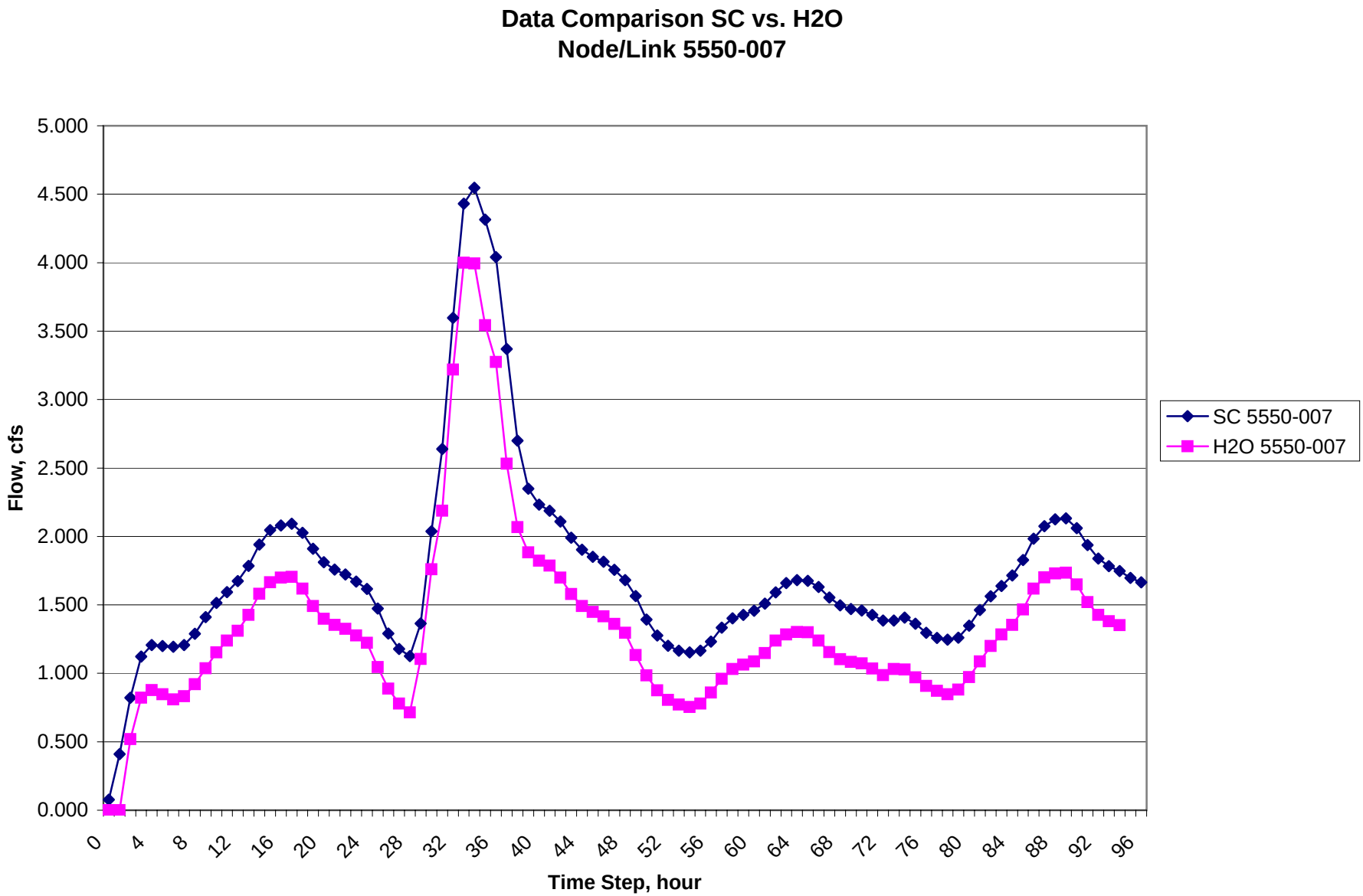

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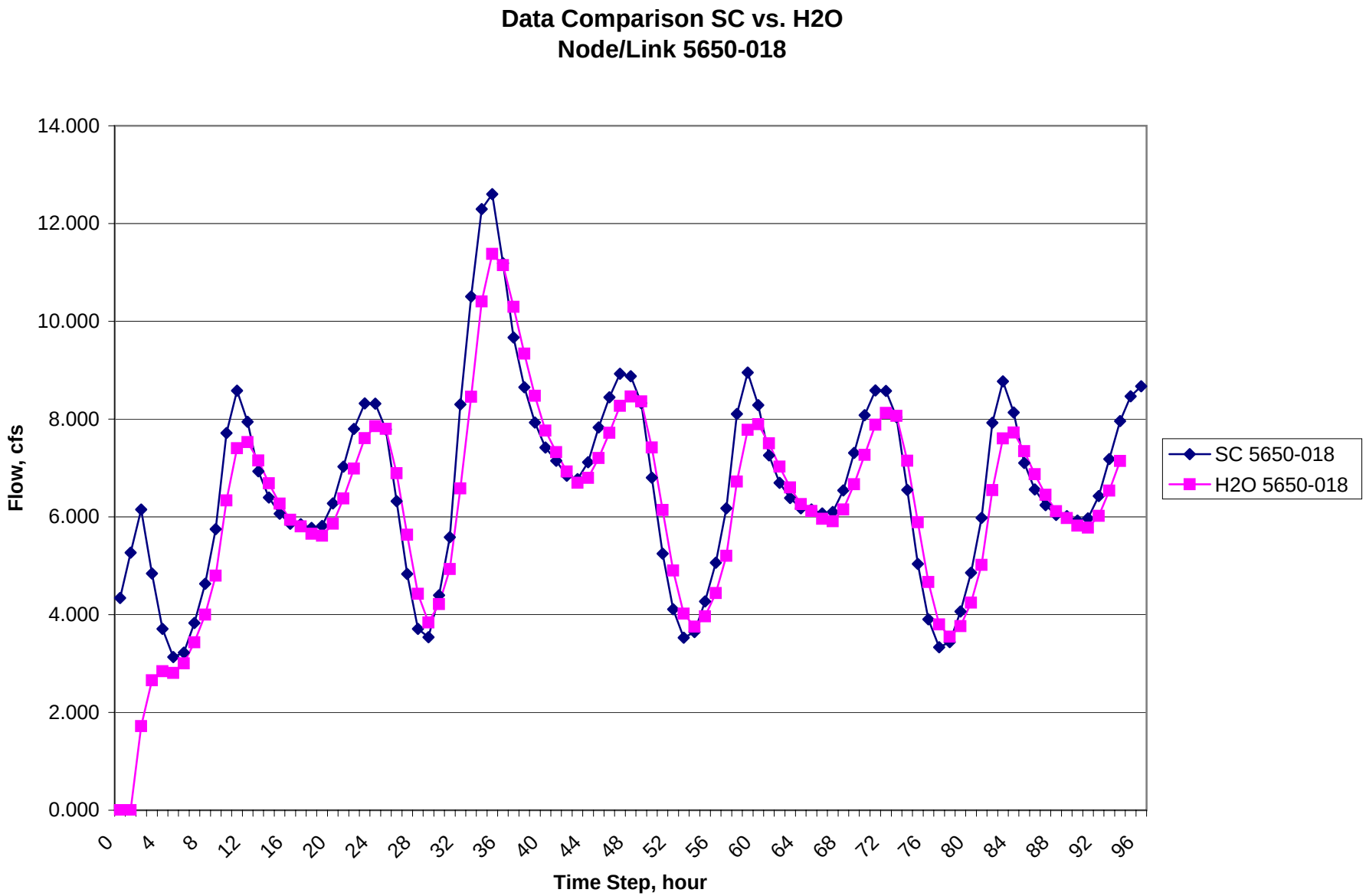

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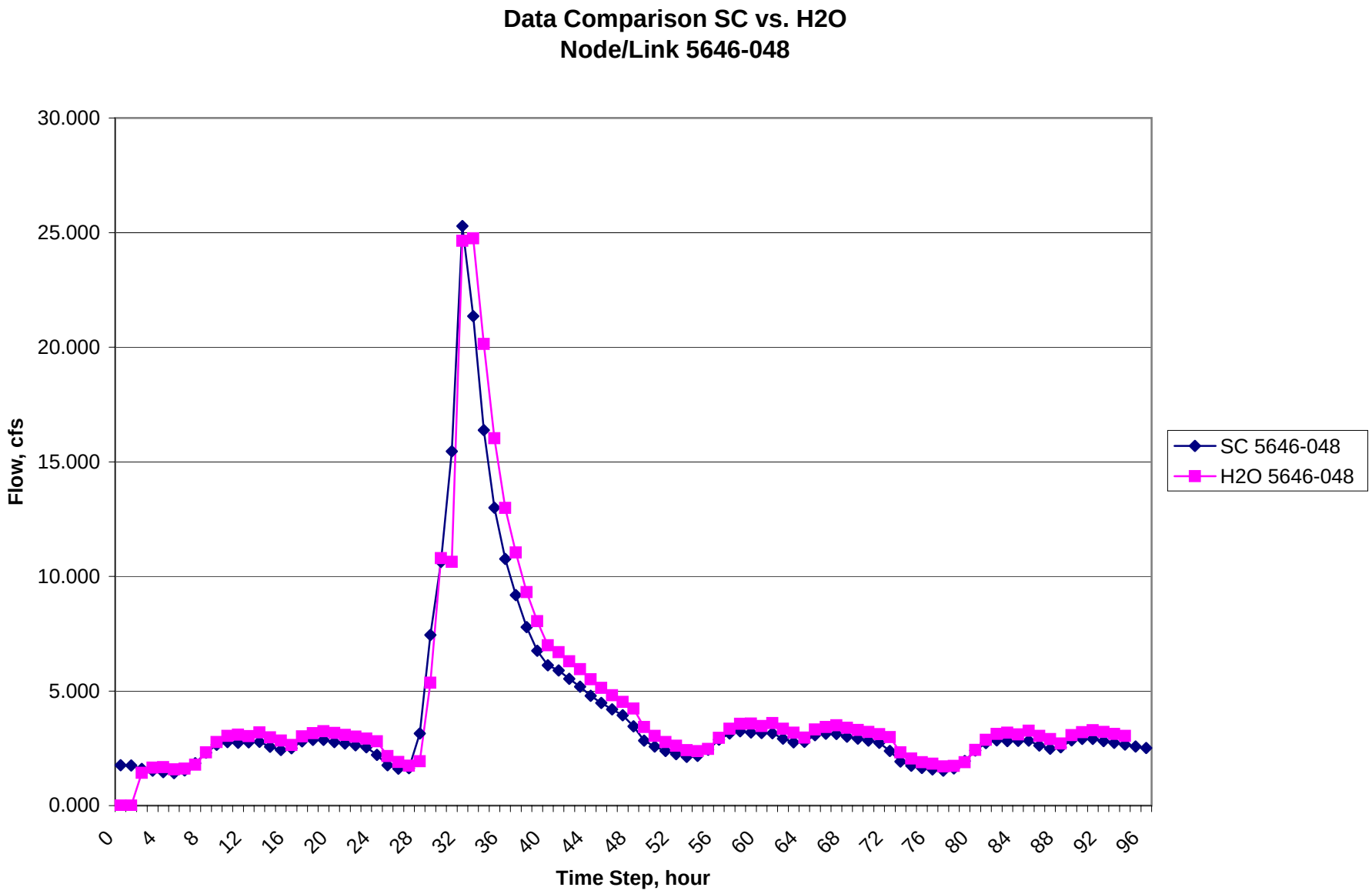

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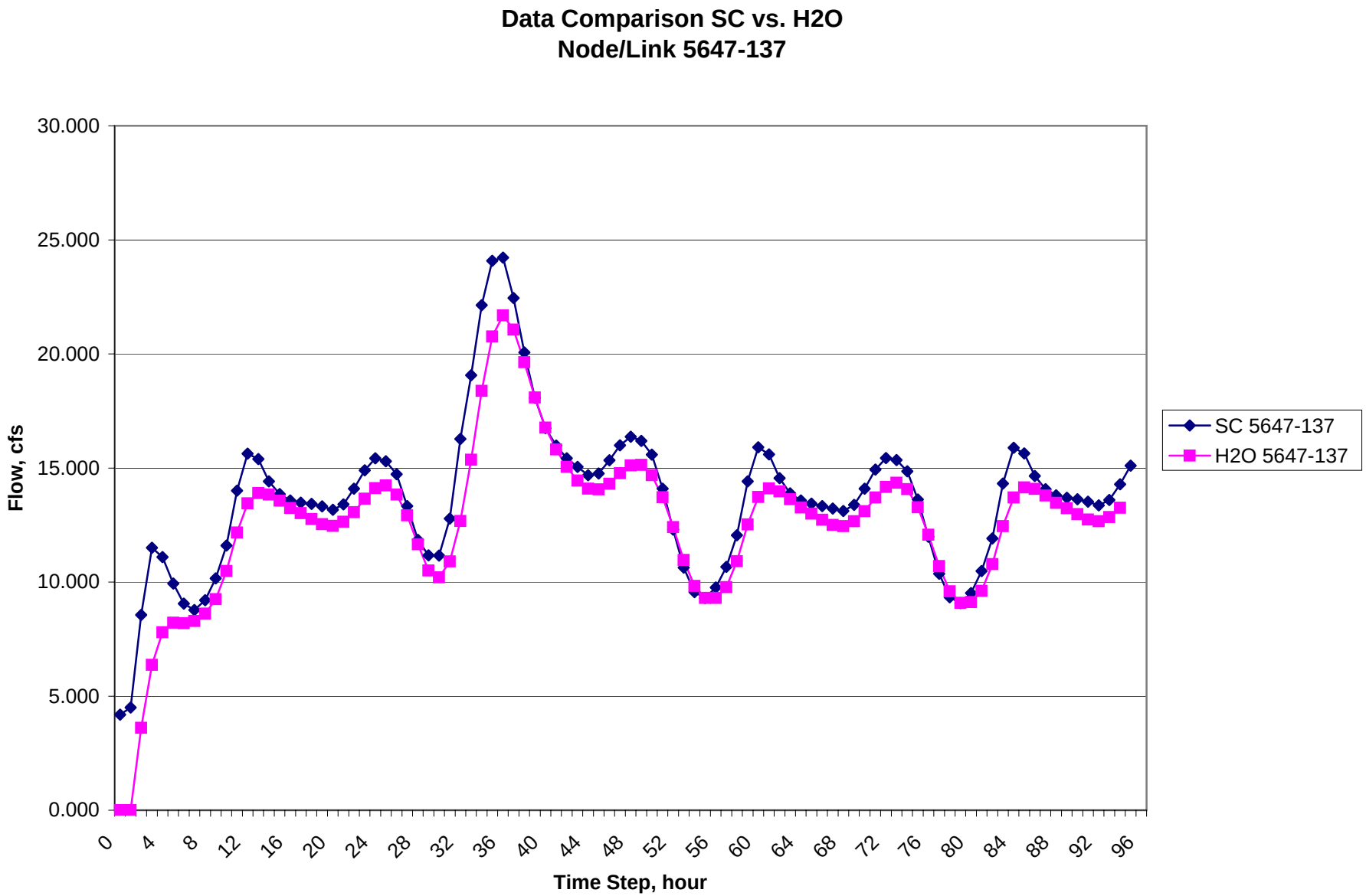

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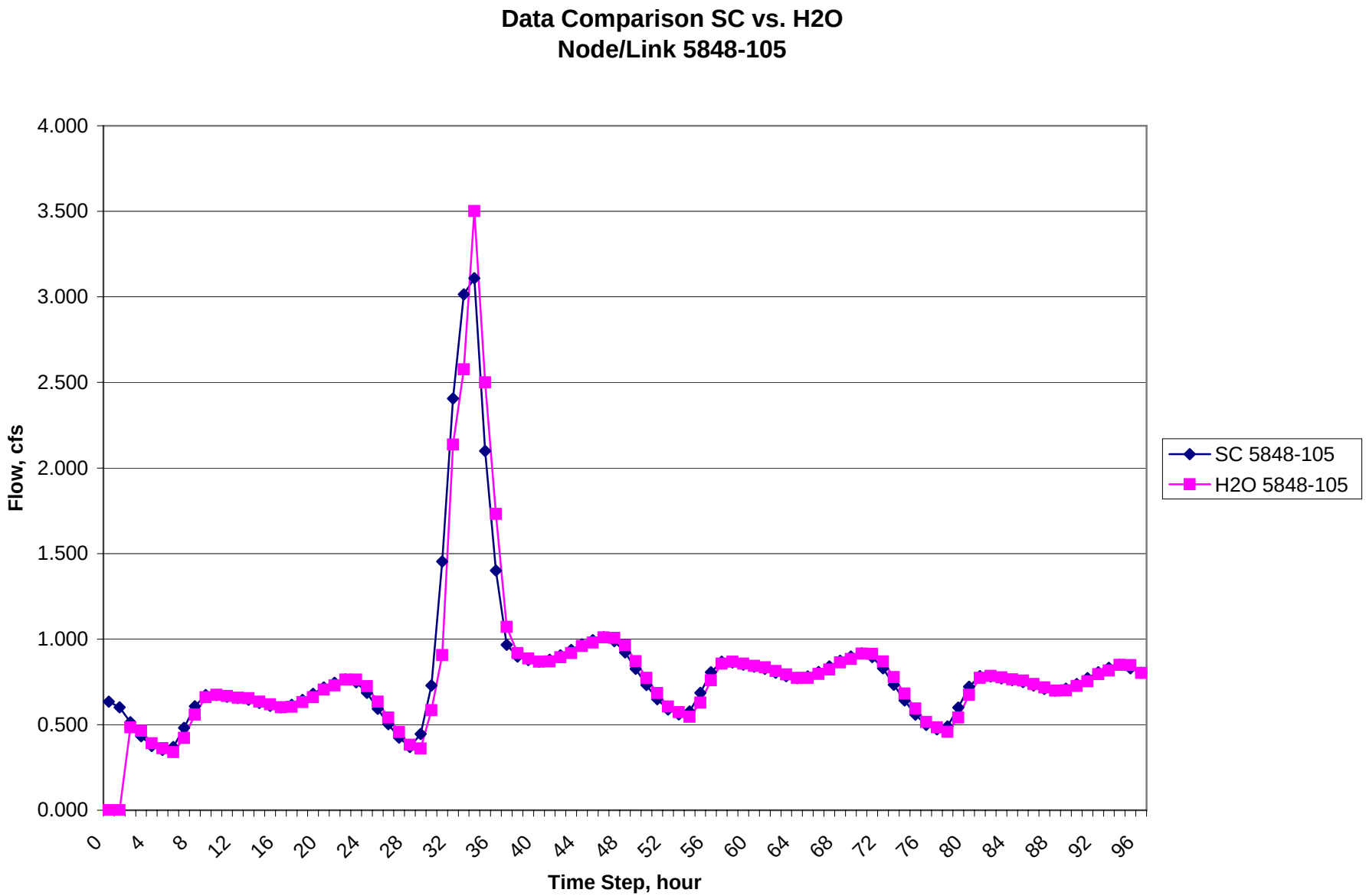

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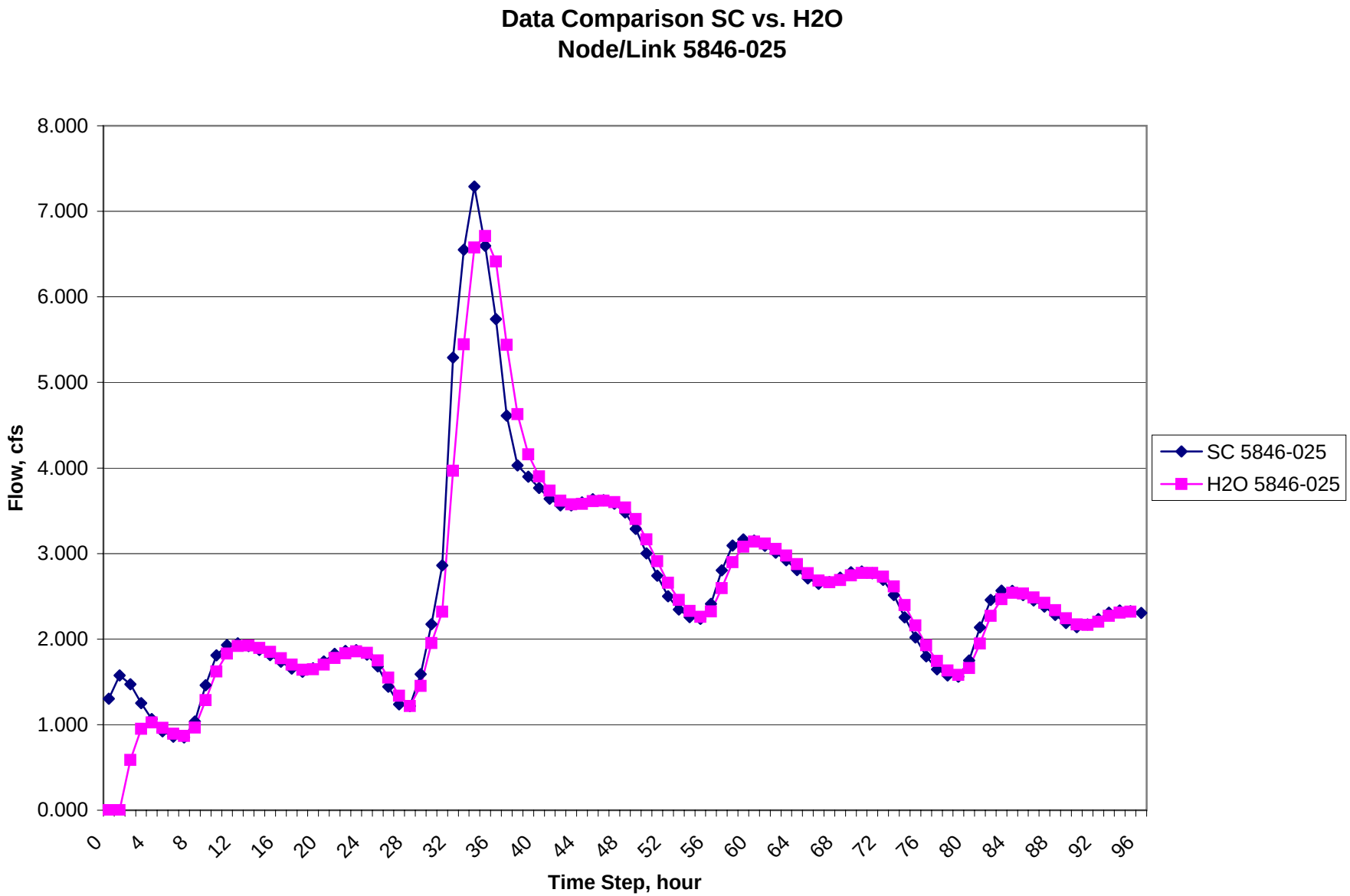

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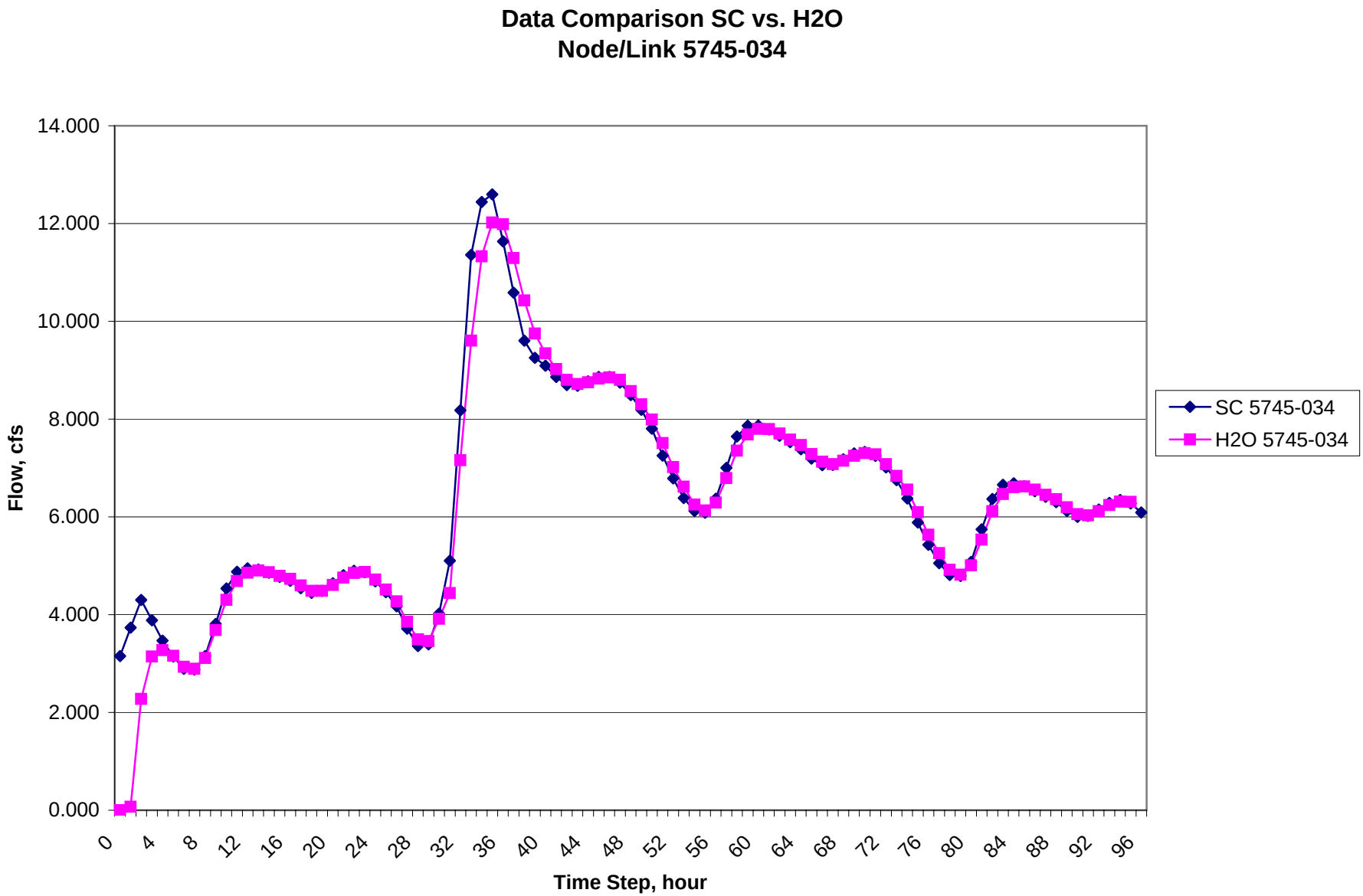

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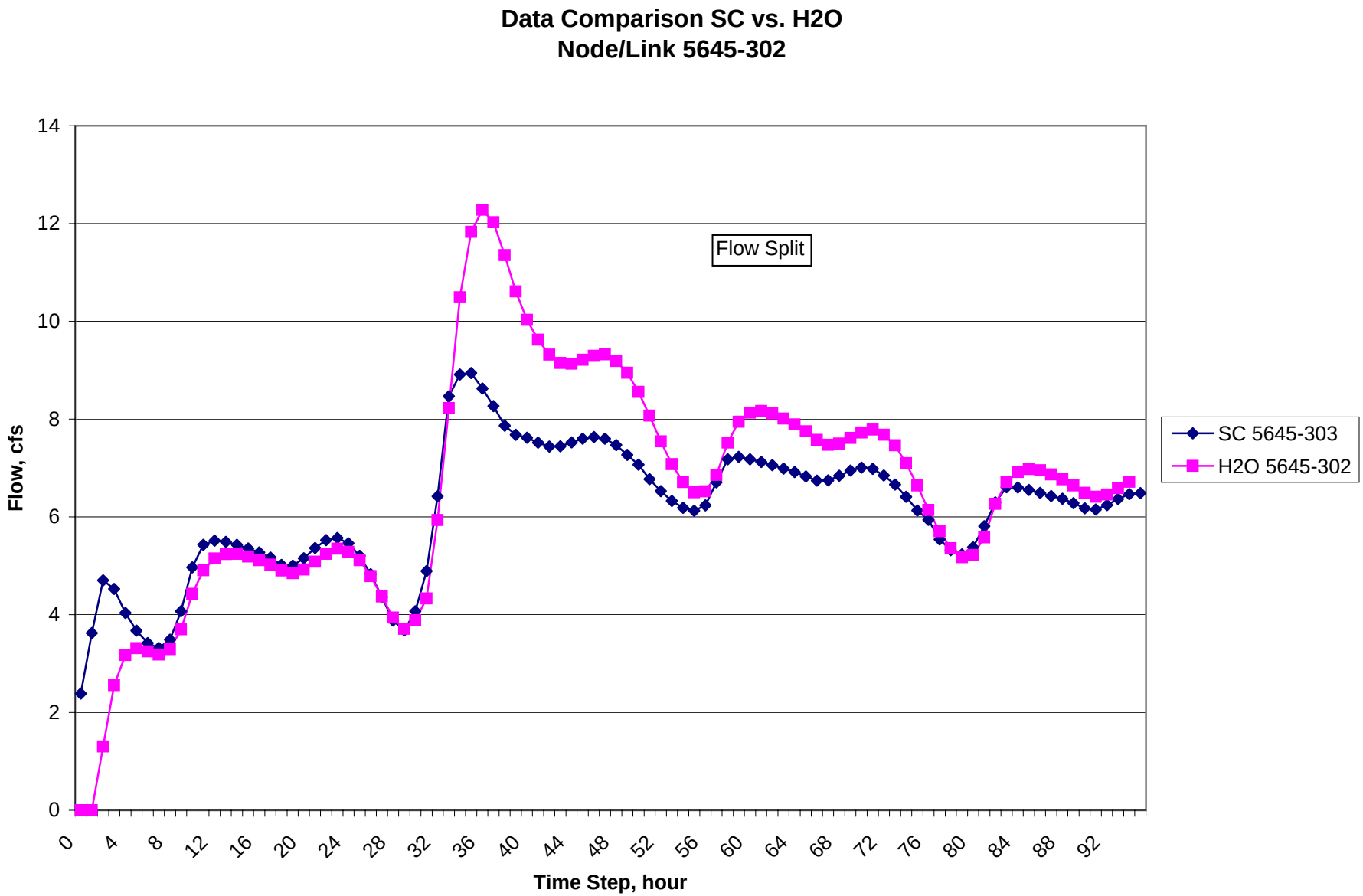

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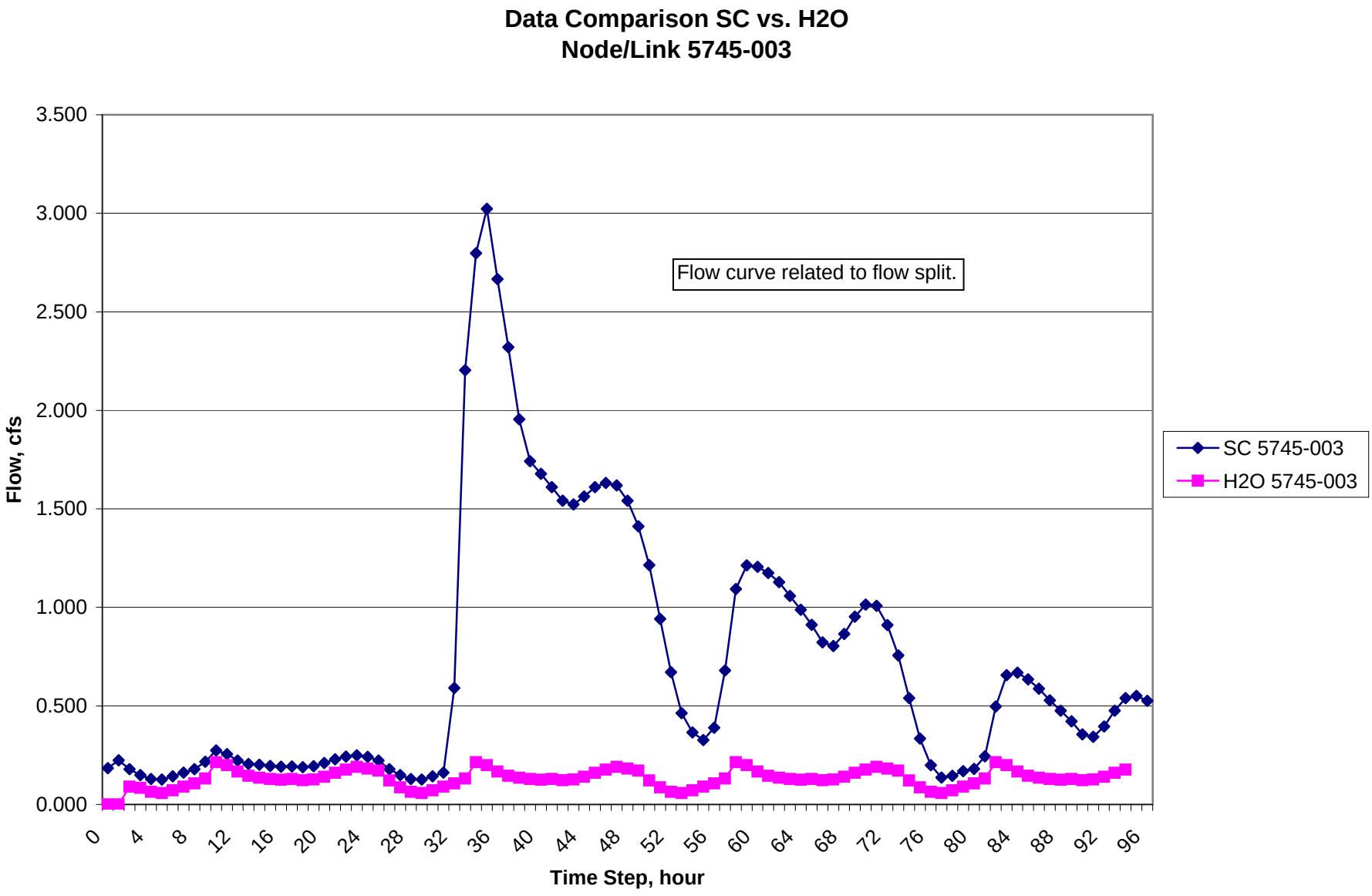

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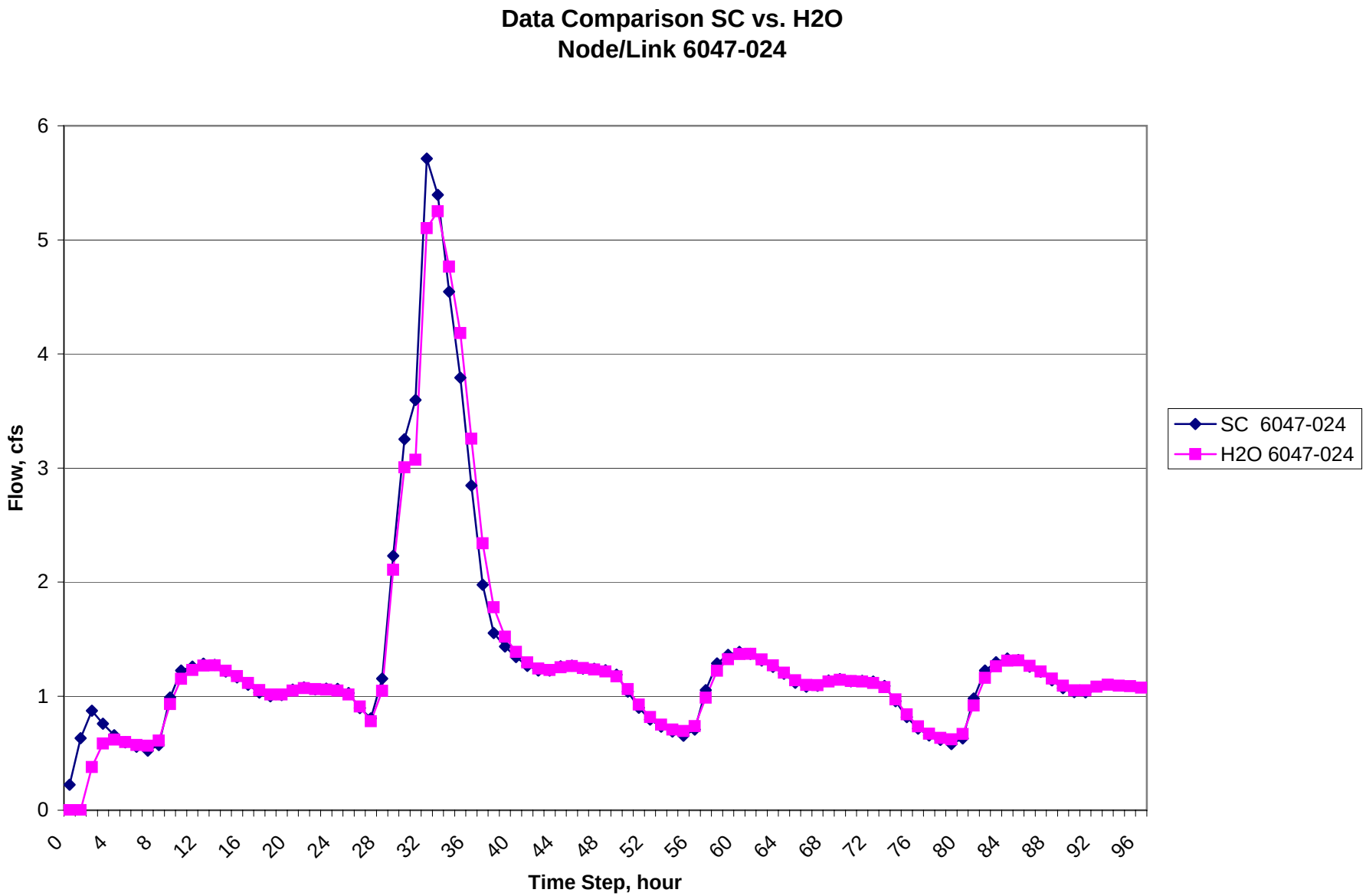

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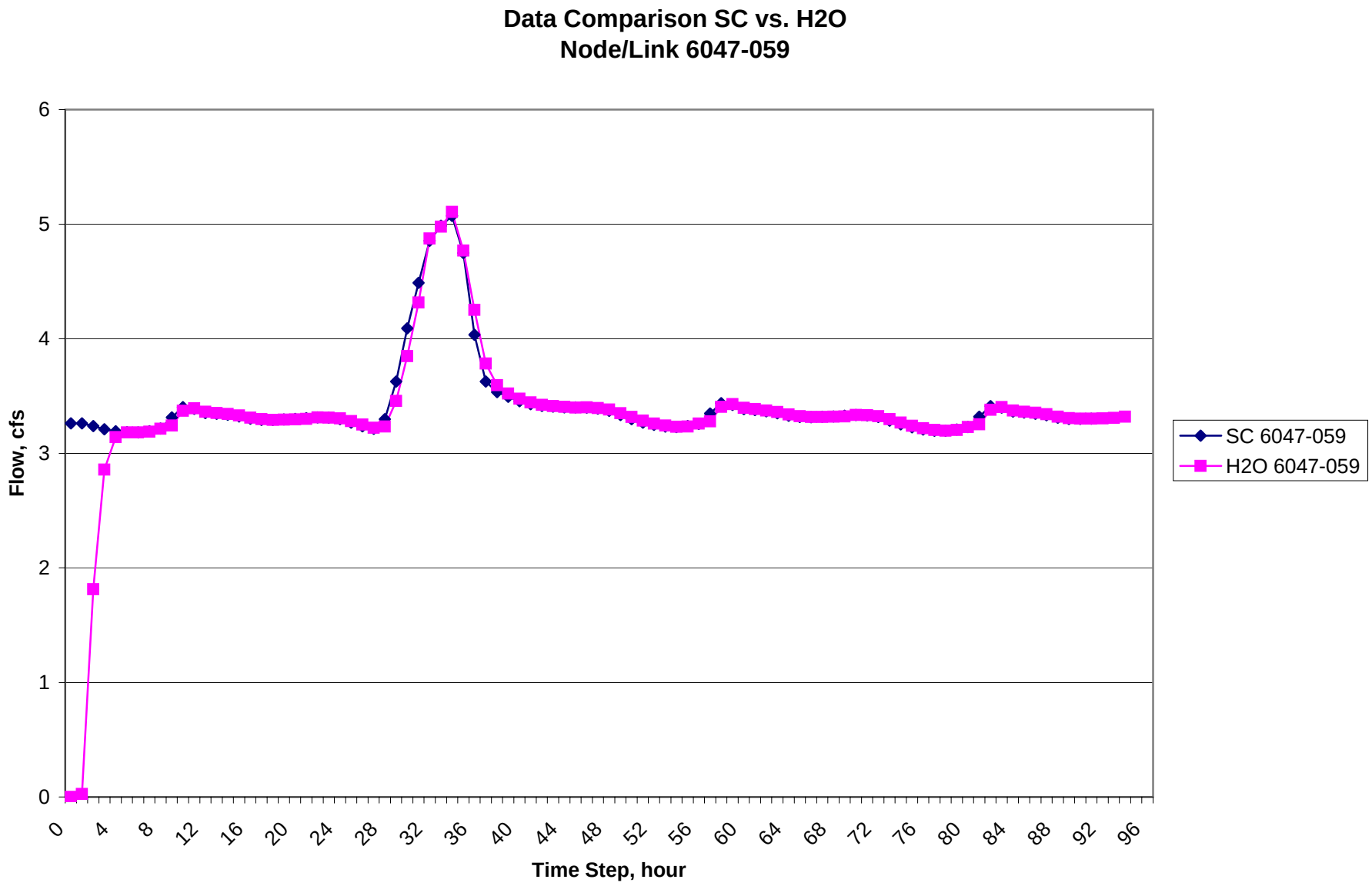

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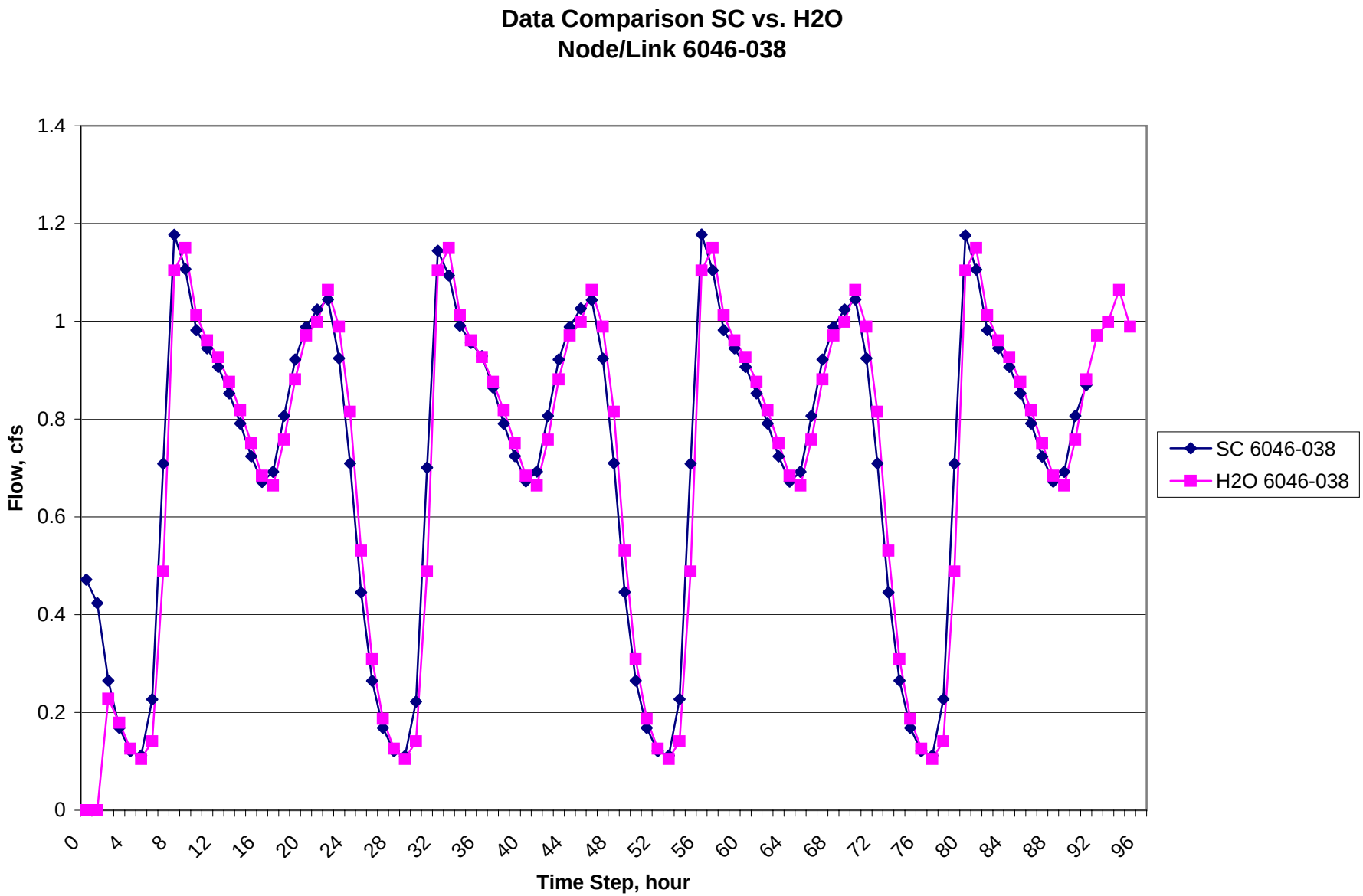

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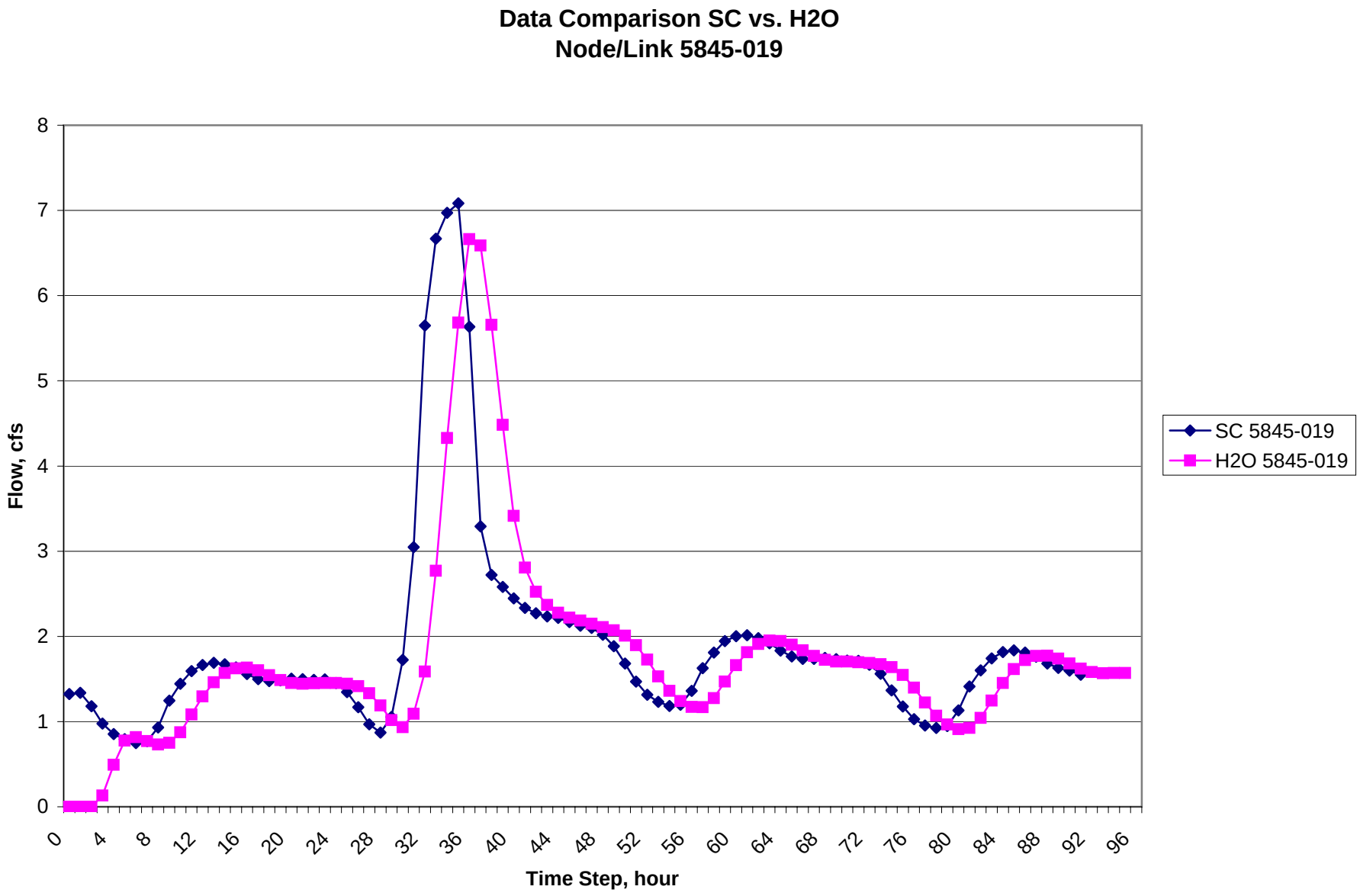

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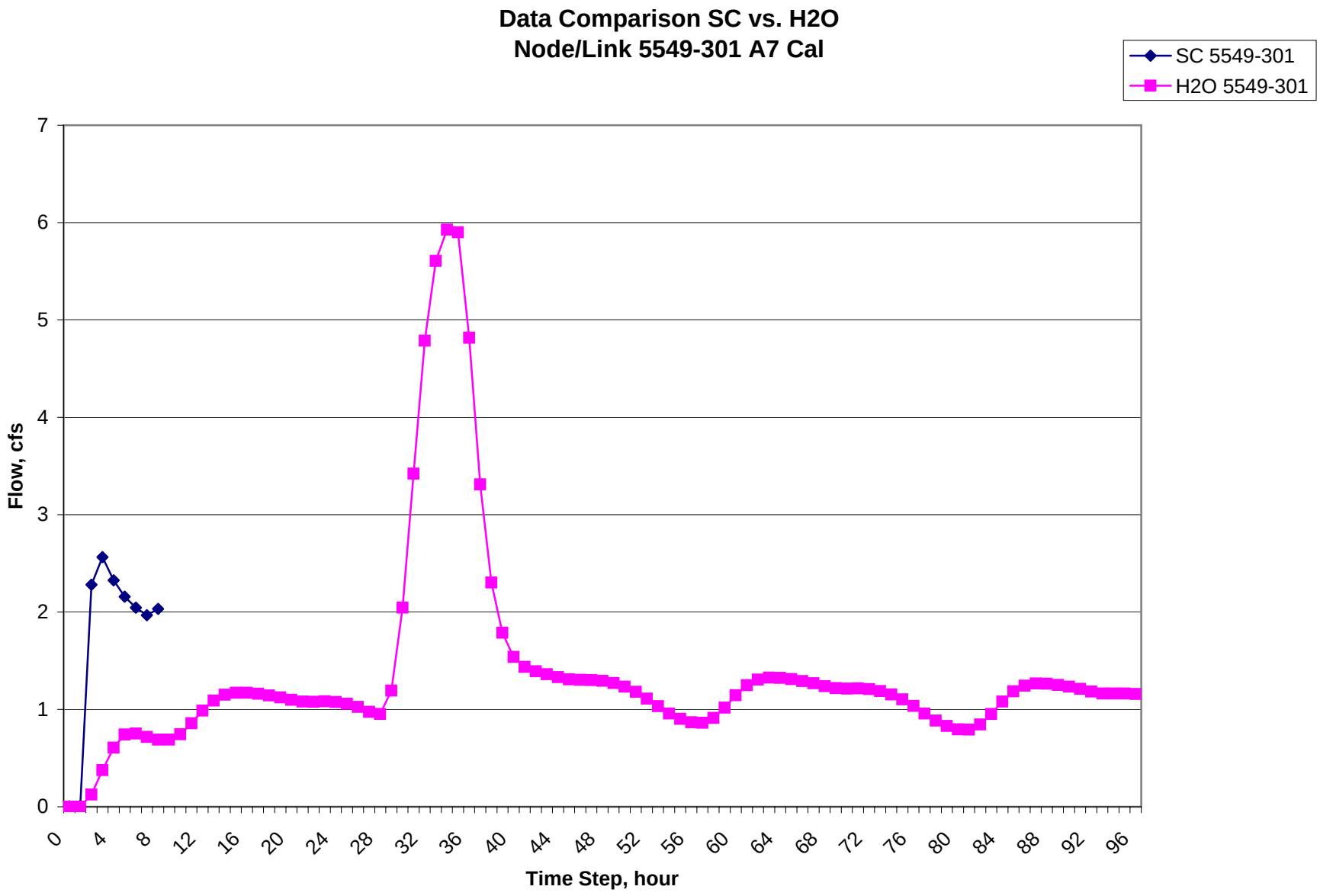
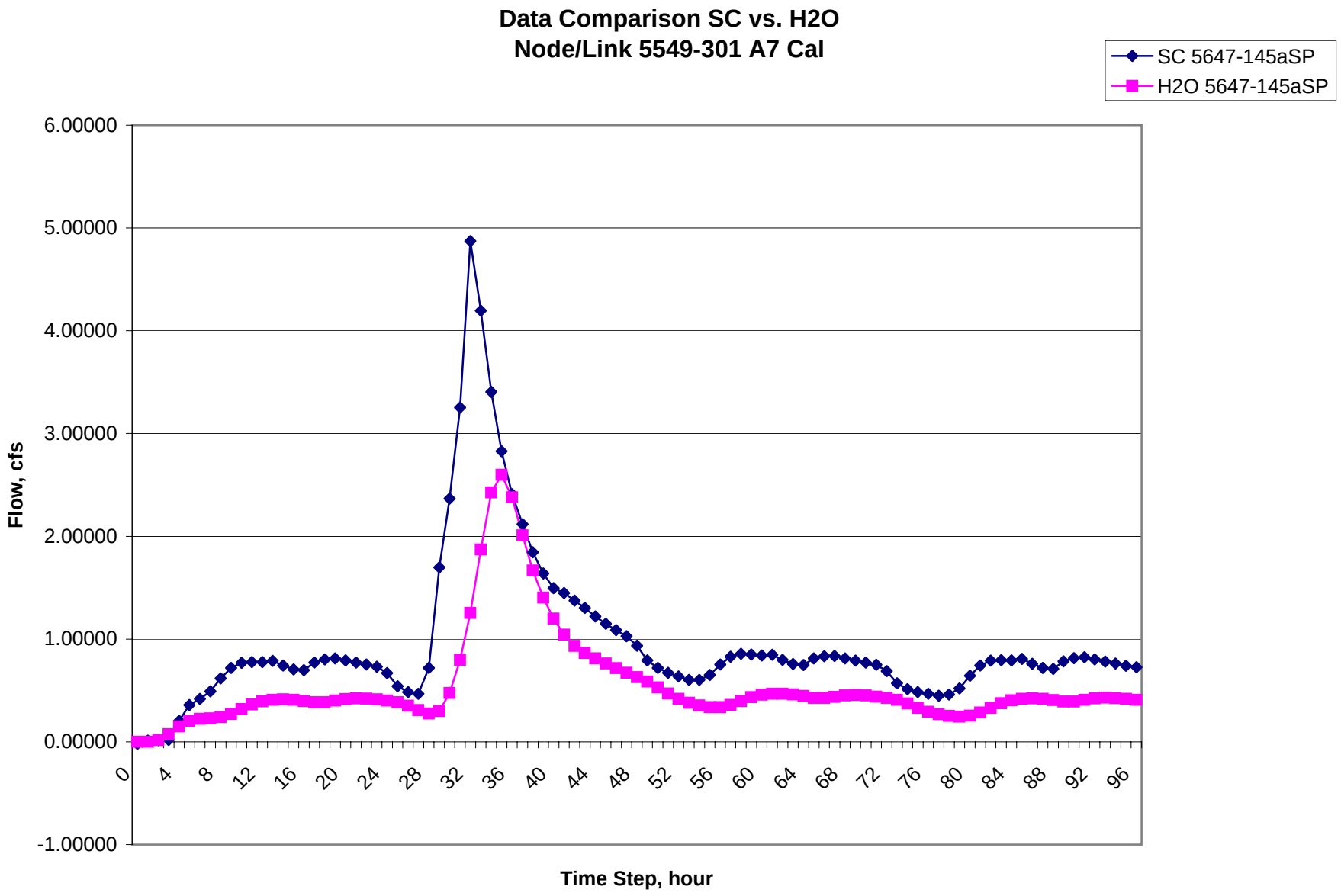
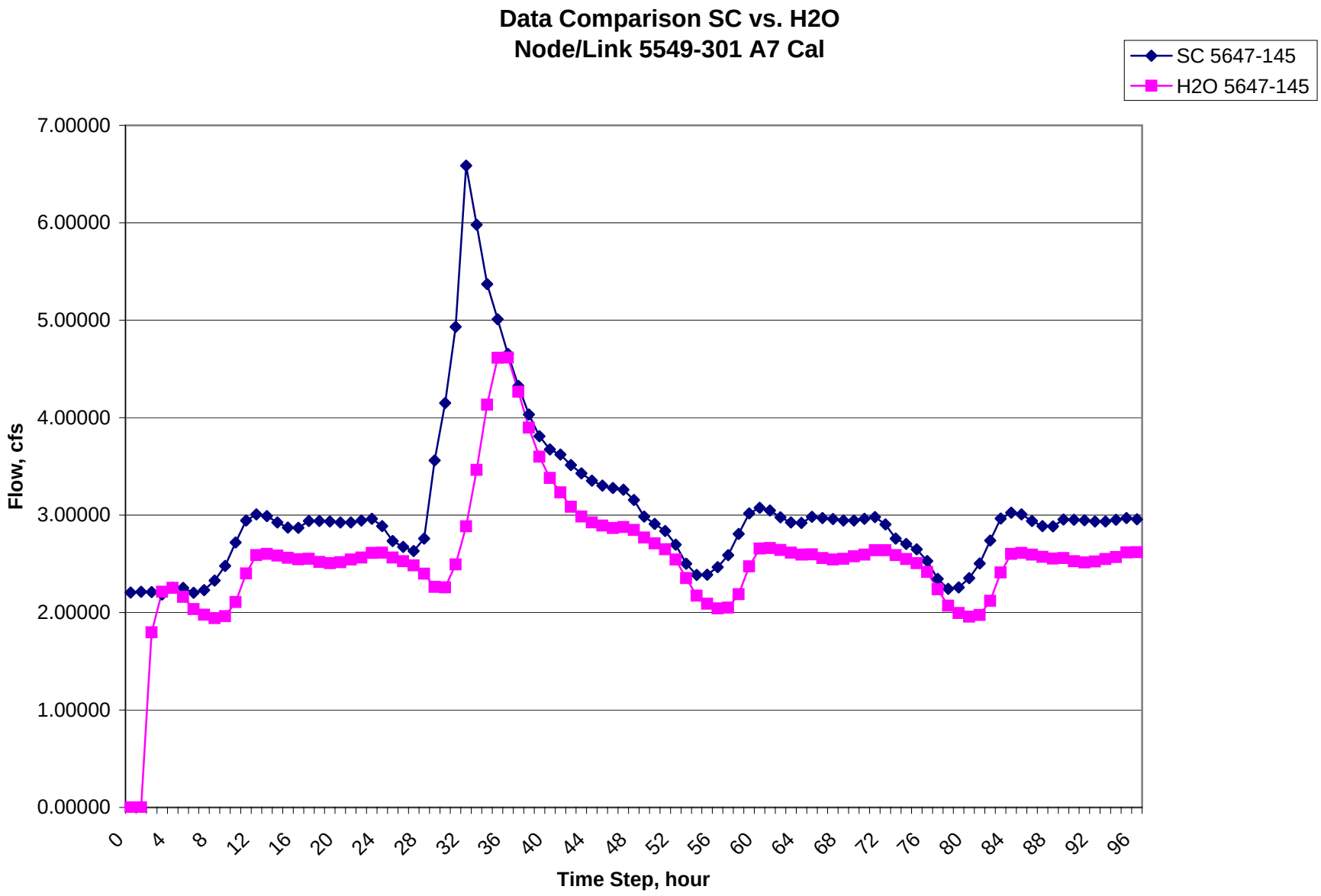
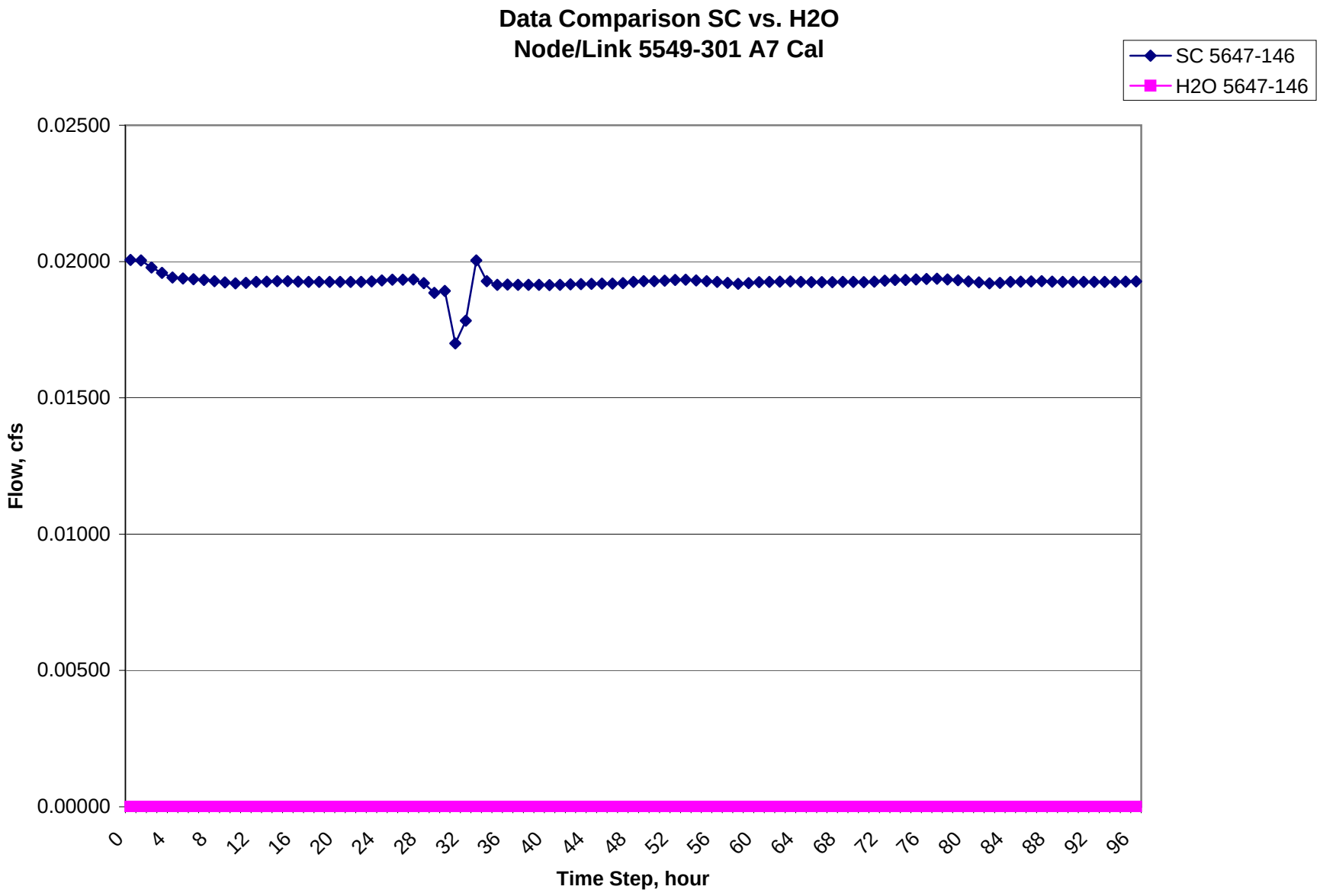
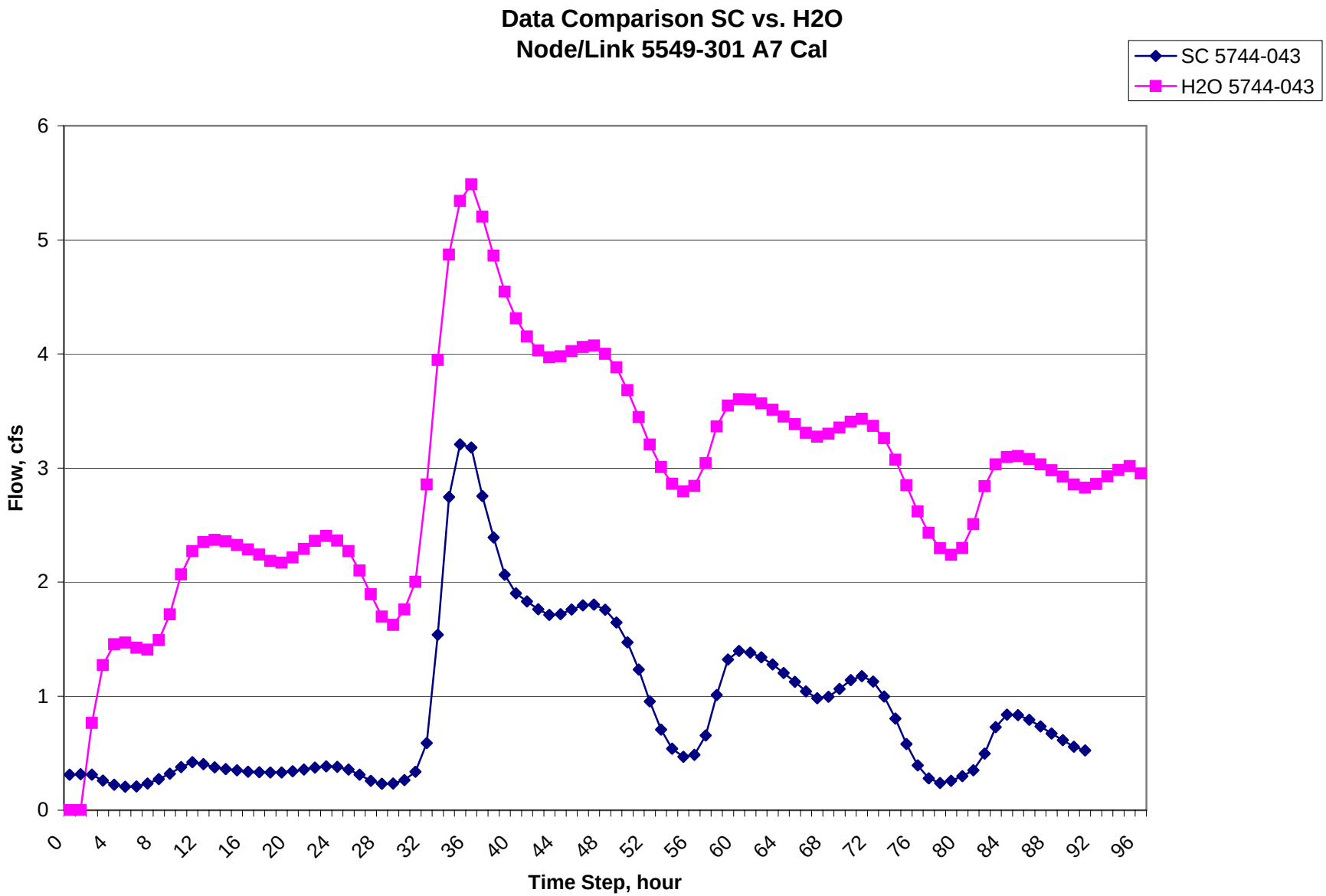

Data Comparison SC vs. H2O
Node/Link 5549-301 A7 Cal
SC 5549-301
H2O 5549-301
Flow, cfs
0
1
2
3
4
5
6
7
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
92
96
Time Step, hour

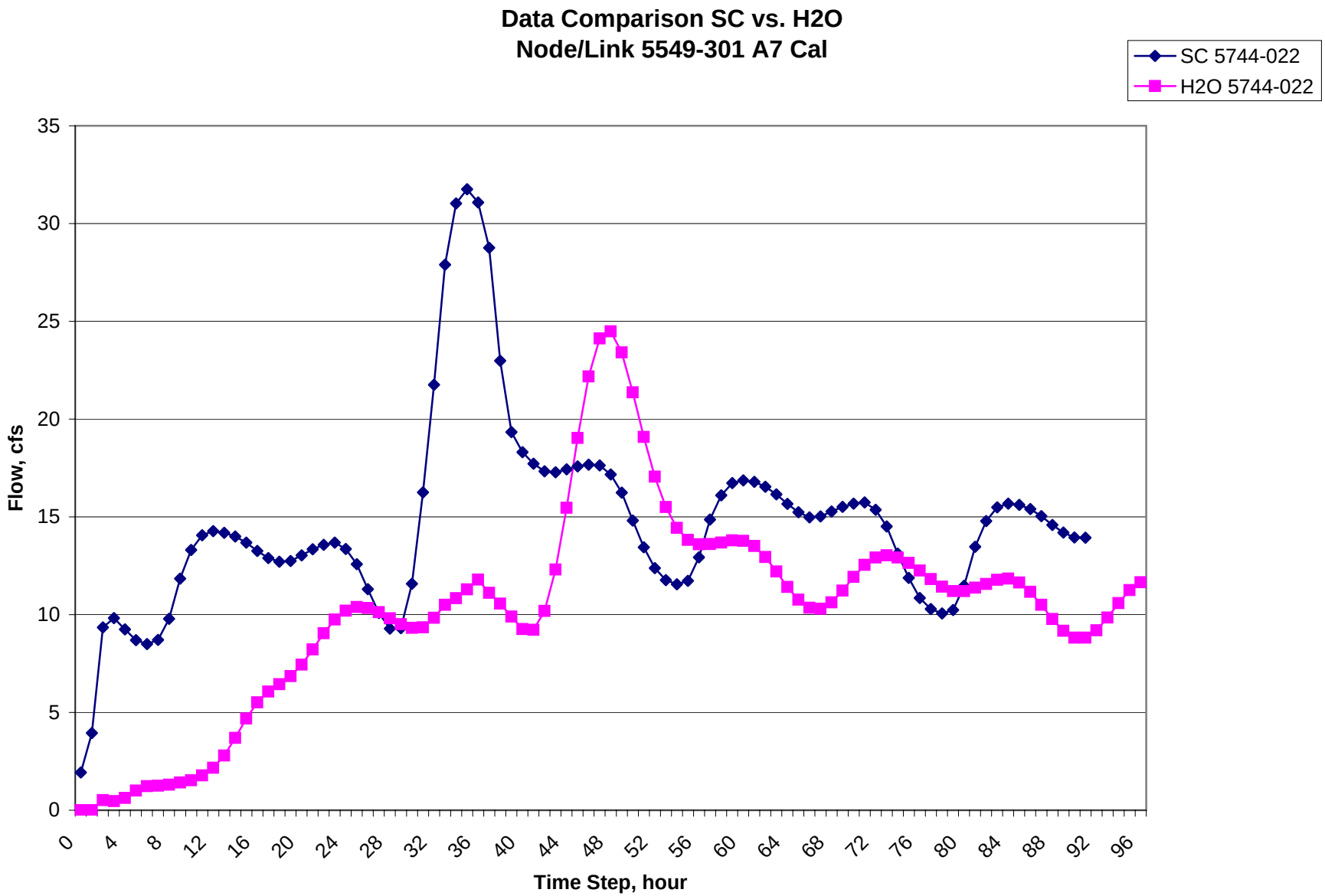

Data Comparison SC vs. H2O
Node/Link 5549-301 A7 Cal
SC 5647-145aSP
H2O 5647-145aSP
6.00000
5.00000
4.00000
3.00000
2.00000
1.00000
0.00000
-1.00000
Flow, cfs
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
92
96
Time Step, hour


Data Comparison SC vs. H2O
Node/Link 5549-301 A7 Cal
SC 5647-145
H2O 5647-145
Flow, cfs
7.00000
6.00000
5.00000
4.00000
3.00000
2.00000
1.00000
0.00000
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
92
96
Time Step, hour


Data Comparison SC vs. H2O
Node/Link 5549-301 A7 Cal
SC 5647-146
H2O 5647-146
0.02500
0.02000
0.01500
0.01000
0.00500
0.00000
Flow, cfs
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60
64
68
72
76
80
84
88
92
96
Time Step, hour



SC_H2O_ModelOutput.xls



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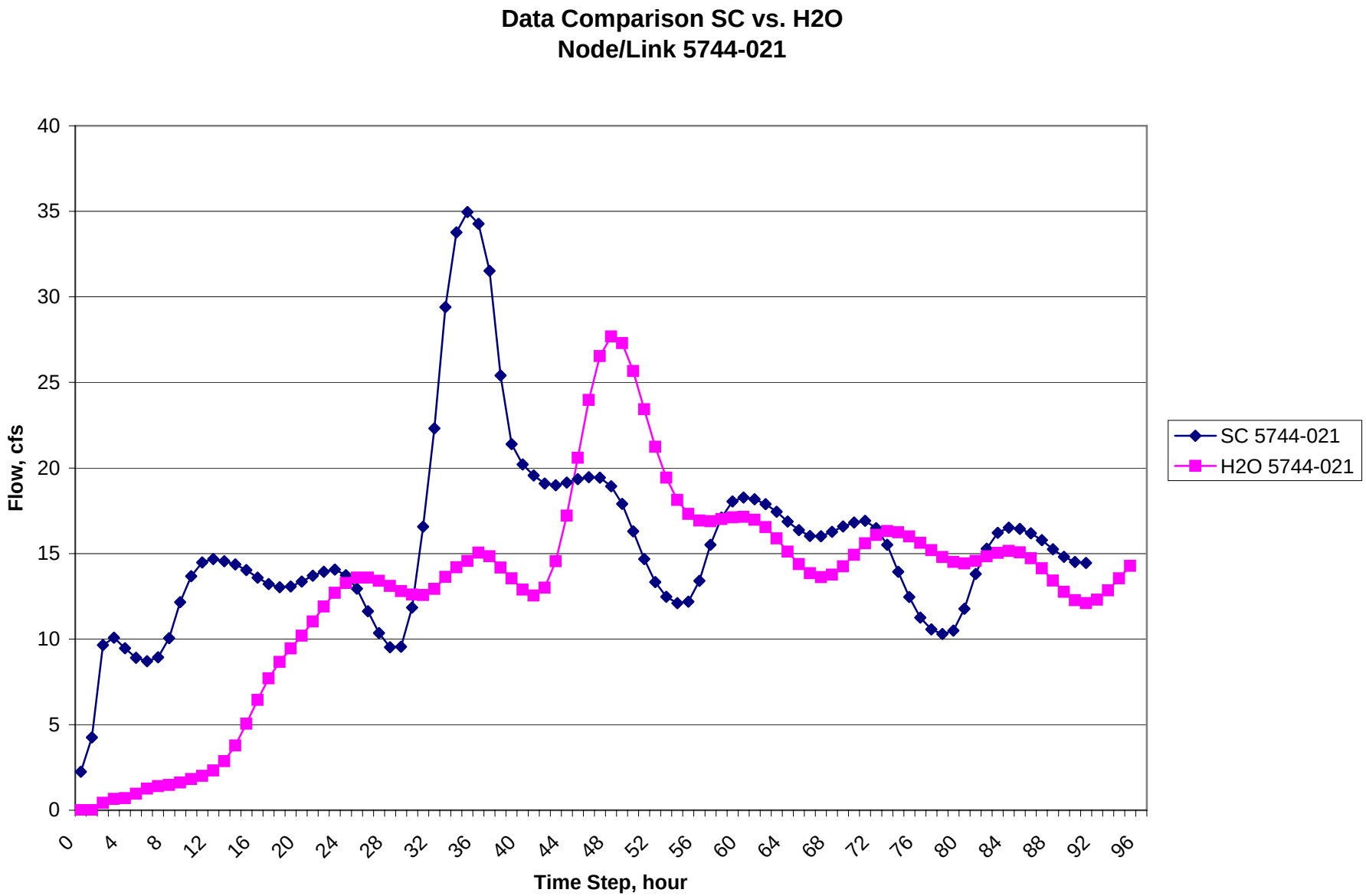

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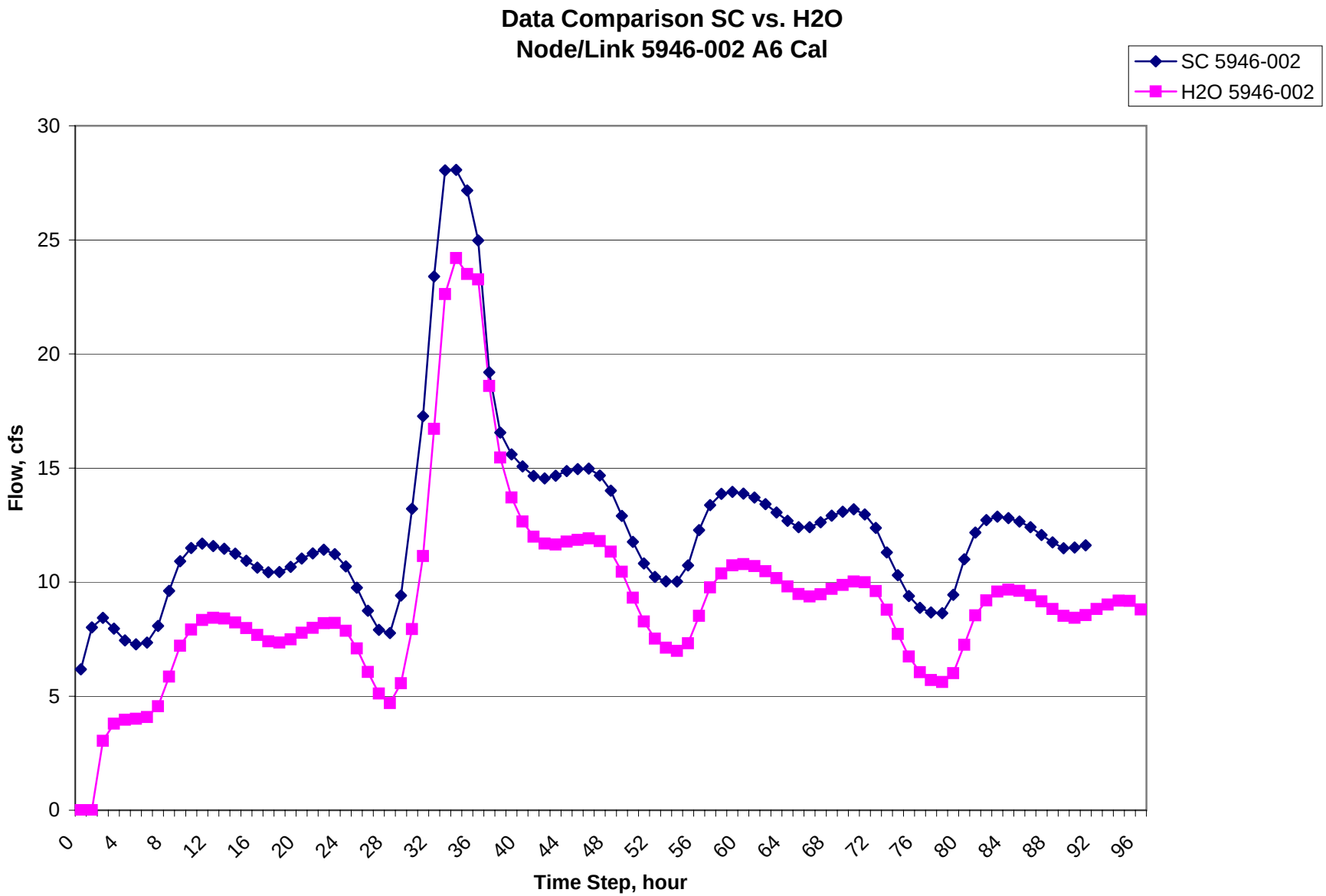

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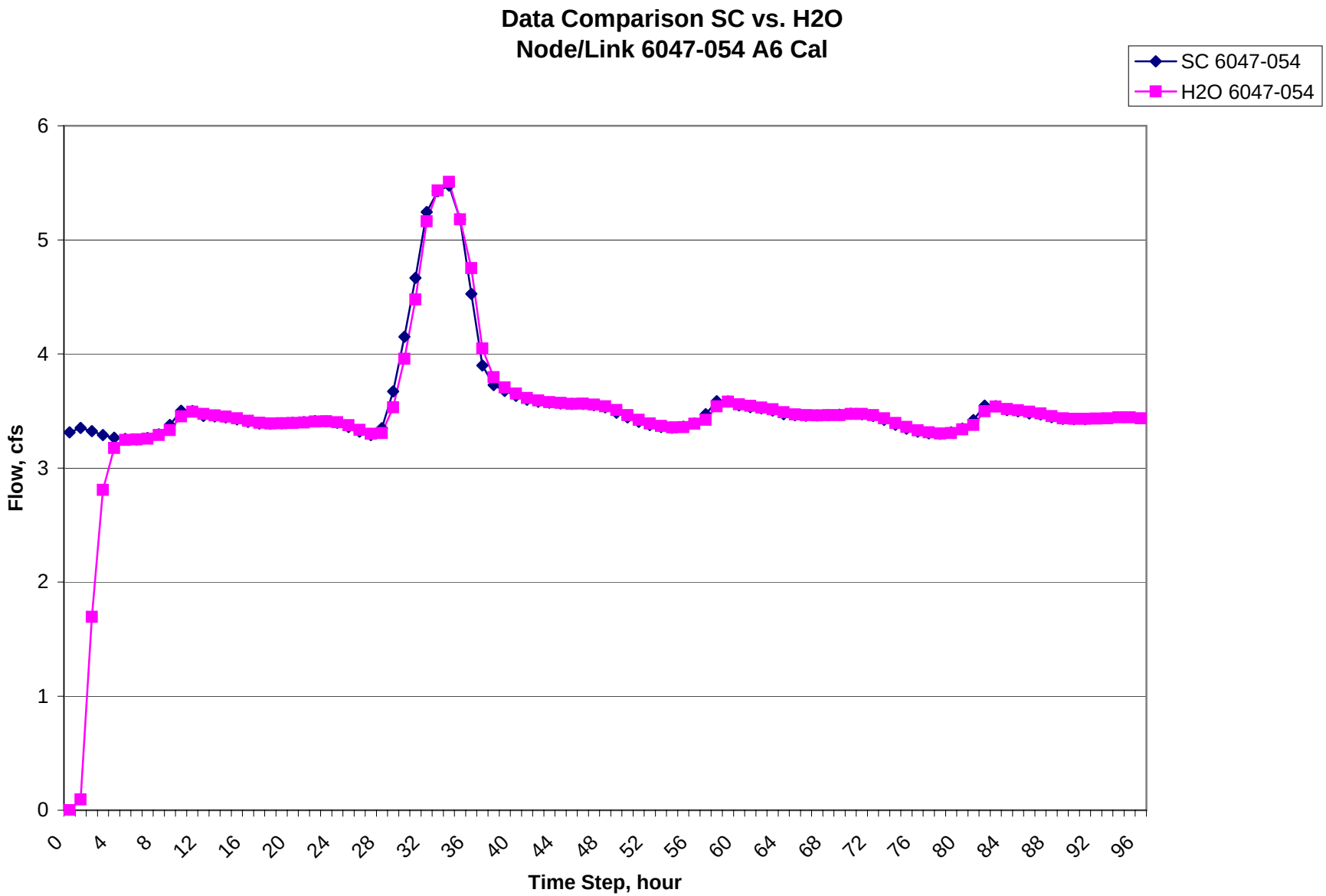
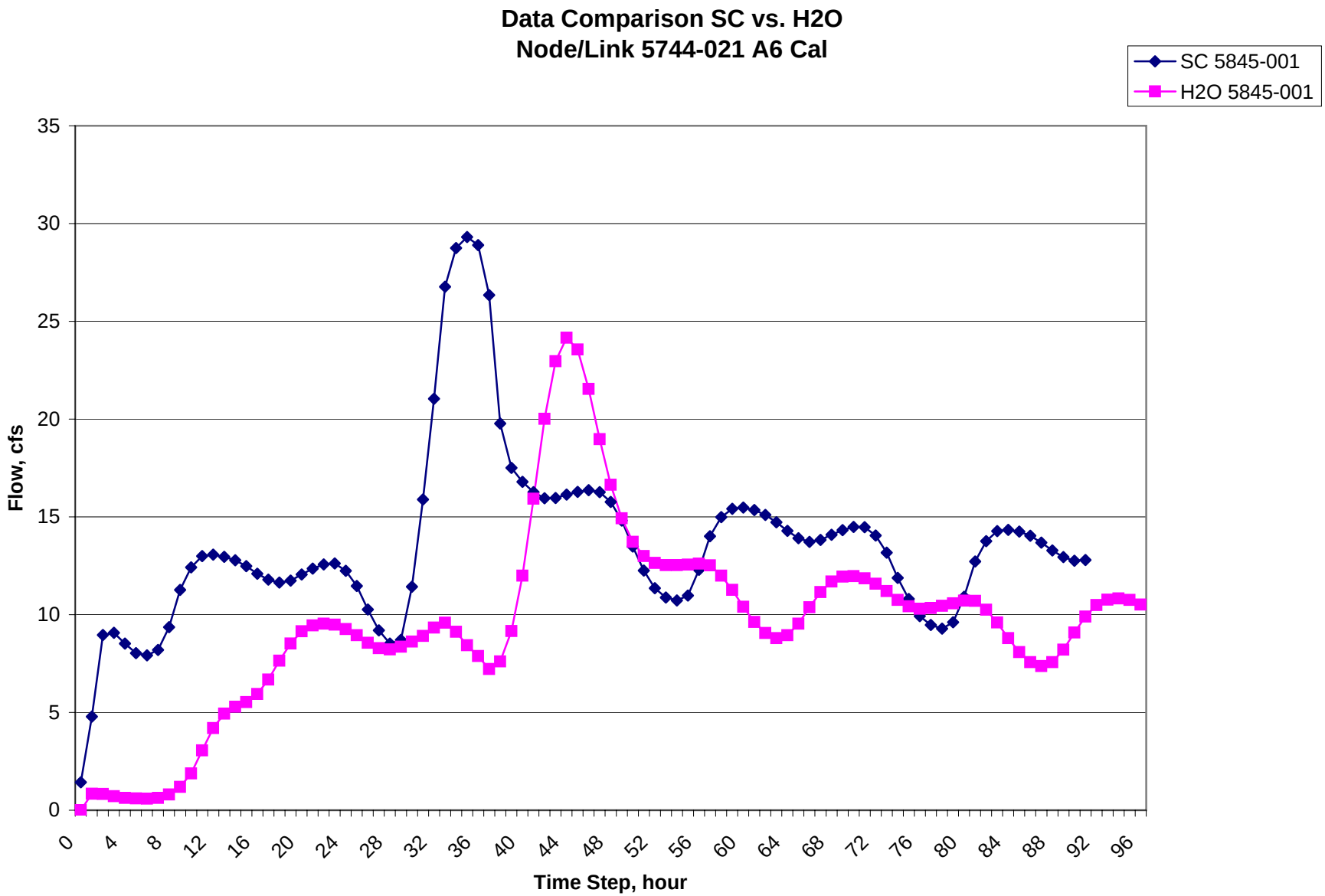


SC_H2O_ModelOutput.xls



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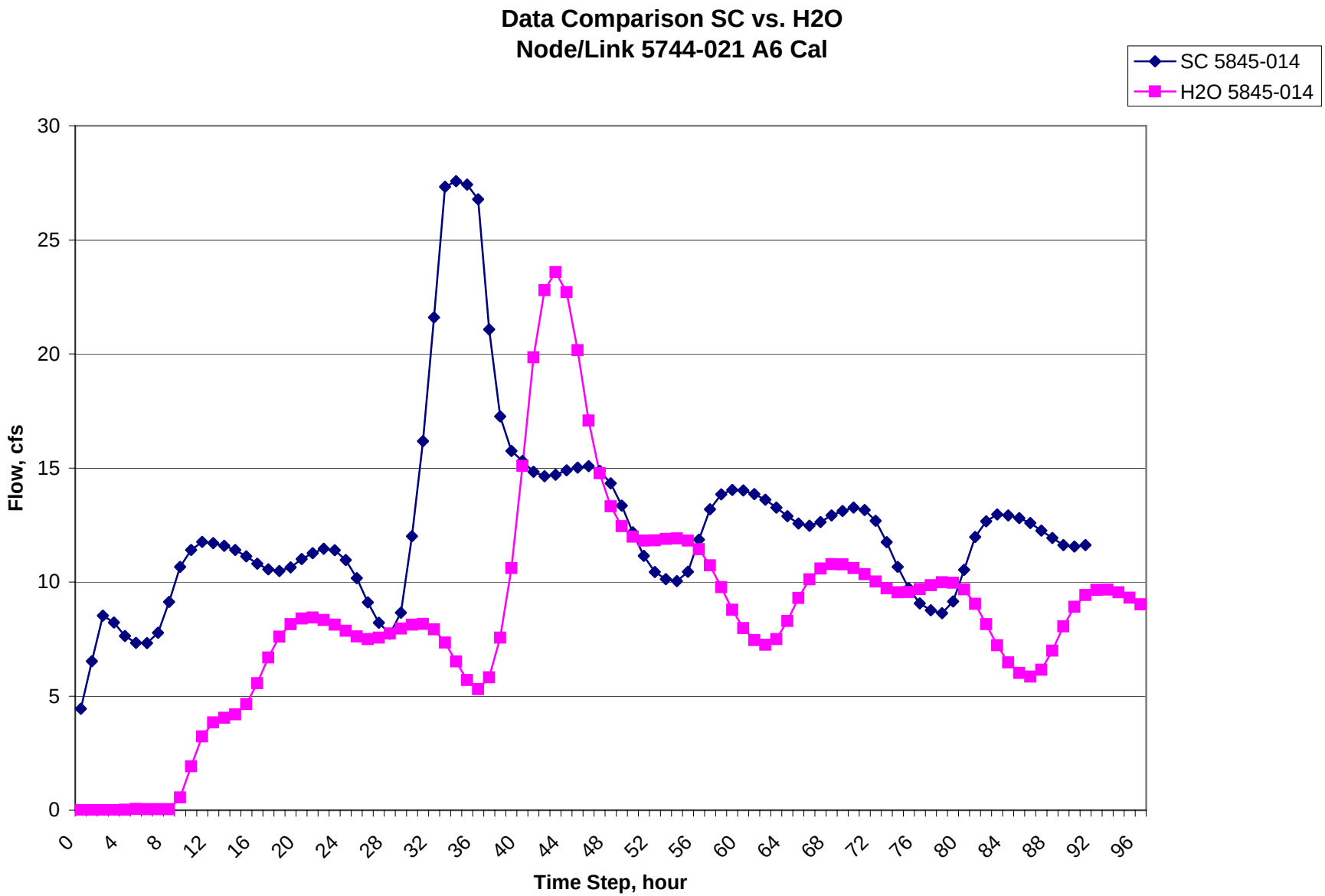

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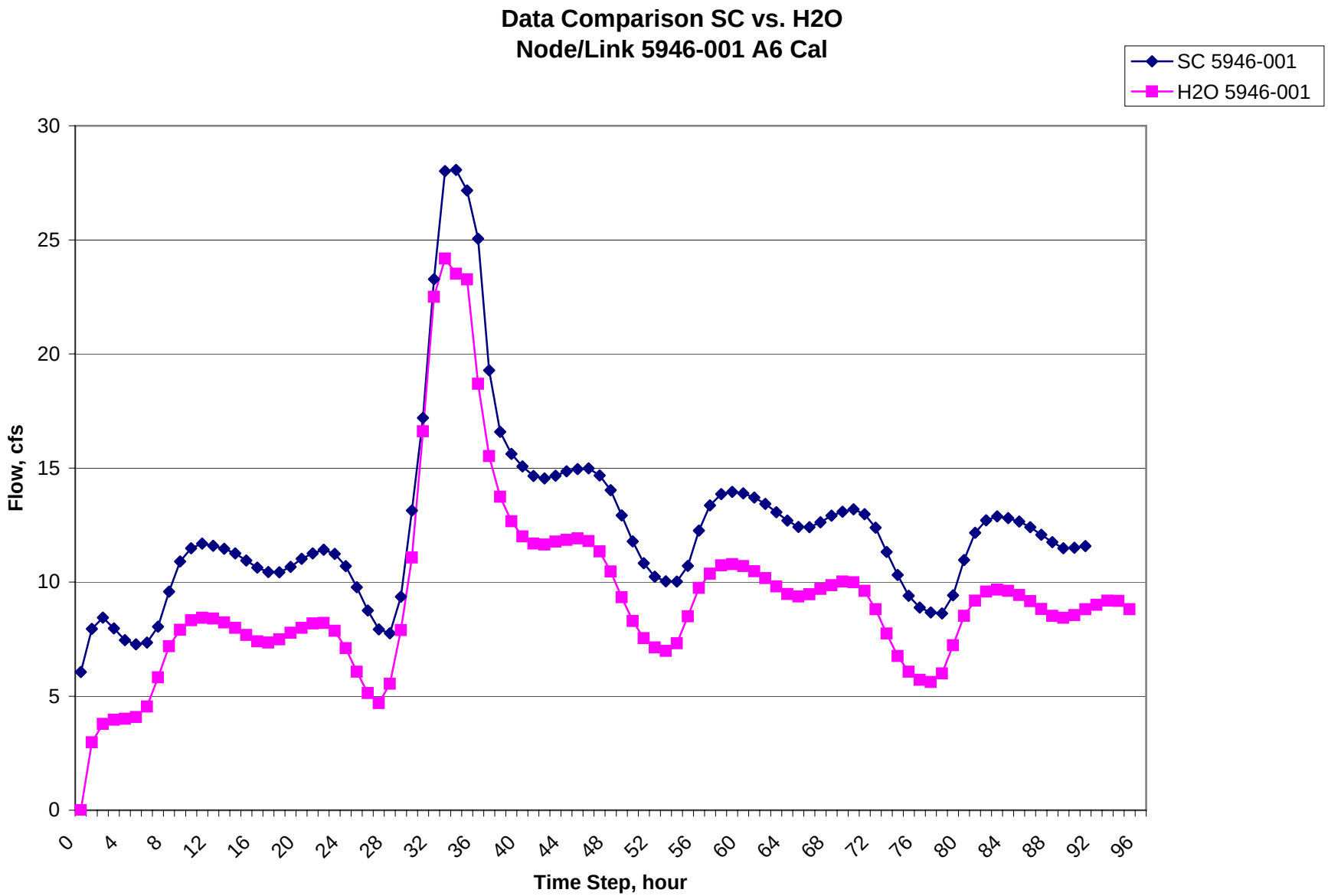

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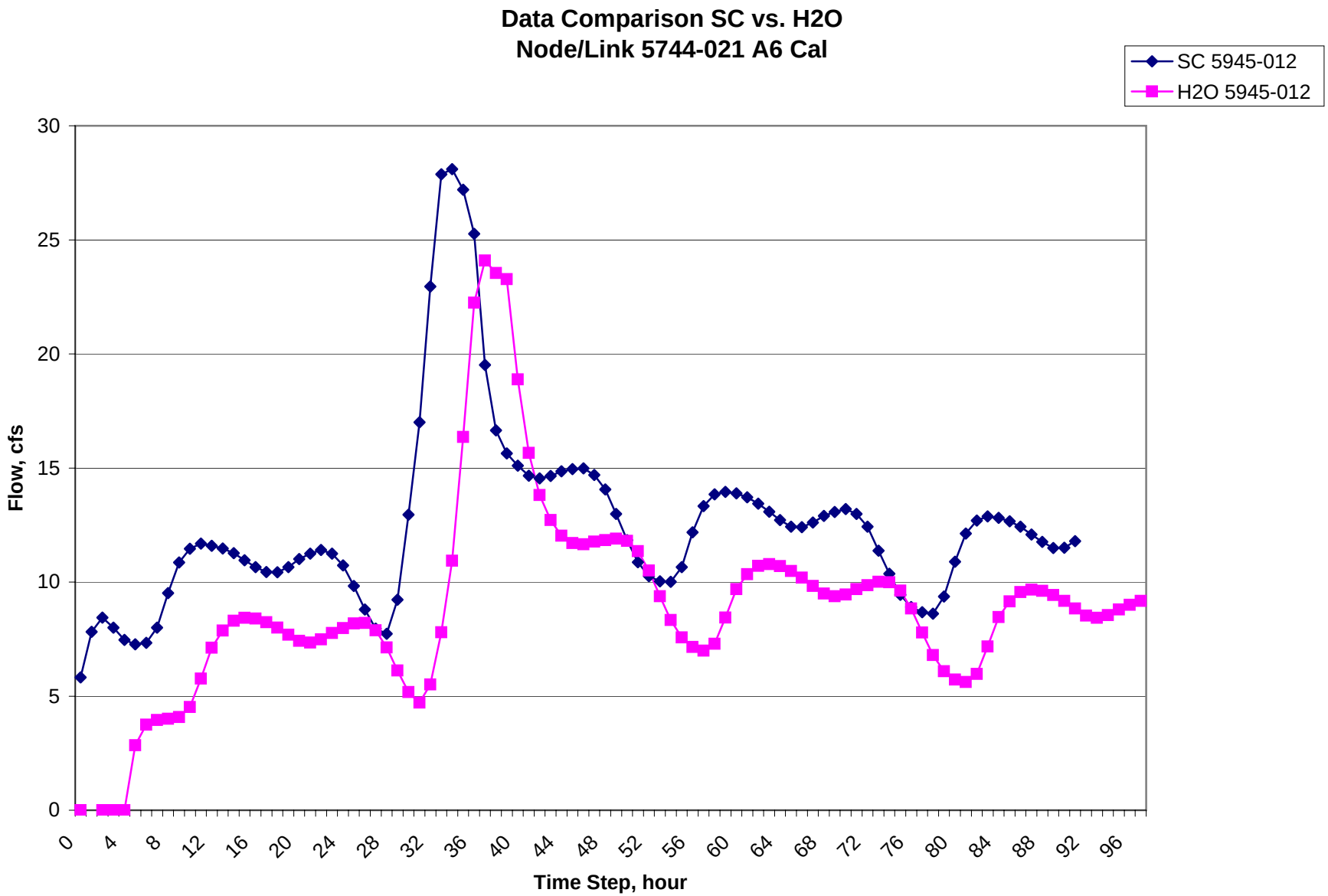


SC_H2O_ModelOutput.xls

APPENDIX H

Flow Projections Organized by Treatment Facility

Plant No. 1 Influent Flow

Plant No. 1 Influent Flow												
	2002		2010		2020		2030		2040		2050	
Sub-Basin	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)
SS22-01	18,833	1.70	18,833	1.70	18,833	1.70	18,833	1.70	18,833	1.70	18,833	1.70
SS22-02	2,813	0.25	2,813	0.89	2,813	0.90	2,813	0.91	2,813	0.92	2,813	0.93
SS22-03	10,032	0.91	10,043	0.92	10,056	0.92	10,068	0.92	10,068	0.92	10,068	0.92
SS22-04	6,672	0.60	6,678	0.60	6,682	0.60	6,683	0.60	6,684	0.60	6,685	0.60
SS22-05	10,939	0.98	10,964	0.99	10,979	0.99	10,979	0.99	10,979	0.99	10,979	0.99
TOTAL	**49,290**	**4.45**	**49,332**	**5.09**	**49,364**	**5.11**	**49,376**	**5.12**	**49,378**	**5.12**	**49,379**	**5.13**
SS1-01	1,827	0.16	1,827	0.16	1,827	0.16	1,827	0.16	1,827	0.16	1,827	0.16
SS1-02	4,879	0.44	4,879	0.44	4,879	0.44	4,879	0.44	4,879	0.44	4,879	0.44
SS1-03	4,748	0.43	4,650	0.42	4,536	0.41	4,430	0.40	4,473	0.40	4,516	0.41
SS1-04	9,987	0.96	10,206	0.98	10,482	1.00	10,757	1.03	11,180	1.07	11,603	1.11
SS1-05	22,058	2.90	22,672	2.97	23,394	3.06	24,073	3.13	25,109	3.24	26,145	3.34
SS1-06	5,648	0.61	5,666	0.62	5,687	0.62	5,706	0.62	5,706	0.63	5,706	0.63
SS1-07	15,378	1.59	15,536	1.61	15,728	1.63	15,914	1.65	16,094	1.67	16,273	1.69
TOTAL	**64,525**	**7.09**	**65,437**	**7.19**	**66,534**	**7.32**	**67,587**	**7.44**	**69,268**	**7.60**	**70,950**	**7.77**
SS23-01	21,107	2.37	21,108	2.38	21,110	2.39	21,112	2.40	21,112	2.40	21,112	2.41
SS23-02	13,346	1.20	13,422	1.21	13,508	1.22	13,584	1.22	13,584	1.22	13,584	1.22
SS23-03	3,114	0.28	3,356	0.30	3,511	0.32	3,519	0.32	4,031	0.36	4,543	0.41
SS23-04	485	0.04	504	0.05	516	0.05	516	0.05	516	0.05	516	0.05
SS23-05	1,942	0.17	1,994	0.18	2,026	0.18	2,026	0.18	2,026	0.18	2,026	0.18
SS23-06	4,564	0.41	4,860	0.44	5,112	0.46	5,247	0.47	5,277	0.47	5,306	0.48
SS23-07	9,587	0.86	9,920	0.89	10,128	0.91	10,128	0.91	10,128	0.91	10,128	0.91
SS23-08	4,371	1.00	4,490	1.03	4,628	1.05	4,756	1.07	4,858	1.09	4,959	1.11
SS23-09	510	0.05	616	0.06	740	0.07	854	0.08	913	0.08	971	0.09
TOTAL	**59,025**	**6.39**	**60,270**	**6.52**	**61,280**	**6.64**	**61,744**	**6.70**	**62,445**	**6.78**	**63,147**	**6.85**
DRY CREEK	21,894	1.97	21,895	1.97	21,895	1.97	21,895	1.97	21,903	1.97	21,912	1.97
TOTAL	**21,894**	**1.97**	**21,895**	**1.97**	**21,895**	**1.97**	**21,895**	**1.97**	**21,903**	**1.97**	**21,912**	**1.97**
WIS-01	20,848	2.65	20,854	2.65	20,861	2.66	20,868	2.66	20,885	3	20,902	2.67
WIS-02	11,728	1.06	11,941	1.07	12,087	1.09	12,114	1.09	12,118	1.09	12,123	1.09
WIS-03	2,197	0.59	2,382	0.61	2,498	0.62	2,501	0.62	2,501	1	2,501	0.62
WIS-04	1,182	0.11	1,182	0.11	1,182	0.11	1,182	0.11	1,182	0.11	1,182	0.11
WIS-05	13,160	1.18	13,234	1.19	13,355	1.20	13,507	1.22	13,507	1.22	13,507	1.22
WIS-06	1,667	1.88	1,707	1.89	1,775	1.89	1,863	1.90	1,864	2	1,865	1.90
TOTAL	**50,782**	**7.47**	**51,298**	**7.52**	**51,759**	**7.56**	**52,033**	**7.59**	**52,056**	**7.60**	**52,079**	**7.60**
KECHI	2,000	0.18	2,427	0.22	3,111	0.28	3,947	0.36	4,583	0.41	5,220	0.47
TOTAL	**2,000**	**0.18**	**2,427**	**0.22**	**3,111**	**0.28**	**3,947**	**0.36**	**4,583**	**0.41**	**5,220**	**0.47**
F-N-01	869	0.08	1,050	0.09	1,230	0.11	1,364	0.12	1,558	0.14	1,753	0.16
F-N-02	3,918	0.35	4,061	0.37	4,230	0.38	4,390	0.40	4,535	0.41	4,679	0.42
F-N-03A	94	0.01	191	0.02	304	0.03	410	0.04	513	0.05	617	0.06
F-N-03B	5	0.00	207	0.02	442	0.04	661	0.06	661	0.06	661	0.06
F-N-04	239	0.02	239	0.02	240	0.02	240	0.02	240	0.02	240	0.02
TOTAL	**5,125**	**0.46**	**5,748**	**0.52**	**6,447**	**0.58**	**7,065**	**0.63**	**7,507**	**0.67**	**7,950**	**0.71**
PLANT NO. 1 TOTAL	**252,642**	**28.01**	**256,407**	**29.03**	**260,389**	**29.46**	**263,646**	**29.81**	**267,141**	**30.16**	**270,636**	**30.51**

Plant No. 2 Influent Flow

Plant No. 2 Influent Flow												
	2002		2010		2020		2030		2040		2050	
Sub-basin	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)
SWI-01	3,278	0.33	3,278	0.33	3,278	0.33	3,278	0.33	3,594	0.36	3,911	0.39
SWI-02	18,768	1.83	19,072	1.86	19,361	1.89	19,557	1.91	19,650	1.92	19,743	1.93
SWI-03	1,907	0.17	2,290	0.21	2,825	0.25	3,413	0.31	3,542	0.32	3,671	0.33
SWI-04	927	0.08	1,009	0.09	1,105	0.10	1,193	0.11	1,213	0.11	1,233	0.11
SWI-05	3,150	0.40	3,150	0.41	3,150	0.41	3,150	0.41	3,186	0.42	3,222	0.42
SWI-06	611	1.44	696	1.44	795	1.45	887	1.46	894	1.46	900	1.47
SWI-07	29	0.34	29	0.35	29	0.36	29	0.36	29.07	0.37	29	0.37
SWI-08	6,558	0.59	6,558	0.59	6,558	0.59	6,558	0.59	6,558	0.59	6,558	0.59
SWI-09	5,032	0.45	5,032	0.45	5,032	0.45	5,032	0.45	5,032	0.45	5,032	0.45
SWI-10	4,209	0.38	4,536	0.41	4,790	0.43	4,889	0.44	4,889	0.44	4,889	0.44
SWI-11	1,280	0.12	2,113	0.19	2,805	0.25	3,148	0.28	3,148	0.28	3,148	0.28
TOTAL	**45,749**	**6.14**	**47,763**	**6.33**	**49,726**	**6.53**	**51,135**	**6.66**	**51,735**	**6.72**	**52,336**	**6.79**
F-SE-01	1,350	0.12	1,379	0.12	1,426	0.13	1,481	0.13	1,893	0.17	2,304	0.21
F-SE-02	1,318	0.12	1,452	0.13	1,815	0.16	2,371	0.21	3,549	0.32	4,727	0.43
TOTAL	**2,667**	**0.24**	**2,832**	**0.25**	**3,240**	**0.29**	**3,852**	**0.35**	**5,441**	**0.49**	**7,030**	**0.63**
F-W-01	421	0.04	789	0.07	1,106	0.10	1,282	0.12	1,348	0.12	1,414	0.13
F-W-02	583	0.05	1,134	0.10	1,576	0.14	1,770	0.16	2,407	0.22	3,045	0.27
TOTAL	**1,004**	**0.09**	**1,923**	**0.17**	**2,682**	**0.24**	**3,052**	**0.27**	**3,755**	**0.34**	**4,458**	**0.40**
F-SW-01	3,312	0.30	3,607	0.32	3,907	0.35	4,137	0.37	4,376	0.39	4,614	0.42
F-SW-02	761	0.07	960	0.09	1,283	0.12	1,679	0.15	1,884	0.17	2,088	0.19
F-SW-03	1,699	0.15	1,970	0.18	2,292	0.21	2,597	0.23	3,024	0.27	3,452	0.31
F-SW-04	948	0.09	1,142	0.10	1,368	0.12	1,577	0.14	1,616	0.15	1,656	0.15
F-SW-08	472	0.04	472	0.04	472	0.04	472	0.04	472	0.04	473	0.04
TOTAL	**7,191**	**0.65**	**8,152**	**0.73**	**9,322**	**0.84**	**10,462**	**0.94**	**11,372**	**1.02**	**12,283**	**1.11**
PLANT NO. 2 TOTAL	**56,611**	**7.12**	**60,669**	**7.49**	**64,970**	**7.90**	**68,501**	**8.23**	**72,304**	**8.58**	**76,107**	**8.93**

Mid Continent Influent Flow

Mid Continent Influent Flow												
	2002		2010		2020		2030		2040		2050	
Sub-Basin	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)
CIS-01	8,176	0.76	8,402	0.78	8,586	0.79	8,672	0.80	8,672.18	0.80	8,672	0.80
CIS-02	698	0.06	787	0.07	866	0.08	913	0.08	990	0.09	1,067	0.10
CIS-03	3,964	0.36	4,281	0.39	4,490	0.40	4,511	0.41	4,529	0.41	4,546	0.41
CIS-04	975	0.09	1,197	0.11	1,338	0.12	1,344	0.12	1,344	0.12	1,344	0.12
CIS-5A	912	0.08	1,286	0.12	1,647	0.15	1,903	0.17	1,967	0.18	2,031	0.18
CIS-5B	229	0.02	419	0.04	641	0.06	848	0.08	848	0.08	849	0.08
CIS-6A	3,196	0.29	3,558	0.32	3,982	0.36	4,379	0.39	4,379	0.39	4,379	0.39
CIS-6B	532	0.05	699	0.06	927	0.08	1,176	0.11	1,202	0.11	1,228	0.11
CIS-07	8,977	0.81	8,977	0.81	8,977	0.81	8,977	0.81	8,977	0.81	8,977	0.81
CIS-08	7,616	0.69	7,633	0.69	7,644	0.69	7,644	0.69	7,644	0.69	7,644	0.69
CIS-09	6,051	0.54	6,131	0.55	6,181	0.56	6,181	0.56	6,181	0.56	6,181	0.56
CIS-10	369	0.03	490	0.04	566	0.05	566	0.05	566	0.05	566	0.05
CIS-11	800	0.87	999	0.89	1,188	0.92	1,320	0.93	1,531.12	0.95	1,742	0.98
CIS-12	11	0.00	11	0.00	11	0.00	12	0.00	12	0.00	12	0.00
TOTAL	**42,508**	**4.65**	**44,869**	**4.86**	**47,044**	**5.07**	**48,444**	**5.20**	**48,840**	**5.23**	**49,237**	**5.27**
F-SW-05	12	0.00	135	0.01	276	0.02	404	0.04	638	0.06	871	0.08
F-SW-06	796	0.07	1,485	0.13	2,432	0.22	3,463	0.31	4,504	0.41	5,544	0.50
F-SW-09	53	0.00	90	0.01	133	0.01	172	0.02	172	0.02	172	0.02
TOTAL	**861**	**0.07**	**1,710**	**0.16**	**2,841**	**0.25**	**4,040**	**0.37**	**5,314**	**0.48**	**6,588**	**0.60**
MID CONTINENT TOTAL	43,369	4.72	46,579	5.02	49,885	5.32	52,484	5.56	54,154	5.72	55,825	5.87

FMC Influent Flow

FMC Influent Flow												
	2002		2010		2020		2030		2040		2050	
Sub-basin	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)
4MC-01	230	0.03	269	0.03	315	0.04	358	0.04	358	0.04	358	0.04
4MC-02	896	0.12	1,035	0.13	1,197	0.15	1,348	0.16	1,476	0.17	1,604	0.18
4MC-BH	767	0.10	835	0.11	965	0.12	1,142	0.14	1,169	0.13	1,197	0.13
4MC-CV	3,968	0.52	4,560	0.59	5,553	0.69	6,799	0.82	6,984	0.8	7,170	0.79
4MC-MH	2,591	0.34	3,093	0.4	3,457	0.43	3,559	0.43	3,616	0.42	3,673	0.40
4MC-SC	5,313	0.69	6,756	0.88	8,056	1.01	8,854	1.06	9,221	1.06	9,588	1.05
TOTAL	**13,764**	**1.79**	**16,547**	**2.15**	**19,544**	**2.44**	**22,059**	**2.65**	**22,825**	**2.62**	**23,591**	**2.6**
WIS-07	0	0.10	1,785	0.16	2,298	0.21	2,477	0.22	2,506	0.23	2,536	0.23
TOTAL	**0**	**0.10**	**1,785**	**0.16**	**2,298**	**0.21**	**2,477**	**0.22**	**2,506**	**0.23**	**2,536**	**0.23**
Walnut-1	0	0.00	489	0.04	994	0.09	1,463	0.13	1,747	0.16	2,031	0.18
Walnut-2	0	0.00	774	0.07	1,474	0.13	2,555	0.23	5,668	0.51	8,780	0.79
Walnut-3A	0	0.00	438	0.04	963	0.09	1,494	0.13	1,647	0.15	1,800	0.16
Walnut-3B	0	0.00	551	0.05	959	0.09	1,665	0.15	1,944	0.17	2,223	0.20
Walnut-4	0	0.00	1,310	0.12	1,753	0.16	2,316	0.21	3,759	0.34	5,202	0.47
TOTAL	**0**	**0.00**	**3,562**	**0.32**	**6,143**	**0.55**	**9,495**	**0.85**	**14,765**	**1.17**	**20,036**	**1.80**
FOUR MILE CREEK TOTA	**13,764**	**1.89**	**21,894**	**2.63**	**27,985**	**3.20**	**34,031**	**3.72**	**40,096**	**4.02**	**46,163**	**4.63**

CCWQRF Influent Flow

CCWQRF Influent Flow												
	2002		2010		2020		2030		2040		2050	
	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)	Pop.	Flow (MGD)
NWI-01	4,540	0.41	4,816	0.43	5,000	0.45	5,023	0.45	5,154	0.46	5,285	0.48
NWI-02	953	0.09	1,059	0.1	1,126	0.1	1,126	0.1	1,154	0.1	1,182	0.11
NWI-03	0	0.00	805	0.07	890	0.08	890	0.08	890	0.08	890	0.08
NWI-04	0	0.00	1,718	0.15	2,121	0.19	2,323	0.21	2,377	0.21	2,431	0.22
TOTAL	**5,492**	**0.49**	**8,398**	**0.76**	**9,136**	**0.82**	**9,362**	**0.84**	**9,575**	**0.86**	**9,788**	**0.88**
F-NW-01	528	0.05	1,529	0.14	3,404	0.31	5,905	0.53	9,769	0.88	13,633	1.23
F-NW-02	201	0.02	556	0.05	777	0.07	777	0.07	820	0.07	862	0.08
F-NW-03	274.7	0.02	697	0.06	1,578	0.14	2,813	0.25	3,577	0.32	4,341	0.39
F-NW-04A	433.6	0.04	852	0.08	1,975	0.18	3,698	0.33	3,827	0.34	3,956	0.36
F-NW-04B	30.0	0.00	74	0.01	160	0.01	279	0.03	327	0.03	376	0.03
F-NW-05A	72.8	0.01	254	0.02	379	0.03	403	0.04	518	0.05	634	0.06
F-NW-05B	50.8	0.00	156	0.01	226	0.02	234	0.02	300	0.03	365	0.03
TOTAL	**1,591**	**0.14**	**4,117**	**0.37**	**8,500**	**0.76**	**14,109**	**1.27**	**19,138**	**1.72**	**24,168**	**2.18**
F-SW-07	107	0.01	237	0.02	580	0.05	1,105	0.1	1,105	0.1	1,105	0.1
TOTAL	**107**	**0.01**	**237**	**0.02**	**580**	**0.05**	**1,105**	**0.1**	**1,105**	**0.1**	**1,105**	**0.1**
CCWQRF TOTAL	**7191**	**0.65**	**12,752**	**1.15**	**18,216**	**1.64**	**24,575**	**2.21**	**29,818**	**2.68**	**35,060**	**3.16**

APPENDIX I

Calculations for Layout and Sizing of Projected Sewer Extensions

Pre-Draft

ID (Char)	Subbasin	Up Manhole	Dn Manhole	Percent of Subbasin (%)	Increm. 2050 ADF	Cumm. 2050 ADF	Peaking Factor	2050 Design Flow (mgd)	Up GND Elev (ft)	Selected Up Invert Elev (ft)	Depth Up MH (ft)	Dn GND Elev (ft)		**Selected Dn Invert Elev (ft)**	Depth Dn MH (ft)	Length (ft)	Ground Slope (ft/ft)	Pipe Slope (ft/ft)	Selected Dia (in)	Pipe Dia (ft)	Pipe Area (sqin)	Pipe W.P. (in)	Pipe Capacity (mgd)	Pct Utilization (<72% to 18", then <92%)	Full Velocity (fps)	0.4 D Velocity (fps)	Probable Base Constr. Cost	Probable Constr. Cost with Contingencies	Probable Project Cost	Phasing
F179	F-N-02	F-N-02-06	F-N-02-05	10%	0.042	0.042	5.10	0.215	1320	1315	5.00	1330	O17	1309.360	20.64	2013	-0.00497	0.0028	10	0.833	0.544979	0.20825	0.748	28.7%	2.12	1.48	$187,209	$243,400	$304,300	
F178	F-N-02	F-N-02-05	F-N-02-04	10%	0.042	0.084	4.80	0.404	1330	1309.36	20.64	1330	O16+P17	1301.910	28.09	2661	0	0.0028	10	0.833	0.544979	0.20825	0.748	54.0%	2.12	1.48	$247,473	$321,700	$402,100	
F177	F-N-02	F-N-02-04	F-N-02-03	10%	0.042	0.126	4.60	0.581	1330	1301.91	28.09	1330	O15+P16	1296.420	33.58	1961	0	0.0028	10	0.833	0.544979	0.20825	0.748	77.7%	2.12	1.48	$182,373	$237,100	$296,400	
F174	F-N-02	F-N-02-03	PLS-005	10%	0.042	0.211	4.40	0.926	1330	1296.42	33.58	1330	O14+P13+P15	1290.860	39.14	3710	0	0.0015	15	1.250	1.227185	0.3125	1.616	57.3%	NB	#VALUE!	$419,230	$545,000	$681,300	
F175	F-N-02	F-N-02-01	F-N-02-02	10%	0.042	0.042	5.10	0.215	1335	1325	10.00	1335	O12	1320.410	14.59	1641	0	0.0028	10	0.833	0.544979	0.20825	0.748	28.7%	2.12	1.48	$152,613	$198,400	$248,000	
F176	F-N-02	F-N-02-02	F-N-02-03	10%	0.042	0.084	4.80	0.404	1335	1320.41	14.59	1330	O13+P12	1313.190	16.81	2577	0.00194	0.0028	10	0.833	0.544979	0.20825	0.748	54.0%	2.12	1.48	$239,661	$311,600	$389,500	
F173	F-N-01	F-N-01-01	F-N-01-02	33%	0.052	0.052	5.00	0.260	1340	1330	10.00	1335	O10	1326.680	8.32	1185	0.00422	0.0028	10	0.833	0.544979	0.20825	0.748	34.8%	2.12	1.48	$110,205	$143,300	$179,100	
F195	F-N-01	F-N-01-02	PLS-005	33%	0.052	0.315	4.30	1.353	1335	1290.86	44.14	1330	O11+P10	1287.940	42.06	1945	0.00257	0.0015	15	1.250	1.227185	0.3125	1.616	83.7%	2.04	1.43	$219,785	$285,700	$357,100	2025
F180	F-N-01	PLS-005	WWTP - NP	33%	0.052	0.367	4.20	1.540	1330	1287.940	42.06	1335		1325.000	10.00	12213	-0.00041	FM	8	0.667	0.349415	0.16675	NA	NA	6.82	NA	$977,040	$1,270,200	$1,587,800	
																													$0	
F172	F-N-02	F-N-02-07	F-N-02-08	10%	0.042	0.042	5.10	0.215	1320	1310	10.00	1320	O18	1301.650	18.35	2087	0	0.004	10	0.833	0.544979	0.20825	0.894	24.0%	2.54	1.78	$194,091	$252,300	$315,400	
F171	F-N-02	F-N-02-08	F-N-02-09	10%	0.042	0.084	4.80	0.404	1320	1301.65	18.35	1320	O19+P18	1291.910	28.09	2435	0	0.004	10	0.833	0.544979	0.20825	0.894	45.2%	2.54	1.78	$226,455	$294,400	$368,000	
F170	F-N-02	F-N-02-09	5451-039	10%	0.042	0.126	4.60	0.581	1320	1291.91	28.09	1320	O20+P19	1309.550	10.45	1598	0	0.0028	10	0.833	0.544979	0.20825	0.748	77.7%	2.12	1.48	$148,614	$193,200	$241,500	
F167	F-N-03B	F-N-03B-01	5753-001	100%	0.060	0.060	5.00	0.298	1385	1375	10.00	1375	O21	1349.500	25.50	3652	0.00274	0.006982	15	1.250	1.227185	0.3125	3.487	8.5%	4.40	3.08	$412,676	$536,500	$670,600	
F241	F-N-04	F-N-04-01	6052-012	50%	0.063	0.063	4.90	0.309	1415	1405	10.00	1395	O22	1372.950	22.05	1000	0.02	0.03205	8	0.667	0.349415	0.16675	1.399	22.1%	6.19	4.33	$80,000	$104,000	$130,000	
F168	F-N-04	F-N-04-02	5953-028	50%	0.063	0.063	4.90	0.309	1410	1400		1375	O23	1365.310		4387	0.00798	0.007907	8	0.667	0.349415	0.16675	0.695	44.4%	3.08	2.16	$350,960	$456,200	$570,300	
F150	F-NW-01	F-NW-01-20	F-NW-01-18	5%	0.061	0.061	4.90	0.301	1375	1365.00	10.00	1365.00	O43	1354.760	10.24	2561	0.0039	0.004	8	0.667	0.349415	0.16675	0.494	60.9%	2.19	1.53	$204,880	$266,300	$332,900	
F149	F-NW-01	F-NW-01-18	F-NW-01-15	5%	0.061	0.123	4.60	0.564	1365	1354.76	10.24	1360.00	O41+P43	1347.500	12.50	2594	0.00193	0.0028	10	0.833	0.544979	0.20825	0.748	75.5%	2.12	1.48	$241,242	$313,600	$392,000	
F148	F-NW-01	F-NW-01-17	F-NW-01-15	5%	0.061	0.061	4.90	0.301	1365	1355.00	10.00	1360.00	O40	1345.400	14.60	2401	0.00208	0.004	8	0.667	0.349415	0.16675	0.494	60.9%	2.19	1.53	$192,080	$249,700	$312,100	
F147	F-NW-01	F-NW-01-15	F-NW-01-14	5%	0.061	0.245	4.40	1.080	1360	1345.40	14.60	1360.00	O38+O40+O41	1341.220	18.78	2784	0	0.0015	15	1.250	1.227185	0.3125	1.616	66.8%	2.04	1.43	$314,592	$409,000	$511,300	
F146	F-NW-01	F-NW-01-13	F-NW-01-12	5%	0.061	0.061	4.90	0.301	1360	1350.00	10.00	1355.00	O36	1345.480	9.52	1130	0.00442	0.004	8	0.667	0.349415	0.16675	0.494	60.9%	2.19	1.53	$90,400	$117,500	$146,900	
F145	F-NW-01	F-NW-01-12	F-NW-01-16	5%	0.061	0.123	4.60	0.564	1355	1345.48	9.52	1365.00	O35+O36	1343.050	21.95	869	-0.01151	0.0028	10	0.833	0.544979	0.20825	0.748	75.5%	2.12	1.48	$80,817	$105,100	$131,400	
F144	F-NW-01	F-NW-01-16	F-NW-01-14	5%	0.061	0.184	4.50	0.828	1365	1343.05	21.95	1360.00	O39+P35	1337.720	22.28	2425	0.00206	0.0022	12	1.000	0.785398	0.25	1.079	76.8%	2.13	1.49	$235,225	$305,800	$382,300	
F143	F-NW-01	F-NW-01-14	F-NW-01-11	5%	0.061	0.491	4.10	2.012	1360	1337.72	22.28	1355.00	O37+O38+O39	1334.630	20.37	2579	0.00194	0.0012	18	1.500	1.767146	0.375	2.351	85.6%	2.06	1.44	$337,849	$439,200	$549,000	
F142	F-NW-01	F-NW-01-19	F-NW-01-11	5%	0.061	0.061	4.90	0.301	1370	1360.00	10.00	1355.00	O42	1345.000	10.00	1149	0.01305	1.183638	8	0.667	0.349415	0.16675	8.504	3.5%	37.65	26.36	$91,920	$119,500	$149,400	
F141	F-NW-01	F-NW-01-11	F-NW-01-07	5%	0.061	0.613	4.00	2.454	1355	1334.63	20.37	1355.00	O34+O37+O42	1333.290	21.71	1340	0	0.001	21	1.750	2.405282	0.4375	3.237	75.8%	2.08	1.46	$207,700	$270,000	$337,500	
F158	F-NW-01	F-NW-01-01	F-NW-01-02	5%	0.061	0.061	4.90	0.301	1370	1360.00	10.00	1370.00	O24	1354.430	15.57	1392	0	0.004	8	0.667	0.349415	0.16675	0.494	60.9%	2.19	1.53	$111,360	$144,800	$181,000	
F157	F-NW-01	F-NW-01-02	F-NW-01-03	5%	0.061	0.123	4.60	0.564	1370	1354.43	15.57	1370.00	O25+P24	1350.300	19.70	1290	0	0.0032	10	0.833	0.544979	0.20825	0.800	70.6%	2.27	1.59	$119,970	$156,000	$195,000	
F156	F-NW-01	F-NW-01-03	F-NW-01-04	5%	0.061	0.184	4.50	0.828	1370	1350.30	19.70	1365.00	O26+P25	1343.820	21.18	2593	0.00193	0.0025	12	1.000	0.785398	0.25	1.151	72.0%	2.27	1.59	$251,521	$327,000	$408,800	
F155	F-NW-01	F-NW-01-04	F-NW-01-05	5%	0.061	0.245	4.40	1.080	1365	1343.82	21.18	1360.00	O27+P26	1341.140	18.86	1341	0.00373	0.002	15	1.250	1.227185	0.3125	1.866	57.9%	2.35	1.65	$151,533	$197,000	$246,300	
F154	F-NW-01	F-NW-01-05	F-NW-01-06	5%	0.061	0.307	4.30	1.319	1360	1341.14	18.86	1355.00	O28+P27	1335.800	19.20	2668	0.00187	0.002	15	1.250	1.227185	0.3125	1.866	70.7%	2.35	1.65	$301,484	$391,900	$489,900	
F153	F-NW-01	F-NW-01-06	F-NW-01-10	5%	0.061	0.368	4.20	1.546	1355	1335.80	19.20	1355.00	O29+P28	1332.610	22.39	2657	0	0.0012	18	1.500	1.767146	0.375	2.351	65.8%	2.06	1.44	$348,067	$452,500	$565,600	
F152	F-NW-01	F-NW-01-10	F-NW-01-09	5%	0.061	0.429	4.10	1.761	1355	1332.61	22.39	1355.00	O33+P29	1330.010	24.99	2605	0	0.001	21	1.750	2.405282	0.4375	3.237	54.4%	2.08	1.46	$403,775	$524,900	$656,100	
F151	F-NW-01	F-NW-01-09	F-NW-01-07	5%	0.061	0.491	4.10	2.012	1355	1330.01	24.99	1355.00	O32+P31	1328.750	26.25	1264	0	0.001	21	1.750	2.405282	0.4375	3.237	62.2%	2.08	1.46	$195,920	$254,700	$318,400	
F140	F-NW-01	F-NW-01-07	F-NW-01-08	5%	0.061	1.166	3.80	4.429	1355	1328.75	26.25	1355.00	O30+O32+O34	1326.950	28.05	2683	0	0.00067	27	2.250	3.976078	0.5625	5.179	85.5%	2.02	1.41	$509,770	$662,700	$828,400	
F203	F-NW-01	F-NW-01-08	4652-TP3	5%	0.061	1.227	3.80	4.663	1355	1326.95	28.05	1350.00	O31+O30	1325.02	24.98	2884	0.00173	0.00067	27	2.250	3.976078	0.5625	5.179	90.0%	2.02	1.41	$547,960	$712,300	$890,400	
F139	F-NW-03	F-NW-03-01	F-NW-03-02	14%	0.055	0.055	5.00	0.274	1380	1370	10.00	1375	O44	1359.520	15.48	2619	0.00191	0.004	8	0.667	0.349415	0.16675	0.494	55.4%	2.19	1.53	$209,520	$272,400	$340,500	
F138	F-NW-03	F-NW-03-02	F-NW-03-03	14%	0.055	0.109	4.70	0.514	1375	1359.52	15.48	1375	O45+P44	1351.860	23.14	2734	0	0.0028	10	0.833	0.544979	0.20825	0.748	68.7%	2.12	1.48	$254,262	$330,500	$413,100	
F137	F-NW-03	F-NW-03-03	F-NW-03-04	14%	0.055	0.164	4.50	0.738	1375	1351.86	23.14	1365	O46+P45	1346.350	18.65	2504	0.00399	0.0022	12	1.000	0.785398	0.25	1.079	68.4%	2.13	1.49	$242,888	$315,800	$394,800	
F136	F-NW-03	F-NW-03-04	F-NW-03-05	14%	0.055	0.219	4.40	0.963	1365	1346.35	18.65	1360	O47+P46	1342.250	17.75	2734	0.00183	0.0015	15	1.250	1.227185	0.3125	1.616	59.6%	2.04	1.43	$308,942	$401,600	$502,000	
F133	F-NW-03	F-NW-03-05	F-NW-03-06	14%	0.055	0.274	4.30	1.176	1360	1342.25	17.75	1355	O48+P47	1338.460	16.54	2525	0.00198	0.0015	15	1.250	1.227185	0.3125	1.616	72.8%	2.04	1.43	$285,325	$370,900	$463,600	
F135	F-NW-03	F-NW-03-06	F-NW-03-07	14%	0.055	0.328	4.30	1.411	1355	1338.46	16.54	1350	O49+P48	1335.950	14.05	2515	0.00199	0.001	18	1.500	1.767146	0.375	2.146	65.8%	1.88	1.32	$329,465	$428,300	$535,400	
F134	F-NW-03	F-NW-03-07	F-NW-03-08	14%	0.055	0.383	4.20	1.608	1350	1335.95	14.05	1335	O50+P49	1320.370	14.63	1317	0.01139	0.01183	18	1.500	1.767146	0.375	7.380	21.8%	6.46	4.52	$172,527	$224,300	$280,400	
											0.00				0.00															
F94	F-NW-04A	F-NW-04A-01	F-NW-04A-02	6%	0.021	0.021	5.40	0.115	1430	1420	10.00	1425	O51	1415.070	9.93	1233	0.00406	0.004	8	0.667	0.349415	0.16675	0.494	23.3%	2.19	1.53	$98,640	$128,200	$160,300	
F93	F-NW-04A	F-NW-04A-02	F-NW-04A-03	6%	0.021	0.043	5.10	0.218	1425	1415.07	9.93	1415	O52+P51	1405.130	9.87	1807	0.00553	0.0055	8	0.667	0.349415	0.16675	0.580	37.6%	2.57	1.80	$144,560	$187,900	$234,900	
F96	F-NW-04A	F-NW-04A-03	F-NW-04A-04	6%	0.021	0.064	4.90	0.314	1415	1405.13	9.87	1430	O53+P52	1399.910	30.09	1305	-0.01149	0.004	8	0.667	0.349415	0.16675	0.494	63.6%	2.19	1.53	$104,400	$135,700	$169,600	
F95	F-NW-04A	F-NW-04A-04	F-NW-04A-05	6%	0.021	0.085	4.80	0.410	1430	1399.91	30.09	1395	O54+P53	1389.170	5.83	2685	0.01304	0.004	8	0.667	0.349415	0.16675	0.494	83.0%	2.19	1.53	$214,800	$279,200	$349,000	
F79	F-NW-04A	F-NW-04A-05	F-NW-04A-13	6%	0.021	0.107	4.70	0.502	1395	1389.17	5.83	1375	O55+P54	1380.600	-5.60	3060	0.00654	0.0028	10	0.833	0.544979	0.20825	0.748	67.1%	2.12	1.48	$284,580	$370,000	$462,500	
F87	F-NW-04A	F-NW-04A-12	F-NW-04A-13	6%	0.021	0.021	5.40	0.115	1385	1375	10.00	1375	O61	1365.000	10.00	2501	0.004	0.004	8	0.667	0.349415	0.16675	0.494	23.3%	2.19	1.53	$200,080	$260,100	$325,100	
F90	F-NW-04A	F-NW-04A-06	F-NW-04A-08	6%	0.021	0.021	5.40	0.115	1425	1415	10.00	1395	O56	1384.720	10.28	1044	0.02874	0.029	8	0.667	0.349415	0.16675	1.331	8.7%	5.89	4.12	$83,520	$108,600	$135,800	
F89	F-NW-04A	F-NW-04A-08	F-NW-04A-09	6%	0.021	0.043	5.10	0.218	1395	1384.72	10.28	1390	O57+P56	1376.290	13.71	2107	0.00237	0.004	8	0.667	0.349415	0.16675	0.494	44.1%	2.19	1.53	$168,560	$219,100	$273,900	
F66	F-NW-04A	F-NW-04A-09	F-NW-04A-10	6%	0.021	0.064	4.90	0.314	1390	1376.29	13.71	1365	O58+P57	1367.450	-2.45	2209	0.01132	0.004	8	0.667	0.349415	0.16675	0.494	63.6%	2.19	1.53	$176,720	$229,700	$287,100	
F64	F-NW-04A	F-NW-04A-10	F-NW-04A-18	6%	0.021	0.085	4.80	0.410	1365	1367.45	-2.45	1365	O59+P58	1362.750	2.25	1175	0	0.004	8	0.667	0.349415	0.16675	0.494	83.0%	2.19	1.53	$94,000	$122,200	$152,800	
F67	F-SW-07	F-NW-04A-11	F-NW-04A-18	100%	0.099	0.099	4.70	0.467	1365	1355	10.00	1365	O60	1347.800	17.20	2571	0	0.0028	10	0.833	0.544979	0.20825	0.748	62.5%	2.12	1.48	$239,103	$310,800	$388,500	
F81	F-NW-04A	F-NW-04A-13	F-NW-04A-14	6%	0.021	0.121	4.70	0.568	1375	1347.80	27.20	1375	O62+P61	1342.930	32.07	1739	0	0.0028	10	0.833	0.544979	0.20825	0.748	75.9%	2.12	1.48	$161,727	$210,200	$262,800	
F82	F-NW-04A	F-NW-04A-14	F-NW-04A-15	6%	0.021	0.142	4.60	0.654	1375	1342.93	32.07	1356	O63+P62	1335.380	20.62	2695	0.00705	0.0028	10	0.833	0.544979	0.20825	0.748	87.4%	2.12	1.48	$250,635	$325,800	$407,300	
F72	F-NW-04A	F-NW-04A-15	F-NW-04A-17	6%	0.021	0.164	4.50	0.736	1356	1335.38	20.62	1350	O64+P63	1329.290	20.71	2770	0.00217	0.0022	12	1.000	0.785398	0.25	1.079	68.2%	2.13	1.49	$268,690	$349,300	$436,600	
F50	F-NW-04A	F-NW-04A-17	F-NW-04A-16	6%	0.021	0.434	4.10	1.779	1350	1329.29	20.71	1350	O66+P65	1327.740	22.26	1288	0	0.0012	18	1.500	1.767146	0.375	2.351	75.7%	2.06	1.44	$168,728	$219,300	$274,100	
F56	F-NW-04A	F-NW-04A-16	F-NW-04A-21	6%	0.021	0.185	4.50	0.832	1350	1327.74	22.26	1356	O65+P64	1310.990	45.01	7614	-0.00079	0.0022	10	0.833	0.544979	0.20825	0.663	125.5%	1.88	1.32	$708,102	$920,500	$1,150,600	
F65	F-NW-04A	F-NW-04A-18	F-NW-04A-19	6%	0.021	0.206	4.40	0.907	1365	1347.800	17.20	1365	O67+P60+P59	1347.530	17.47	123	0	0.0022	12	1.000	0.785398	0.25	1.079	84.1%	2.13	1.49	$11,931	$15,500	$19,400	
F73	F-NW-04A	F-NW-04A-19	F-NW-04A-20	6%	0.021	0.228	4.40	1.001	1365	1347.53	17.47	1345	O68+P67	1341.530	3.47	2726	0.00734	0.0022	12	1.000	0.785398	0.25	1.079	92.8%	2.13	1.49	$264,422	$343,700	$429,600	
F46	F-NW-04A	F-NW-04A-20	F-NW-04A-17	6%	0.021	0.228	4.40	1.001	1345	1341.53	3.47	1350	O69+P68	1338.640	11.36	1313	-0.00381	0.0022	12	1.000	0.785398	0.25	1.079	92.8%	2.13	1.49	$127,361	$165,600	$207,000	
											0.00				0.00															
F199	F-SE-01	F-SE-01-06	F-SE-01-09	20%	0.041	0.041	5.10	0.211	1275	1265.00	10.00	1265	O74+P73	1257.130	7.87	2812	0.00356	0.0028	10	0.833	0.544979	0.20825	0.748	28.3%	2.12	1.48	$261,516	$340,000	$425,000	
F1	F-SE-01	F-SE-01-09	5740-003	20%	0.041	0.083	4.80	0.398	1265		17.94	1260	O77+P76	1245.420	14.58	1369	0.00365	0.0012	21	1.750	2.405282	0.4375	3.546	11.2%	2.28	1.60	$212,195	$275,900	$344,900	
F198	F-SE-01	F-SE-01-11	F-SE-01-10	20%	0.041	0.041	5.10	0.211	1265	1255	10.00	1270	O80	1247.060	22.94	1986	-0.00252	0.004	8	0.667	0.349415	0.16675	0.494	42.8%	2.19	1.53	$158,880	$206,500	$258,100	
F191	F-SE-01	F-SE-01-10	PLS-007	20%	0.041	0.083	4.80	0.398	1270	1247.06	22.94	1260	O79+P80	1238.830	21.17	2058	0.00486	0.004	8	0.667	0.349415	0.16675	0.494	80.6%	2.19	1.53	$164,640	$214,000	$267,500	
F101	F-SE-01	PLS-007	5740-003	20%	0.041	0.124	4.60	0.572	1260	1238.830	21.17	1260	O78+P79	1245.440	14.56	5538	0	FM	6	0.500	0.19635	0.125	NA	NA	4.51	NA	$387,660	$504,000	$630,000	
											0.00				0.00															
F57	F-SE-02	F-SE-02-01	F-SE-02-02	7%	0.030	0.030	5.30	0.158	1355	1345	10.00	1345	O81	1333.750	11.25	2812	0.00356	0.004	8	0.667	0.349415	0.16675	0.494	31.9%	2.19	1.53	$224,960	$292,400	$365,500	
F37	F-SE-02	F-SE-02-02	F-SE-02-03	7%	0.030	0.060	5.00	0.298	1345	1333.75	11.25	1335	O82+P81	1320.900	14.10	3212	0.00311	0.004	8	0.667	0.349415	0.16675	0.494	60.3%	2.19	1.53	$256,960	$334,000	$417,500	
F36	F-SE-02	F-SE-02-03	F-SE-02-04	7%	0.030	0.089	4.80	0.429	1335	1320.90	14.10	1325	O83+P82	1315.690	9.31	1860	0.00538	0.0028	10	0.833	0.544979	0.20825	0.748	57.3%	2.12	1.48	$172,980	$224,900	$281,100	
F60	F-SE-02	F-SE-02-05	F-SE-02-06	7%	0.030	0.030	5.30	0.158	1360	1350	10.00	1355	O85	1339.630	15.37	2592	0.00193	0.004	8	0.667	0.349415	0.16675	0.494	31.9%	2.19	1.53	$207,360	$269,600	$337,000	
F59	F-SE-02	F-SE-02-06	F-SE-02-04	7%	0.030	0.060	5.00	0.298	1355	1339.63	15.37	1325	O86+P85	1314.870	10.13	2913	0.0103	0.0085	8	0.667	0.349415	0.16675	0.721	41.3%	3.19	2.23	$233,040	$303,000	$378,800	
F58	F-SE-02	F-SE-02-07	F-SE-02-08	7%	0.030	0.030	5.30	0.158	1355	1345	10.00	1355	O87	1339.000	16.00	1500	0	0.004	8	0.667	0.349415	0.16675	0.494	31.9%	2.19	1.53	$120,000	$156,000	$195,000	
F47	F-SE-02	F-SE-02-08	F-SE-02-09	7%	0.030	0.060	5.00	0.298	1355	1339.00	16.00	1345	O88+P87	1328.190	16.81	2702	0.0037	0.004	8	0.667	0.349415	0.16675	0.494	60.3%	2.19	1.53	$216,160	$281,000	$351,300	
F48	F-SE-02	F-SE-02-09	F-SE-02-10	7%	0.030	0.089	4.80	0.429	1345	1328.19	16.81	1335	O89+P88	1318.360	16.64	3512	0.00285	0.0028	10	0.833	0.544979	0.20825	0.748	57.3%	2.12	1.48	$326,616	$424,600	$530,800	
F23	F-SE-02	F-SE-02-10	F-SE-02-04	7%	0.030	0.119	4.70	0.560	1335	1318.36	16.64	1325	O90+P89	1314.410	10.59	1318	0.00759	0.003	10	0.833	0.544979	0.20825	0.774	72.3%	2.20	1.54	$122,574	$159,300	$199,100	
F16	F-SE-02	F-SE-02-11	F-SE-02-04	7%	0.030	0.298	4.30	1.280	1325	1314.410	10.59	1320	O84+P90+P83+P8	1306.840	13.16	3153	0.00159	0.0024	15	1.250	1.227185	0.3125	2.044	62.6%	2.58	1.81	$356,289	$463,200	$579,000	

ID (Char)	Subbasin	Up Manhole	Dn Manhole	Percent of Subbasin (%)	Increm. 2050 ADF	Cumm. 2050 ADF	Peaking Factor	2050 Design Flow (mgd)	Up GND Elev (ft)	Selected Up Invert Elev (ft)	Depth Up MH (ft)	Dn GND Elev (ft)		**Selected Dn Invert Elev (ft)**	Depth Dn MH (ft)	Length (ft)	Ground Slope (ft/ft)	Pipe Slope (ft/ft)	Selected Dia (in)	Pipe Dia (ft)	Pipe Area (sqin)	Pipe W.P. (in)	Pipe Capacity (mgd)	Pct Utilization (<72% to 18", then <92%)	Full Velocity (fps)	0.4 D Velocity (fps)	Probable Base Constr. Cost	Probable Constr. Cost with Contingencies	Probable Project Cost	Phasing
F15	F-SE-02	F-SE-02-11	PLS-002	7%	0.030	0.328	4.30	1.409	1320	1306.840	13.16	1310	O91+P84	1299.750	10.25	2954	0.00339	0.0024	15	1.250	1.227185	0.3125	2.044	68.9%	2.58	1.81	$333,802	$433,900	$542,400	
F187	F-SE-02	PLS-002	5740-003	7%	0.030	0.357	4.20	1.501	1310	1299.75	10.25	1260	O92+P91	1250.000	10.00	21355	0.00234	FM	8	0.667	0.349415	0.16675	NA	NA	6.64	NA	$1,708,400	$2,220,900	$2,776,100	
F100	F-SE-02	F-SE-02-12	F-SE-02-13	7%	0.030	0.030	5.30	0.158	1371	1361	10.00	1348	O93	1318.280	29.72	5340	0.00431	0.008	8	0.667	0.349415	0.16675	0.699	22.6%	3.09	2.16	$427,200	$555,400	$694,300	
F99	F-SE-02	F-SE-02-13	F-SE-02-14	7%	0.030	0.060	5.00	0.298	1348	1318.28	29.72	1346	O94+P93	1304.960	41.04	3330	0.0006	0.004	8	0.667	0.349415	0.16675	0.494	60.3%	2.19	1.53	$266,400	$346,300	$432,900	
											0.00				0.00															
F106	F-SW-01	F-SW-01-01	5640-005	33%	0.137	0.137	4.60	0.630	1260	1250	10.00	1260	O97	1241.790	18.21	2648	0	0.0031	12	1.000	0.785398	0.25	1.281	49.2%	2.52	1.76	$256,856	$333,900	$417,400	
F105	F-SW-01	F-SW-01-02	5441-009	33%	0.137	0.137	4.60	0.630	1270	1260	10.00	1270	O98	1254.990	15.01	2676	0	0.001872	12	1.000	0.785398	0.25	0.996	63.3%	1.96	1.37	$259,572	$337,400	$421,800	
F104	F-SW-01	F-SW-01-03	5441-010	33%	0.137	0.137	4.60	0.630	1270	1260	10.00	1270	O99	1254.610	15.39	2709	0	0.00199	12	1.000	0.785398	0.25	1.027	61.4%	2.02	1.41	$262,773	$341,600	$427,000	
											0.00				0.00															
F110	F-SW-02	F-SW-02-04	F-SW-02-03	25%	0.047	0.047	5.10	0.240	1310	1300	10.00	1305	O103	1285.150	19.85	5304	0.00094	0.0028	10	0.833	0.544979	0.20825	0.748	32.0%	2.12	1.48	$493,272	$641,300	$801,600	
F109	F-SW-02	F-SW-02-03	F-SW-02-02	25%	0.047	0.094	4.80	0.451	1305	1285.150	19.85	1295	O102+P103	1270.190	24.81	5342	0.00187	0.0028	10	0.833	0.544979	0.20825	0.748	60.3%	2.12	1.48	$496,806	$645,800	$807,300	
F108	F-SW-02	F-SW-02-02	F-SW-02-01	25%	0.047	0.141	4.60	0.648	1295	1270.190	24.81	1285	O101+P102	1258.490	26.51	5317	0.00188	0.0022	12	1.000	0.785398	0.25	1.079	60.1%	2.13	1.49	$515,749	$670,500	$838,100	
F107	F-SW-02	F-SW-02-01	5341-008	25%	0.047	0.188	4.50	0.846	1285	1258.490	26.51	1275	O100+P101	1257.750	17.25	5235	0.00191	0.0022	12	1.000	0.785398	0.25	1.079	78.4%	2.13	1.49	$507,795	$660,100	$825,100	
											0.00				0.00															
F132	F-SW-03	F-SW-03-01	F-SW-03-02	4%	0.012	0.012	5.70	0.071	1390	1380	10.00	1380	O104	1369.100	10.90	2724	0.00367	0.004	8	0.667	0.349415	0.16675	0.494	14.3%	2.19	1.53	$217,920	$283,300	$354,100	
F131	F-SW-03	F-SW-03-02	F-SW-03-03	4%	0.012	0.025	5.40	0.134	1380	1369.100	10.90	1365	O105+P104	1357.920	7.08	2796	0.00536	0.004	8	0.667	0.349415	0.16675	0.494	27.2%	2.19	1.53	$223,680	$290,800	$363,500	
F130	F-SW-03	F-SW-03-03	F-SW-03-04	4%	0.012	0.037	5.20	0.194	1365	1357.920	7.08	1365	O106+P105	1350.440	14.56	2673	0	0.0028	10	0.833	0.544979	0.20825	0.748	25.9%	2.12	1.48	$248,589	$323,200	$404,000	
F129	F-SW-03	F-SW-03-04	F-SW-03-05	4%	0.012	0.050	5.00	0.249	1365	1350.440	14.56	1365	O107+P106	1343.390	21.61	2517	0	0.0028	10	0.833	0.544979	0.20825	0.748	33.2%	2.12	1.48	$234,081	$304,300	$380,400	
F128	F-SW-03	F-SW-03-05	F-SW-03-06	4%	0.012	0.062	4.90	0.304	1365	1343.390	21.61	1350	O108+P107	1336.340	13.66	2517	0.00596	0.0028	10	0.833	0.544979	0.20825	0.748	40.7%	2.12	1.48	$234,081	$304,300	$380,400	
F127	F-SW-03	F-SW-03-06	F-SW-03-07	4%	0.012	0.075	4.90	0.365	1350	1336.340	13.66	1345	O109+P108	1329.030	15.97	2609	0.00192	0.0028	10	0.833	0.544979	0.20825	0.748	48.8%	2.12	1.48	$242,637	$315,400	$394,300	
F126	F-SW-03	F-SW-03-07	F-SW-03-08	4%	0.012	0.087	4.80	0.418	1345	1329.030	15.97	1335	O110+P109	1321.730	13.27	2606	0.00384	0.0028	10	0.833	0.544979	0.20825	0.748	55.8%	2.12	1.48	$242,358	$315,100	$393,900	
F125	F-SW-03	F-SW-03-08	F-SW-03-09	4%	0.012	0.099	4.70	0.467	1335	1321.730	13.27	1335	O111+P110	1314.290	20.71	2657	0	0.0028	10	0.833	0.544979	0.20825	0.748	62.5%	2.12	1.48	$247,101	$321,200	$401,500	
F124	F-SW-03	F-SW-03-09	F-SW-03-10	4%	0.012	0.112	4.70	0.526	1335	1314.290	20.71	1330	O112+P111	1306.940	23.06	2626	0.0019	0.0028	10	0.833	0.544979	0.20825	0.748	70.3%	2.12	1.48	$244,218	$317,500	$396,900	
F123	F-SW-03	F-SW-03-10	F-SW-03-11	4%	0.012	0.124	4.60	0.572	1330	1306.940	23.06	1325	O113+P112	1301.530	23.47	2461	0.00203	0.0022	12	1.000	0.785398	0.25	1.079	53.0%	2.13	1.49	$238,717	$310,300	$387,900	
F122	F-SW-03	F-SW-03-11	F-SW-03-13	4%	0.012	0.137	4.60	0.629	1325	1301.530	23.47	1315	O114+P113	1295.610	19.39	2690	0.00372	0.0022	12	1.000	0.785398	0.25	1.079	58.3%	2.13	1.49	$260,930	$339,200	$424,000	
F121	F-SW-03	F-SW-03-13	F-SW-03-12	4%	0.012	0.149	4.60	0.686	1315	1295.610	19.39	1320	O116+P115	1290.080	29.92	2513	-0.00199	0.0022	12	1.000	0.785398	0.25	1.079	63.6%	2.13	1.49	$243,761	$316,900	$396,100	
F120	F-SW-03	F-SW-03-12	F-SW-03-14	4%	0.012	0.162	4.50	0.727	1320	1290.080	29.92	1310	O115+P114	1284.470	25.53	2549	0.00392	0.0022	12	1.000	0.785398	0.25	1.079	67.4%	2.13	1.49	$247,253	$321,400	$401,800	
F119	F-SW-03	F-SW-03-14	F-SW-03-20	4%	0.012	0.162	4.50	0.727	1310	1284.470	25.53	1310	O117+P115	1278.720	31.28	2613	0	0.0022	12	1.000	0.785398	0.25	1.079	67.4%	2.13	1.49	$253,461	$329,500	$411,900	
F201	F-SW-03	F-SW-03-14	PLS-008	4%	0.012	0.174	4.50	0.783	1310	1284.470	25.53	1310	O118+P116	1283.680	26.32	358	0	0.0022	12	1.000	0.785398	0.25	1.079	72.6%	2.13	1.49	$34,726	$45,100	$56,400	
F202	F-SW-03	PLS-008	4843-046	4%	0.012	0.174	4.50	0.783	1310	1283.680	26.32	1325	O167+P118	1310.700	14.30	3336	-0.0045	0.0022	6	0.500	0.19635	0.125	NA	NA	6.17	NA	$233,520	$303,600	$379,500	
F118	F-SW-03	F-SW-03-15	F-SW-03-16	4%	0.012	0.012	5.70	0.071	1320	1310	10.00	1320	O119	1302.430	17.57	2703	0	0.0028	10	0.833	0.544979	0.20825	0.748	9.5%	2.12	1.48	$251,379	$326,800	$408,500	
F117	F-SW-03	F-SW-03-16	F-SW-03-17	4%	0.012	0.025	5.40	0.134	1320	1302.430	17.57	1315	O120+P119	1295.120	19.88	2612	0.00191	0.0028	10	0.833	0.544979	0.20825	0.748	17.9%	2.12	1.48	$242,916	$315,800	$394,800	
F116	F-SW-03	F-SW-03-17	F-SW-03-18	4%	0.012	0.037	5.20	0.194	1315	1295.120	19.88	1315	O121+P120	1287.850	27.15	2597	0	0.0028	10	0.833	0.544979	0.20825	0.748	25.9%	2.12	1.48	$241,521	$314,000	$392,500	
F115	F-SW-03	F-SW-03-18	F-SW-03-19	4%	0.012	0.050	5.00	0.249	1315	1287.850	27.15	1300	O122+P121	1280.250	19.75	2716	0.00552	0.0028	10	0.833	0.544979	0.20825	0.748	33.2%	2.12	1.48	$252,588	$328,400	$410,500	
F114	F-SW-03	F-SW-03-19	F-SW-03-20	4%	0.012	0.062	4.90	0.304	1300	1280.250	19.75	1310	O123+P122	1272.880	37.12	2631	-0.0038	0.0028	10	0.833	0.544979	0.20825	0.748	40.7%	2.12	1.48	$244,683	$318,100	$397,600	
F185	F-SW-03	F-SW-03-20	F-SW-03-21	4%	0.012	0.249	4.40	1.093	1310	1272.880	37.12	1300	O124+P123+P117	1267.190	32.81	2586	0.00387	0.0022	15	1.250	1.227185	0.3125	1.957	55.9%	2.47	1.73	$292,218	$379,900	$474,900	
F184	F-SW-03	F-SW-03-21	F-SW-03-22	4%	0.012	0.261	4.30	1.122	1300	1267.190	32.81	1295	O125+P124	1260.870	34.13	2872	0.00174	0.0022	15	1.250	1.227185	0.3125	1.957	57.3%	2.47	1.73	$324,536	$421,900	$527,400	
F113	F-SW-04	F-SW-03-22	F-SW-03-23	100%	0.149	0.410	4.20	1.722	1295	1260.870	34.13	1290	O126+P125	1255.940	34.06	4111	0.00122	0.0012	15	1.250	1.227185	0.3125	1.446	119.1%	1.82	1.27	$464,543	$603,900	$754,900	
F200	F-SW-03	F-SW-03-23	F-SW-03-24	4%	0.012	0.422	4.20	1.774	1290	1255.940	34.06	1305	O127+P126	1253.510	51.49	2021	-0.00742	0.0012	15	1.250	1.227185	0.3125	1.446	122.7%	1.82	1.27	$228,373	$296,900	$371,100	
F112	F-SW-03	F-SW-03-24	F-SW-03-25	4%	0.012	0.435	4.10	1.783	1305	1253.510	51.49	1290	O128+P127	1251.180	38.82	1944	0.00772	0.0012	15	1.250	1.227185	0.3125	1.446	123.3%	1.82	1.27	$219,672	$285,600	$357,000	
F111	F-SW-03	F-SW-03-25	LS-57	4%	0.012	0.447	4.10	1.834	1290	1251.180	38.82	1330	O129+P128	1246.780	83.22	1999	-0.02001	0.0022	15	1.250	1.227185	0.3125	1.957	93.7%	2.47	1.73	$225,887	$293,700	$367,100	
															0.00															
F92	F-SW-06	F-SW-06-01	F-SW-06-02	5%	0.025	0.025	5.40	0.135	1415	1405	10.00	1410	O130	1399.800	10.20	945	0.00529	0.0055	8	0.667	0.349415	0.16675	0.580	23.2%	2.57	1.80	$75,600	$98,300	$122,900	
F91	F-SW-06	F-SW-06-02	F-SW-06-04	5%	0.025	0.050	5.00	0.249	1410	1399.800	10.20	1390	O131+P130	1379.630	10.37	2123	0.00942	0.0095	8	0.667	0.349415	0.16675	0.762	32.7%	3.37	2.36	$169,840	$220,800	$276,000	
F88	F-SW-06	F-SW-06-04	F-SW-06-03	5%	0.025	0.075	4.90	0.367	1390	1379.630	10.37	1395	O132+P131	1376.990	18.01	661	-0.00756	0.004	10	0.833	0.544979	0.20825	0.894	41.0%	2.54	1.78	$61,473	$79,900	$99,900	
F75	F-SW-06	F-SW-06-03	F-SW-06-05	5%	0.025	0.100	4.70	0.469	1395	1376.990	18.01	1370	O133+P132	1359.410	10.59	2705	0.00924	0.0065	10	0.833	0.544979	0.20825	1.140	41.1%	3.24	2.27	$251,565	$327,000	$408,800	
F74	F-SW-06	F-SW-06-05	F-SW-06-06	5%	0.025	0.125	4.60	0.574	1370	1359.410	10.59	1360	O134+P133	1352.400	7.60	2502	0.004	0.0028	10	0.833	0.544979	0.20825	0.748	76.7%	2.12	1.48	$232,686	$302,500	$378,100	
F62	F-SW-06	F-SW-06-06	F-SW-06-07	5%	0.025	0.150	4.60	0.689	1360	1352.400	7.60	1360	O135+P134	1345.380	14.62	3193	0	0.0022	12	1.000	0.785398	0.25	1.079	63.8%	2.13	1.49	$309,721	$402,600	$503,300	
F49	F-SW-06	F-SW-06-07	F-SW-06-08	5%	0.025	0.175	4.50	0.786	1360	1345.380	14.62	1345	O136+P135	1334.800	10.20	962	0.01559	0.011	12	1.000	0.785398	0.25	2.414	32.6%	4.75	3.33	$93,314	$121,300	$151,600	
F45	F-SW-06	F-SW-06-08	F-SW-06-09	5%	0.025	0.200	4.40	0.878	1345	1334.800	10.20	1340	O137+P136	1326.630	13.37	1486	0.00336	0.0055	15	1.250	1.227185	0.3125	3.095	28.4%	3.90	2.73	$167,918	$218,300	$272,900	
F30	F-SW-06	F-SW-06-09	F-SW-06-10	5%	0.025	0.225	4.40	0.988	1340	1326.630	13.37	1330	O138+P137	1319.920	10.08	1343	0.00745	0.005	15	1.250	1.227185	0.3125	2.951	33.5%	3.72	2.60	$151,759	$197,300	$246,600	
F29	F-SW-06	F-SW-06-10	F-SW-06-16	5%	0.025	0.249	4.40	1.098	1330	1319.920	10.08	1330	O139+P138	1317.060	12.94	1299	0	0.0022	15	1.250	1.227185	0.3125	1.957	56.1%	2.47	1.73	$146,787	$190,800	$238,500	
F85	F-SW-06	F-SW-06-13	F-SW-06-14	5%	0.025	0.025	5.40	0.135	1355	1345	10.00	1350	O140	1336.470	13.53	3046	0.00164	0.0028	10	0.833	0.544979	0.20825	0.748	18.0%	2.12	1.48	$283,278	$368,300	$460,400	
F61	F-SW-06	F-SW-06-14	F-SW-06-15	5%	0.025	0.050	5.00	0.249	1350	1336.470	13.53	1340	O141+P140	1327.110	12.89	3342	0.00299	0.0028	10	0.833	0.544979	0.20825	0.748	33.4%	2.12	1.48	$310,806	$404,000	$505,000	
F32	F-SW-06	F-SW-06-15	F-SW-06-16	5%	0.025	0.075	4.90	0.367	1340	1327.110	12.89	1330	O142+P141	1319.530	10.47	2707	0.00369	0.0028	10	0.833	0.544979	0.20825	0.748	49.0%	2.12	1.48	$251,751	$327,300	$409,100	
F31	F-SW-06	F-SW-06-16	F-SW-06-17	5%	0.025	0.349	4.20	1.467	1330	1317.060	12.94	1330	O143+P142+P139	1316.810	13.19	208	0	0.0012	18	1.500	1.767146	0.375	2.351	62.4%	2.06	1.44	$27,248	$35,400	$44,300	
F33	F-SW-06	F-SW-06-17	F-SW-06-18	5%	0.025	0.374	4.20	1.572	1330	1316.810	13.19	1335	O144+P143	1313.710	21.29	2585	-0.00193	0.0012	18	1.500	1.767146	0.375	2.351	66.9%	2.06	1.44	$338,635	$440,200	$550,300	
F38	F-SW-06	F-SW-06-18	F-SW-06-20	5%	0.025	0.399	4.20	1.677	1335	1313.710	21.29	1336	O145+P144	1310.510	25.49	2670	-0.00037	0.0012	18	1.500	1.767146	0.375	2.351	71.3%	2.06	1.44	$349,770	$454,700	$568,400	
F41	F-SW-06	F-SW-06-20	F-SW-06-21	5%	0.025	0.424	4.20	1.781	1336	1310.510	25.49	1335	O147+P146	1307.180	27.82	2775	0.00036	0.0012	18	1.500	1.767146	0.375	2.351	75.8%	2.06	1.44	$363,525	$472,600	$590,800	
F11	F-SW-06	F-SW-06-21	F-SW-06-22	5%	0.025	0.449	4.10	1.841	1335	1307.180	27.82	1308	O148+P147	1302.710	5.29	3729	0.00724	0.0012	18	1.500	1.767146	0.375	2.351	78.3%	2.06	1.44	$488,499	$635,000	$793,800	
F8	F-SW-06	F-SW-06-22	4844-001	5%	0.025	0.474	4.10	1.944	1308	1302.71	5.29	1305	O149+P148	1283.560	21.44	2293	0.00131	0.008352	18	1.500	1.767146	0.375	6.201	31.3%	5.43	3.80	$300,383	$390,500	$488,100	
											0.00				0.00															
F103	F-SW-08	F-SW-08-10	PLS-006	50%	0.021	0.021	5.40	0.115	1260	1250	10.00	1255	O150	1214.750	40.25	8813	0.00057	0.004	8	0.667	0.349415	0.16675	0.494	23.3%	2.19	1.53	$705,040	$916,600	$1,145,800	
F102	F-SW-08	PLS-006	OUTLET-001	50%	0.021	0.043	5.10	0.217	1255	1214.750	40.25	1260	O151+P150	1173.640	86.36	10277	-0.00049	0.004	6	0.500	0.19635	0.125	0.229	94.8%	1.80	1.26	$719,390	$935,200	$1,169,000	
											0.00				0.00															
F34	F-W-02	F-W-02-11	F-W-02-10	10%	0.027	0.027	5.30	0.145	1320	1310	10.00	1325	O163	1302.620	22.38	1846	-0.00271	0.004	8	0.667	0.349415	0.16675	0.494	29.4%	2.19	1.53	$147,680	$192,000	$240,000	
F20	F-W-02	F-W-02-10	F-W-02-13	10%	0.027	0.055	5.00	0.274	1325	1302.620	22.38	1330	O162+P163+P161	1295.240	34.76	1846	-0.00271	0.004	8	0.667	0.349415	0.16675	0.494	55.5%	2.19	1.53	$147,680	$192,000	$240,000	
F22	F-W-02	F-W-02-09	F-W-02-10	10%	0.027	0.082	4.80	0.395	1325	1295.240	29.76	1325	O160+P162	1284.170	40.83	2768	0	0.004	8	0.667	0.349415	0.16675	0.494	79.9%	2.19	1.53	$221,440	$287,900	$359,900	
F24	F-W-02	F-W-02-08	F-W-02-09	10%	0.027	0.110	4.70	0.515	1330	1284.170	45.83	1325	O159+P160	1276.670	48.33	2678	0.00187	0.0028	10	0.833	0.544979	0.20825	0.748	68.9%	2.12	1.48	$249,054	$323,800	$404,800	
F39	F-W-02	F-W-02-05	F-W-02-06	10%	0.027	0.192	4.50	0.863	1330	1320.000	10.00	1330	O156+P157	1314.250	15.75	2614	0	0.0022	12	1.000	0.785398	0.25	1.079	80.0%	2.13	1.49	$253,558	$329,600	$412,000	
F27	F-W-02	F-W-02-06	F-W-02-07	10%	0.027	0.164	4.50	0.740	1330	1314.250	15.75	1327	O157+P158	1311.460	15.54	1266	0.00237	0.0022	12	1.000	0.785398	0.25	1.079	68.6%	2.13	1.49	$122,802	$159,600	$199,500	
F28	F-W-02	F-W-02-07	F-W-02-08	10%	0.027	0.137	4.60	0.630	1327	1311.460	15.54	1330	O158+P159	1303.960	26.04	2678	-0.00112	0.0028	10	0.833	0.544979	0.20825	0.748	84.3%	2.12	1.48	$249,054	$323,800	$404,800	
F192	F-W-02	F-W-02-13	F-W-02-12	10%	0.027	0.219	4.40	0.965	1330	1295.240	34.76	1330	O155+P156	1291.180	38.82	1846	0	0.0022	12	1.000	0.785398	0.25	1.079	89.4%	2.13	1.49	$179,062	$232,800	$291,000	
F183	F-W-02	F-W-02-02	F-W-02-03	10%	0.027	0.027	5.30	0.145	1335	1325	10.00	1335	O153+P154	1314.640	20.36	2590	0	0.004	8	0.667	0.349415	0.16675	0.494	29.4%	2.19	1.53	$207,200	$269,400	$336,800	
F182	F-W-01	F-W-02-03	F-W-02-01	100%	0.127	0.374	4.20	1.570	1335	1291.180	43.82	1335	O154+P155	1288.660	46.34	2098	0	0.0012	18	1.500	1.767146	0.375	2.351	66.8%	2.06	1.44	$274,838	$357,300	$446,600	
F240	F-W-02	F-W-02-01	WWTP - NP	10%	0.027	0.401	4.20	1.685	1335	1288.660	46.34	1335	O152+P153	1287.460	47.54	1000	0	0.0012	18	1.500	1.767146	0.375	2.351	71.7%	2.06	1.44	$131,000	$170,300	$212,900	
											0.00				0.00															
F180	F-N-02	PLS-005	WWTP - NP	10%	0.042	0.042	5.10	0.215	1330	1287.940	42.06	1335		1325.000	10.00	12213	-0.00041	FM	6	0.500	0.19635	0.125	NA	NA	1.69	NA	$854,910	$1,111,400	$1,389,300	
F161	WALNU-2	WALNU-2-02	WALNU-2-03	6%	0.047	0.047	5.10	0.242	1390	1380.000	10.00	1370	O169+P168	1365.300	4.70	1336	0.01497	0.011	8	0.667	0.349415	0.16675	0.820	29.5%	3.63	2.54	$106,880	$138,900	$173,600	
F71	WALNU-2	WALNU-2-03	WALNU-2-04	6%	0.047	0.095	4.80	0.455	1370	1365.30	4.70	1370	O170+P169	1359.590	10.41	2594	0	0.0022	12	1.000	0.785398	0.25	1.079	42.2%	2.13	1.49	$251,618	$327,100	$408,900	
F79	WALNU-2	WALNU-2-04	WALNU-2-05	6%	0.047	0.142	4.60	0.654	1370	1359.59	10.41	1370	O171+P170	1357.600	12.40	1330	0	0.0015	15	1.250	1.227185	0.3125	1.616	40.5%	2.04	1.43	$150,290	$195,400	$244,300	
F68	WALNU-2	WALNU-2-05	WALNU-2-06	6%	0.047	0.190	4.50	0.853	1370	1357.60	12.40	1365	O172+P171	1353.700	11.30	2597	0.00193	0.0015	15	1.250	1.227185	0.3125	1.616	52.8%	2.04	1.43	$293,461	$381,500	$476,900	

Pre-Draft

ID (Char)	Subbasin	Up Manhole	Dn Manhole	Percent of Subbasin (%)	Increm. 2050 ADF	Cumm. 2050 ADF	Peaking Factor	2050 Design Flow (mgd)	Up GND Elev (ft)	Selected Up Invert Elev (ft)	Depth Up MH (ft)	Dn GND Elev (ft)		**Selected Dn Invert Elev (ft)**	Depth Dn MH (ft)	Length (ft)	Ground Slope (ft/ft)	Pipe Slope (ft/ft)	Selected Dia (in)	Pipe Dia (ft)	Pipe Area (sqin)	Pipe W.P. (in)	Pipe Capacity (mgd)	Pct Utilization (<72% to 18", then <92%)	Full Velocity (fps)	0.4 D Velocity (fps)	Probable Base Constr. Cost	Probable Constr. Cost with Contingencies	Probable Project Cost	Phasing
F165	WALNU-2	WALNU-2-06	WALNU-2-07	6%	0.047	0.237	4.40	1.043	1365	1353.70	11.30	1360	O173+P172	1352.800	7.20	746	0.0067	0.0012	18	1.500	1.767146	0.375	2.351	44.4%	2.06	1.44	$97,726	$127,000	$158,800	
F63	WALNU-2	WALNU-2-07	WALNU-2-13	6%	0.047	0.474	4.10	1.944	1360	1344.740	15.26	1350	O174+P173+P178	1340.860	9.14	3237	0.00309	0.0012	18	1.500	1.767146	0.375	2.351	82.7%	2.06	1.44	$424,047	$551,300	$689,100	
F77	WALNU-2	WALNU-2-09	WALNU-2-10	6%	0.047	0.047	5.10	0.242	1375	1365	10.00	1375	O175	1361.920	13.08	770	0	0.004	8	0.667	0.349415	0.16675	0.494	48.9%	2.19	1.53	$61,600	$80,100	$100,100	
F78	WALNU-2	WALNU-2-10	WALNU-2-11	6%	0.047	0.095	4.80	0.455	1375	1361.92	13.08	1380	O176+P175	1354.680	25.32	2584	-0.00193	0.0028	10	0.833	0.544979	0.20825	0.748	60.8%	2.12	1.48	$240,312	$312,400	$390,500	
F84	WALNU-2	WALNU-2-11	WALNU-2-12	6%	0.047	0.142	4.60	0.654	1380	1354.68	25.32	1375	O177+P176	1349.090	25.91	2539	0.00197	0.0022	12	1.000	0.785398	0.25	1.079	60.6%	2.13	1.49	$246,283	$320,200	$400,300	
F83	WALNU-2	WALNU-2-12	WALNU-2-07	6%	0.047	0.190	4.50	0.853	1375	1349.09	25.91	1360	O178+O177	1344.740	15.26	3629	0.00413	0.0012	18	1.500	1.767146	0.375	2.351	36.3%	2.06	1.44	$475,399	$618,000	$772,500	
F51	WALNU-2	WALNU-2-13	WALNU-2-14	6%	0.047	0.522	4.10	2.138	1350	1340.860	9.14	1345	O179+P174	1335.110	9.89	2875	0.00174	0.002	18	1.500	1.767146	0.375	3.035	70.5%	2.66	1.86	$376,625	$489,600	$612,000	
F52	WALNU-2	WALNU-2-14	WALNU-2-15	6%	0.047	0.569	4.00	2.276	1345	1335.11	9.89	1340	O180+P179	1329.300	10.70	2903	0.00172	0.002	21	1.750	2.405282	0.4375	4.578	49.7%	2.94	2.06	$449,965	$585,000	$731,300	
F163	WALNU-2	WALNU-2-15	PLS-003	6%	0.047	0.616	4.00	2.465	1340	1329.30	10.70	1340	O181+P180	1324.170	15.83	2563	0	0.002	21	1.750	2.405282	0.4375	4.578	53.9%	2.94	2.06	$397,265	$516,400	$645,500	
F197	WALNU-2	PLS-003	4MC_WWTP	6%	0.047	0.664	4.00	2.655	1340	1324.170	15.83	1285	O164+P181	1265.000	20.00	27677	0.00199	FM	16	1.333	1.395565	0.33325	NA	NA	2.94	NA	$3,127,501	$4,065,800	$5,082,300	
											0.00																			
F69	WALNU-2	WALNU-2-17	WALNU-2-18	6%	0.047	0.047	5.10	0.242	1355	1345	10.00	1365	O182	1336.730	28.27	2954	-0.00339	0.0028	10	0.833	0.544979	0.20825	0.748	32.3%	2.12	1.48	$274,722	$357,100	$446,400	
F70	WALNU-2	WALNU-2-18	WALNU-3B-01	6%	0.047	0.095	4.80	0.455	1365	1336.73	28.27	1360	O183+P182	1328.410	31.59	2972	0.00168	0.0028	10	0.833	0.544979	0.20825	0.748	60.8%	2.12	1.48	$276,396	$359,300	$449,100	
F53	WALNU-3B	WALNU-3B-01	4MC-CV-01	20%	0.040	0.135	4.60	0.620	1360	1328.41	31.59	1350	O184+P183	1322.540	27.46	2668	0.00375	0.0022	12	1.000	0.785398	0.25	1.079	57.5%	2.13	1.49	$258,796	$336,400	$420,500	
F35	WALNU-3B	4MC-CV-01	4MC-CV-02	20%	0.040	0.175	4.50	0.787	1350	1322.54	27.46	1335	O185+P184	1317.370	17.63	2351	0.00638	0.0022	12	1.000	0.785398	0.25	1.079	72.9%	2.13	1.49	$228,047	$296,500	$370,600	
F25	WALNU-3B	4MC-CV-02	WALNU-3B-02	20%	0.040	0.215	4.40	0.945	1335	1317.37	17.63	1330	O186+P185	1315.370	14.63	1336	0.00374	0.0015	15	1.250	1.227185	0.3125	1.616	58.5%	2.04	1.43	$150,968	$196,300	$245,400	
F17	WALNU-3B	WALNU-3B-02	WALNU-3B-03	20%	0.040	0.255	4.30	1.096	1330	1315.37	14.63	1325	O187+P186	1309.030	15.97	4229	0.00118	0.0015	15	1.250	1.227185	0.3125	1.616	67.8%	2.04	1.43	$477,877	$621,200	$776,500	
F14	WALNU-3B	WALNU-3B-03	6448-001	20%	0.040	0.295	4.30	1.268	1325	1309.03	15.97	1320	O188+P187	1304.460	15.54	3191	0.00157	0.0022	15	1.250	1.227185	0.3125	1.957	64.8%	2.47	1.73	$360,583	$468,800	$586,000	
											0.00				0.00															
F43	WALNU-4	WALNU-4-01	WALNU-4-02	8%	0.037	0.037	5.20	0.195	1350	1340	10.00	1340	O189	1329.890	10.11	1839	0.00544	0.0055	8	0.667	0.349415	0.16675	0.580	33.6%	2.57	1.80	$147,120	$191,300	$239,100	
F44	WALNU-4	WALNU-4-02	WALNU-4-03	8%	0.037	0.075	4.90	0.367	1340	1329.89	10.11	1325	O190+P189	1313.950	11.05	2452	0.00612	0.0065	8	0.667	0.349415	0.16675	0.630	58.3%	2.79	1.95	$196,160	$255,000	$318,800	
F9	WALNU-4	WALNU-4-03	WALNU-4-04	8%	0.037	0.112	4.70	0.528	1325	1313.95	11.05	1310	O191+P190	1299.690	10.31	1584	0.00947	0.009	8	0.667	0.349415	0.16675	0.742	71.2%	3.29	2.30	$126,720	$164,700	$205,900	
F10	WALNU-4	WALNU-4-04	WALNU-4-05	8%	0.037	0.150	4.60	0.689	1310	1299.69	10.31	1315	O192+P191	1296.610	18.39	1399	-0.00357	0.0022	12	1.000	0.785398	0.25	1.079	63.9%	2.13	1.49	$135,703	$176,400	$220,500	
F12	WALNU-4	WALNU-4-05	WALNU-4-10	8%	0.037	0.187	4.50	0.843	1315	1296.61	18.39	1295	O193+P192	1284.970	10.03	2530	0.00791	0.0046	12	1.000	0.785398	0.25	1.561	54.0%	3.07	2.15	$245,410	$319,000	$398,800	
F26	WALNU-4	WALNU-4-07	WALNU-4-08	8%	0.037	0.037	5.20	0.195	1330	1320	10.00	1315	O195	1304.570	10.43	2661	0.00564	0.0058	8	0.667	0.349415	0.16675	0.595	32.7%	2.63	1.84	$212,880	$276,700	$345,900	
F13	WALNU-4	WALNU-4-08	WALNU-4-09	8%	0.037	0.075	4.90	0.367	1315	1304.57	10.43	1300	O196+P195	1289.490	10.51	2600	0.00577	0.0058	8	0.667	0.349415	0.16675	0.595	61.7%	2.63	1.84	$208,000	$270,400	$338,000	
F7	WALNU-4	WALNU-4-09	WALNU-4-10	8%	0.037	0.112	4.70	0.528	1300	1289.49	10.51	1295	O197+P196	1284.470	10.53	865	0.00578	0.0058	10	0.833	0.544979	0.20825	1.077	49.0%	3.06	2.14	$80,445	$104,600	$130,800	
F4	WALNU-4	WALNU-4-10	WALNU-4-11	8%	0.037	0.300	4.30	1.288	1295	1284.470	10.53	1300	O198+O197+O193	1283.190	16.81	213	-0.02347	0.006	12	1.000	0.785398	0.25	1.783	72.3%	3.51	2.46	$20,661	$26,900	$33,600	
F18	WALNU-4	WALNU-4-06	WALNU-4-11	8%	0.037	0.037	5.20	0.195	1325	1315	10.00	1300	O194	1289.280	10.72	2338	0.01069	0.011	8	0.667	0.349415	0.16675	0.820	23.8%	3.63	2.54	$187,040	$243,200	$304,000	
F6	WALNU-4	WALNU-4-11	WALNU-4-12	8%	0.037	0.375	4.20	1.573	1300	1283.190	16.81	1295	O199+P194+P198	1279.560	15.44	3028	0.00165	0.0012	18	1.500	1.767146	0.375	2.351	66.9%	2.06	1.44	$396,668	$515,700	$644,600	
F5	WALNU-4	WALNU-4-13	WALNU-4-12	8%	0.037	0.037	5.20	0.195	1295	1285	10.00	1295	O201	1276.200	18.80	3144	0	0.0028	10	0.833	0.544979	0.20825	0.748	26.0%	2.12	1.48	$292,392	$380,100	$475,100	
F3	WALNU-4	WALNU-4-12	6445-057	8%	0.037	0.449	4.10	1.843	1295	1276.200	18.80	1290	O200+P201+P199	1277.140	12.86	2102	0.00238	0.0012	18	1.500	1.767146	0.375	2.351	78.4%	2.06	1.44	$275,362	$358,000	$447,500	

APPENDIX J

Flow and Rainfall Monitoring Program

APPENDIX J

FLOW AND RAINFALL MONITORING PROGRAM

PROGRAM OBJECTIVES

Flow and rainfall monitoring will help City of Wichita better understand the condition and performance of its collection system. Although the City of Wichita completed an extensive flow and rainfall monitoring program covering the entire city from 1994 to 2001, the prior monitoring results are not current due to the passage of time and system changes. New testing will provide current information on actual system flows. The new monitoring recommended in the report text is focused on determining flow parameters for:

- The Four Mile Creek sanitary sewer system and facilities, which were acquired by the City since the prior monitoring programs were completed,
- The relief sewers and lift station expansions recommended by hydraulic modeling, to confirm the need for the improvements and determine appropriate sizing, and
- The monitoring locations that showed high levels of infiltration/inflow (I/I) in the 1994 to 2001 monitoring program.

SCHEDULE

A preliminary program schedule was prepared based on two sets of monitoring per year (spring and fall), using up to twelve monitors at a time, and completing the recommended monitoring before the next 5-year Master Plan Update. The preliminary schedule can be adjusted as desired by the City of Wichita. The schedule was prioritized to collect Four Mile Creek data first, followed by collecting data on flows for recommended improvement projects, and finishing with collecting data at the prior high I/I monitoring sites.

Typically, short-term flow monitoring programs require the meters to be in place for at least six to ten weeks in order to capture sufficient dry weather and wet weather periods. In the Wichita area, flow monitoring is usually most productive during the

months that have higher monthly average rainfall, which are April through September. October through March typically have substantially less rainfall and are less productive for flow monitoring. Since the rain that actually occurs is highly variable, the City of Wichita should plan on 10-week programs but closely monitor the data received to determine when sufficient data has been collected. Typically, observing at last one week of dry weather and at least four to five storm events that are significant enough to produce measurable I/I flows is sufficient. The meters should be interrogated and data analyzed weekly to determine when enough data has been collected to begin removing the meters, which may require more or less time than the typical program.

Capturing sufficient rain events is important to help make decisions regarding system improvements. The Capital Improvements Plan and sizing of new sewers for the upcoming Master Plan cycle depend on securing reliable flow and rainfall metering data.

FLOW METERING LOCATIONS

The recommended flow monitoring locations for the Four Mile Creek, recommended improvement projects, and prior high I/I monitoring site programs are shown on the figure located at the end of Appendix J.

Four Mile Creek

The City of Wichita has taken ownership of the Four Mile Creek sanitary sewer facilities and wastewater treatment plant. No prior flow and rainfall monitoring data are available for Four Mile Creek. The City of Wichita reports that flow to the wastewater treatment plant suggest the presence of higher levels of I/I. Flow monitoring is recommended to determine the actual flows in Four Mile Creek sewers. A program using nine to ten flow meter sites will provide sufficient data. Table J-1 lists the proposed monitoring manholes for Four Mile Creek.

Table J-1. Recommended Four Mile Creek Flow Monitoring

Site Number	*Manhole*	*Pipe Diameter (in)*	*Monitor Date*
1	6446-216	21	Spring 07
2	6448-006	18	Spring 07
3	6348-148	18	Spring 07

Site Number	*Manhole*	*Pipe Diameter (in)*	*Monitor Date*
4	6349-144	18	Spring 07
5	6446-001	36	Spring 07
6	6346-059	30	Spring 07
7	6346-002	24	Spring 07
8	6246-147	15	Spring 07
9	6246-017	24	Spring 07

The results of the Four Mile Creek flow and rainfall monitoring will indicate any sub-basins that have high levels of I/I and merit further flow monitoring in smaller sub-basins and field inspections to determine the sources of I/I for correction. With the actual current flow parameters by sub-basin, the model should be updated. The updated model should be used to determine actual system performance in Four Mile Creek sewers and to adjust sizing of the recommended relief sewers.

Future Potentially Overloaded Pipes

Flow projections show a number of pipes within the system will be at or exceeding capacity. Relief sewers are recommended to reduce flow in these sewers. To confirm the need for relief sewers, flow and rainfall monitoring will be completed for each project. Table J-2 lists the proposed monitoring manholes for the proposed relief sewers.

Table J-2. Relief Sewers[3]

Relief Sewer Project No.	*Manhole*	*Pipe Diameter (in)*	*Monitor Date*
R9	5441-009	60	Fall 07
R10	5541-006	60	Fall 07
R8	5242-001	54	Fall 07
R7	5244-014	36	Fall 07
R6	5245-014	36	Fall 07
R11[1]	6349-144	18	Spring 07
R4	4843-038	12	Fall 07
R3	4846-011	30	Fall 07

Relief Sewer Project No.	*Manhole*	*Pipe Diameter (in)*	*Monitor Date*
R5	4844-001	18	Fall 07
R2	4847-012	18	Fall 07
R1	4747-002	24	Fall 07
R12[2]	L.S. 55	18	--
R13[1]	6446-2165	21	Spring 07

[1] Flow data for projects R11 and R13 will be provided by the recommended Four Mile Creek flow monitoring program.

[2] Use of lift station records is recommended in lieu of monitoring.

[3] The monitoring sites in Table 2 are sorted from highest to lowest ratio of peak modeled flow vs. full pipe capacity.

The results of the flow and rainfall monitoring will indicate the actual levels of I/I and peaking factors for sub-basins tributary to the recommended relief sewer projects and lift stations. If the results indicate the peak wet weather flows are actually less than the pipe capacities, the relief project would not be required. The model should be updated to reflect the actual flow parameters. The updated model should then be used to determine whether or not recommended facilities are needed and confirm the appropriate sizing.

Critical Previous Flow Monitoring Locations

Table J-3 lists the locations that had high levels of I/I in the 1994-2001 monitoring program, based on the ratio of peak wet weather flow (PWF) to peak dry weather flow (PDF). Since 2001, the City of Wichita has completed pipe relief projects and a city-wide sump pump removal project to address I/I. The City of Wichita believes wet weather overflows from the current sewer system do not typically occur. Flow monitoring of the critical manholes in Table J-3 is recommended to determine whether the previous high levels of I/I have been reduced. These manholes include sites in WIS, SS23, SWI, NWI, and CIS drainage basins.

Table J-3. Critical Previous Flow Monitoring Manholes[1]

Site Number	*Manhole*	*Pipe Diameter (in)*	*Monitor Date*
1	5549-306	36	Spring 08
2	6050-009	21	Spring 08

Site Number	*Manhole*	*Pipe Diameter (in)*	*Monitor Date*
3	6149-001	21	Spring 08
4	4746-003	36	Spring 08
5	5451-037	12	Spring 08
6	6046-039S	24	Spring 08
7	5845-050	18	Spring 08
8	5647-178	48	Spring 08
9	5547-693	36	Spring 08
10	4850-001	15	Spring 08
11	4950-002	21	Fall 08
12	6147-005	15	Fall 08
13	6052-002	24	Fall 08
14	6048-014	24	Fall 08
15	5645-195	42	Fall 08
16	5645-184	42	Fall 08
17	5049-031	24	Fall 08
18	5644-256	60	Fall 08
19	5951-024	15	Fall 08
20	5549-018	36	Fall 08
21	5952-001	30	Spring 09
22	5950-001	21	Spring 09
23	5245-001	36	Spring 09

[1] The monitoring sites in Table J-3 are sorted from highest to lowest ratio of peak modeled flow vs. full pipe capacity.

The results of the critical locations flow and rainfall monitoring should confirm whether previously determine higher levels of I/I at these locations in the 1994 to 2001 program have been reduced, due to the sump pump program and other system changes. If higher levels of I/I are still present, additional relief sewer facilities may be required to prevent overloaded sewers. The model should be updated to reflect the actual flow parameters. The updated model should then be used to determine the impact of actual flows on the trunk sewers and whether any additional facilities are indicated.

RAINFALL MONITORING

Continuous recording tipping-bucket type rainfall gages monitored concurrent with the flow monitoring is required to correlate rainfall during storm events with the resulting wastewater flow rates. Rain data should be recorded electronically. Ideally, the rain gauge would be linked to the flow monitor equipment to automatically collect rain and flow data simultaneously. The data is then processed to define each rainfall event.

The locations for rain gages must be determined before installing each flow monitor. Ideally, a separate rain gage should be installed for each flow monitor. A common solution is to install a rain gage at or near each flow monitoring manhole to reduce travel time for maintenance and data downloading. Since the Four Mile Creek program covers an entire drainage basin, four or five gages distributed across the Four Mile Creek basin would be sufficient.

The City of Wichita's storm water utility operates the permanent rain gages in Table J-4. Data from the permanent gages can be useful if the gage is close to the monitored area or if multiple gages surround the monitored area. The permanent gage data will probably be most useful for the sites that have large tributary areas in the critical locations and relief sewers programs.

Table J-4. Existing City of Wichita Utility Rain Gages

Gage Location	*Gage Type*
29th N. and Woodlawn	Punch Tape
Sunnydale – 101st N. and Hillside	Punch Tape
Westlink – Harvest Park Pool Building	Punch Tape
Mount Hope and Big Arkansas River	Punch Tape
6500 S. Seneca	Real Time
I-235 and Pawnee	Real Time
I-235 and Maple	Real Time
37th and Woodrow	Real Time
Oliver at Gypsum Creek	Real Time
Kellogg and Oliver – at Pump Station	Real Time
199th W. and Kellogg	Real Time
167th and Dry Creek	Real Time
167th and Cowskin Creek	Real Time

Gage Location	*Gage Type*
Andale	Real Time
St. Mary's	Real Time

An alternate source of the rainfall data needed for flow monitoring programs is the NEXRAD weather radar system. Combining NEXRAD images with computer programs that calibrate the radar data to rain gage data permits a detailed distribution of rainfall over the drainage basins in a manner closely representing the actual precipitation patterns. The City of Wichita's existing storm water utility rain gage network could provide the calibration data needed for NEXRAD analysis. The City would contract with a firm specialized in NEXRAD rainfall analysis to convert the radar information to rainfall data for the desired storm events and sub-basins.

METERING EQUIPMENT

The City of Wichita ten (10) flow meters for temporary sewer flow monitoring. The meters are ISCO model 2150 open channel flow meters.

Each monitoring unit includes a sensor probe that measures both depth of flow and average flow velocity. The depth of water is determined by pressure measurement. The sensor emits an ultrasonic wave and measures the frequency shift of returned echoes using Doppler technology to determine the mean flow velocity. The flow rate is calculated by the continuity equation as the product of flow area times mean velocity. The flow area is a function of the flow depth and the pipe dimensions.

The sensors are mounted on an expandable aluminum ring installed in the sewer pipe. If possible, the sensor should be installed in the upstream pipe flowing into the manhole to avoid turbulence in the manhole invert.

The signal from the sensors to the monitor passes through a communications cable to the monitoring unit. The monitoring units were suspended from brackets mounted in the manhole wall near the top of each manhole and were set to collect and store depth of flow and velocity readings at 15 minute intervals. A portable laptop computer is used to retrieve data from the monitors. The meters operate on a 6-volt power supply, but options are available for other power supplies if desired.

In 2006, ISCO acquired MGD Technologies Inc. along with their Acoustic Doppler Flow Monitor (ADFM) equipment. The ADFM uses multiple sensors that emit short pulses along narrow paths pointed in different directions to measure velocity in determine the velocity profile across the flow cross-section. The Acoustic Doppler

technology is reported to be more accurate than the Doppler technology, and the ADFM is recommended by ISCO, for sewer sizes or flow depths greater than approximately 2 or 3 feet. The ADFM does not require field calibration. The City of Wichita should consider selecting ADFM's if additional monitors are purchased.

AUTOMATION POTENTIAL FOR EXISTING METERS

The ISCO open channel flow monitoring line offers the following potential enhancements to automate work:

- Module 2102 provides wireless transmission capacity. The transmitter's wireless signals can generally be read 100 to 150 feet away from the flow meter. The manhole lid does not have to be removed to transmit information. With this equipment, the person maintaining the meter can interrogate the meter and download the meter data remotely from their vehicle on a "drive by" basis. This feature can significantly reduce the time required to check maintenance condition and download data, especially when multiple meters require servicing.
- Field Wizard is a portable hand-held computer designed specifically for interrogating the meters, setting up the meters, and downloading meter data. Using the field wizard equipment replaces the need to use a laptop computer for these functions.
- Equipment is also available for modem communication (such as to a SCADA system), or for cell-phone communication. These options could be used depending on The City of Wichita's preference. Either option would allow the operator to interrogate the meter and download meter data remotely from a SCADA terminal or from their office.

Since any of the three automation tools listed above could make the program more efficient, the City of Wichita should consider implementing their use.

FIELD INSPECTIONS AND INSTALLATION PROCEDURES

The proposed flow monitoring locations in this Appendix are preliminary locations that must be field verified. Meaningful flow data can be acquired only where hydraulic conditions are suitable. Unsuitable sites may include those with unstable hydraulic patterns, silt buildup, electronic interference, or unsafe or difficult access. Each potential monitoring site should be examined for suitable access and hydraulic conditions. Where necessary, select an alternate manhole upstream or downstream from

the preliminary site that captures the desired tributary area. Desirable hydraulic conditions include:

- Uniformly shaped pipe for placement of sensor in the upstream section of pipe in a manhole,
- Uniform flow pattern, away from disturbances such as tributary entries, hydraulic jumps, pipe bends at the manhole, drop connections, and offset pipe joints,
- Sufficient slope in the pipe and manhole invert to counter capacity problems that cause backup conditions,
- No or limited silt buildup in the pipe invert (if necessary the meter sensor can be located on the band above the silt level), and
- No evidence of surcharging in the manhole.

Proper installation of the meter is an essential part of securing accurate data. The manufacturer's directions for the meter installation and setup should be followed. Training by the vendor is recommended for City of Wichita employees who install the meters. Installation and setup could alternatively be provided by an engineering firm, and equipment supplier, or the equipment manufacturer. The placement of the meters can seriously affect the accuracy of the data.

The City of Wichita's ISCO meters have an optional setting that allows the unit to record at a variable time interval. The data is recorded more frequently when the flow is changing rapidly. This optional setting should be used when setting up the meters to improve the data capture during wet weather.

Meters should be calibrated prior to use according to manufacturer's recommendations. The flow depth should be checked with an independent device at installation. The pipe dimensions or diameter should be carefully measured to the nearest 1/8 inch.

MAINTENANCE PROCEDURES

Some meter locations will require minimal maintenance and other locations will require regular attention. Silt and debris build-up will cause some meters to have higher data losses and resulting maintenance needs than others. A site that has repeated loss of data may require either moving the meter to another site or replacing the equipment. Confined space entry may be required for some maintenance.

City personnel should regularly check the each flow monitor as follows:

1 Measure Power Supply -Record power levels and replace batteries, if necessary.

2 Verify Depth of Flow and Velocity - During the site visit, one team member should enter the manhole to measure the depth and velocity of flow at the sensor.

The manual measurements are compared to the monitor readings to check that the monitors are working correctly.

3 Measure Silt Level - Measure the depth of silt at the sensor.

4 Perform Hydraulic Calibration - The monitoring site should be calibrated by multiple depth and velocity readings.

FLOW AND RAINFALL DATA ANALYSIS PROCEDURES FOR DETERMINING HYDRAULIC MODELING PARAMETERS

The software (ISCO Flowlink) provided by the flow meter manufacturer should be used for the majority of the flow and rainfall data analysis work. The software records and organizes flow data and rain data, and prepares standard graphs and reports useful for analysis. A standard data table summarizes the flow or rain data on a user-selected period (15-minute preferable) for each monitoring day along with each day's total, minimum and peak values. The software features permit identifying dry weather days and determining the average dry weather flows and diurnal flow pattern. The software can compare the dry weather flow pattern with a storm event flow pattern to calculate I/I flows, and graphically display the dry weather flow, wet weather flow, I/I flow along with rainfall to document each rain event's flow response. The data can be exported from the software for further analysis in Microsoft Excel.

The major data analysis items are the following:

- Rainfall analysis,
- Determination of ADDF, PDF, and dry weather flow patterns,
- Determination of infiltration,
- Determination of inflow,
- Determination of inflow vs. rainfall relationship, and
- Calculation of 10-year storm event peak wet weather flow.

Rainfall Data Analysis

For each rainfall event, an incremental summary of 15-minute rainfall intervals and total rainfall for the day is prepared. If more than one rain gage is used for a meter site, a Thiessen analysis is performed to determine the percentage allocation of the different gages to the tributary area to each flow monitoring site. The Theissen per-

centages are then applied to the rainfall pattern from each gage to determine the overall pattern applicable to the tributary area.

Daily rainfall totals and distributions are developed for each gauge. This data is compared against rainfall intensity-duration curves for the Wichita area to determine the return interval of each storm event.

The dates used to perform the detailed flow analyses should be selected from rainfall data and flow data.

Flowlink software should be used to produce standard tables of rainfall during the monitoring period, and to determine the rainfall periods, total rain per day, total rain per event. A wet weather period is considered to contain two or more separate events if a substantial gap in rainfall occurs (typically at least four hours without rain). The actual minimum inter-event interval can be statistically determined from historical rainfall data, and can vary geographically.

This table is meant to show the variation in measured rainfall by each rain gage for a given day. The events for which a definable flow response occurred should be selected for detailed analysis to determine inflow. The rain events selected for analysis should be noted on the table.

Where multiple rain gages are used to cover given flow meter, the Thiessen polygon method should be used to delineate the area of influence for each rain gage. A figure showing the study area, rain gage locations, and the area represented by each rain gage should be prepared. The percentage of each flow monitor's total tributary area that is within each rain gage's Theissen polygon is then determined. The Theissen percentages are applied to each rain gage's observed rainfall to determine a composite rainfall pattern for the flow meter area. This may require exporting rain data to a spreadsheet for the calculation, and re-importing the composite data to Flowlink.

Determination of ADDF, PDF, and Dry Weather Flow Patterns

The Average Dry Day Flow (ADDF) is determined by first selecting representative data for each of the seven days of the week. The seven representative days are not necessarily consecutive. The average total monitored flow for each seven-day period represents the ADDF for that subsystem. The average of the seven daily peak hourly flow values represents the peak dry weather flow. The ratio between this value and the average flow for the seven days is the dry weather peaking factor for the area tributary to the meter site. When analyzing multiple meters, it is helpful to compile the values in a summary table having the following column headings:

- Subsystem name or number;

- ADDF;
- Diurnal peaking factor; and
- Peak hourly flow (incremental and cumulative) for each subsystem.

For some locations there may be a significant difference between weekday and weekend flow patterns. Where such differences are significant the pattern with higher flows should be used.

Determination of Infiltration

Dry weather infiltration is the difference between ADDF and base wastewater production. The base wastewater production is commonly assumed to be equal to the winter month potable water use. Dry weather infiltration is not a necessary modeling parameter but can indicate areas of permanent ground water infiltration.

Wet weather infiltration is determined using flow data from the days following significant rainfall events. The total wet weather infiltration flow is determined by subtracting ADDF from the total flow measured during infiltration periods. Night-time flow readings are usually considered the most reliable for this analysis.

Determination of Inflow and Inflow vs. Rainfall Relationship

Inflow should be calculated for each rain event at each flow monitoring site. The inflow for each time period during a rain event is determined by subtracting the ADDF diurnal flow curve from the storm event monitored flows. The highest calculated inflow rate is the peak inflow for that storm. Flowlink software can provide the inflow calculations and associated graphs.

Typically, the amount of inflow that a meter site will observe will vary substantially from event to event depending on the rainfall patterns and antecedent soil moisture conditions. The methodology used to estimate the response to be expected from different storm events is named the inflow coefficient method. The inflow coefficient method uses the following formula:

$Q = K * i * A$, where

Q = peak inflow (cfs).
K = inflow coefficient.
i = rainfall intensity for observed storm (or design storm) and time of concentration (in/hr)
A = developed area (acres).

The time of concentration is the time from initiation of peak rainfall to the time of peak inflow, and is usually observed in the flow and rainfall monitoring data. This parameter should be determined for each rainfall event at each monitoring point.

A table should be prepared including for each event the event date and time, the tributary area, the rainfall intensity corresponding to the monitored area's time of concentration, and the peak inflow rate. Then, the inflow coefficient observed for each storm is calculated as defined above. The average coefficient of all the observed events is then calculated. Certain rain events may be judged poor quality events and excluded from the calculation. The average K value calculated for each flow monitoring site can be used to determine inflow for the rainfall intensity corresponding to any desired recurrence interval storm event. For the City of Wichita, the 10-year frequency storm event has been used for design.

The inflow coefficient method is analogous to the Rational method for estimating peak storm water runoff.

Inflow coefficients for subsystems receiving flow from upstream subsystems can also be calculated with the inflow coefficient method. This method uses measured cumulative flows, cumulative areas, tributary subsystem inflow coefficients, and tributary areas to determine inflow coefficients for interior subsystems. The inflow generated within an downstream subsystem must be calculated because measured flow includes the cumulative effect from all tributary subsystems. System dynamics considers the time of travel through the sewer system. Each downstream subsystem inflow coefficient can be determined using the following weighted coefficient formula:

$$K_t = \frac{K_1 A_1 + K_2 A_2 + \dots K_i A_i}{A_t}$$

Where: Kt = Cumulative inflow coefficient.
Ki = Tributary subsystem inflow coefficient.
Ai = Tributary subsystem area.
At = Total tributary area.

A summary table should show tributary areas, times of concentration, and inflow coefficients for each subsystem. The table should include the following column headings:

- Flow meter name or number;
- Area (acres) for the subsystem and the cumulative area contributing flow through the meter;

- Time of concentration (min.) for the subsystem and cumulative for all the area contributing flow through the meter; and
- Inflow Coefficient "K" for the subsystem and cumulative for all the area contributing flow through the meter.
- 1-year design total inflow; and
- 10-year design total inflow.

This table should present subsystem information sorted by subsystem number. The 1-year and 10-year inflow are estimated by assuming the time of concentrations listed in the previous table are the storm durations. Storm intensity is a determined from the City of Wichita area rainfall intensity-duration-frequency curve.

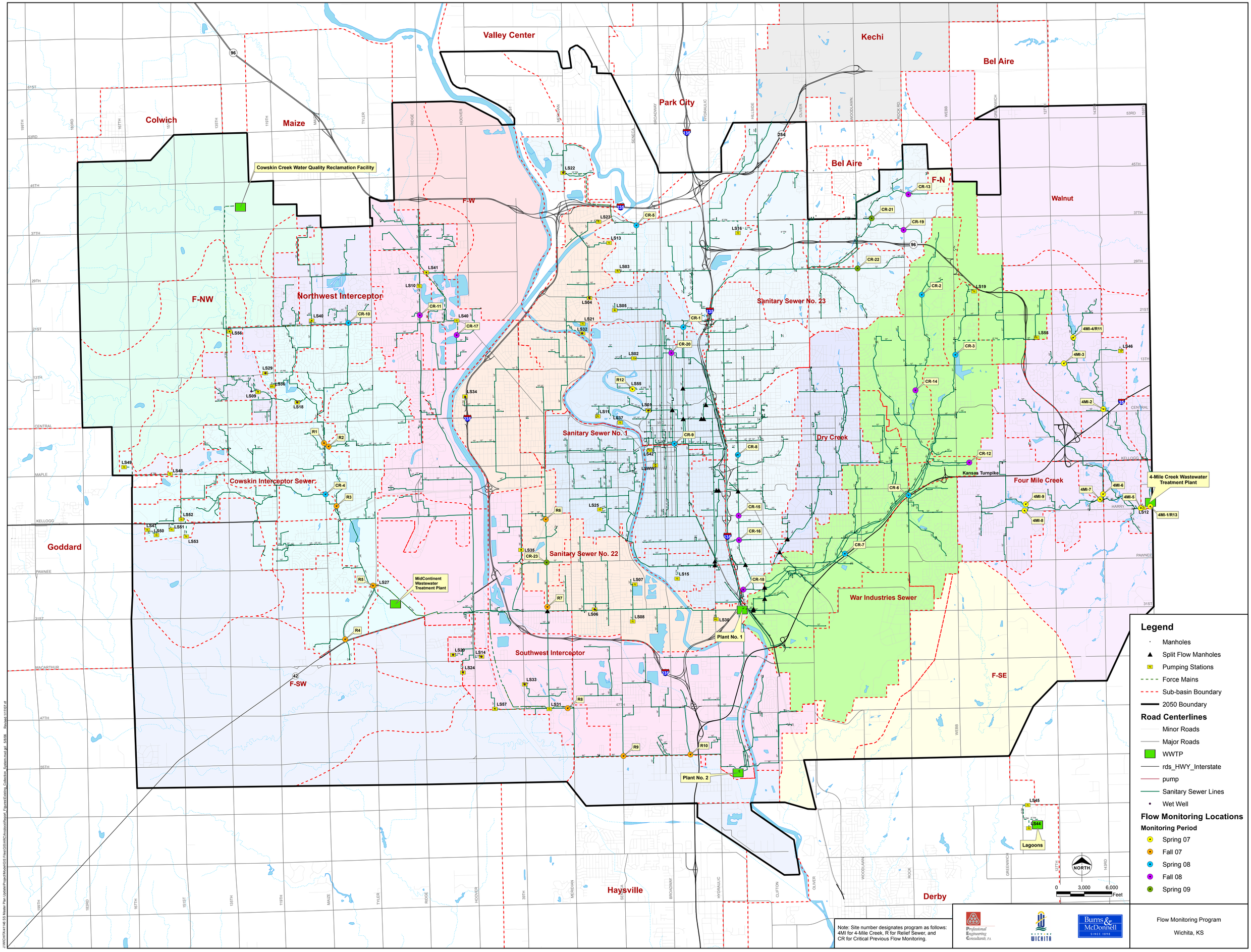
Calculation of 10-year Storm Event Peak Wet Weather Flow

The flow parameters determined for each meter site should be used to determine the total PWF for the design 10-year storm event. The total 10-year storm event peak wet weather flow (PWF) is the sum of:

- ADDF;
- Wet weather infiltration; and
- Peak inflow for the 10-year storm event.

The wet weather infiltration is included in the total peak flow calculation because storm events can occur following a prior event.

The 10-year PWF divided by the ADDF indicates the PWF peaking factor. This peaking factor can be compared to the design peaking factor curve used in the hydraulic model. The peaking factor is a general indicator of I/I levels in the sub-basin.



Note: Site number designates program as follows: 4MI for 4-Mile Creek, R for Relief Sewer, and CR for Critical Previous Flow Monitoring.

Professional Engineering Consultants, P.A.

City of Wichita

Burns & McDonnell Since 1898

Flow Monitoring Program

Wichita, KS

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APPENDIX K

Recommended Model Maintenance and Update Program

APPENDIX K

Recommended Model Maintenance and Update Program

INTRODUCTION

This Appendix describes a recommended program for model maintenance and updates which includes:

- City of Wichita current model maintenance procedures and objectives, including potential model enhancements to take advantage of the selected software's capabilities;
- Incorporation of periodic software updates and enhancements;
- Incorporation of system changes, including capital improvements project (CIP) facilities;
- Incorporation of updated growth projections;
- Periodic model recalibration; and
- Training needs for new users and retraining for existing users.

It is vital that the hydraulic model be kept up to date by trained City of Wichita staff or by experienced consultant staff. Without regular updates, the model data will quickly become outdated. A City of Wichita staff individual should be designated to be in control of the model, and provided the appropriate training as described later. The model physical network data for trunk sewers, lift stations and other facilities should be kept up to date to incorporate new facilities or changes to existing facilities on at least an annual basis, if not more frequently. The model flow data for base flows, infiltration and inflow flows for new information regarding planned development, population growth, and flow monitoring program results should also be updated annually, if not more frequently. The availability of new flow monitoring information will allow improved calibration of the model based on actual flows. The updated and re-calibrated model can then be used with reasonable confidence to evaluate the required sizing and staging of facilities recommended in this Master Plan Update.

CITY OF WICHITA PROCEDURES AND OBJECTIVES

The previous SewerCAT hydraulic model had not been updated since it was originally delivered, and no current procedures existed for maintaining that model. The City of Wichita's objectives for the current model include having a model available for in-house use, being able to keep it updated with new facilities and new flow information as it becomes available, and ensuring that the model continues to represent the actual sanitary sewer collection system.

PERIODIC SOFTWARE UPDATES AND ENHANCEMENTS

The City of Wichita can incorporate the MWH-Soft H20MAP Sewer Pro software updates and enhancements that periodically become available so long as the maintenance agreement with the software vendor is kept up to date. All available software updates should be made at the time the program is originally installed from CD. Future updates can be installed at any time. City staff should check for available updates at least annually for the modeling software as well as the network license manager.

The H20MAP Sewer Pro User's Guide details the steps to follow for software updates. The first step is to secure a maintenance key (a coded number) from the vendor and apply it to the license. The maintenance key needs to be updated annually and a current key is required before the vendor will provide updates. The second process is to check for the availability of updates on the vendor's website www.mwhsoft.com, download the update executable file and run the update. The model software installation includes the MWH-Soft Live Update/Upgrade Checker, which can be used to check for and download updates. A "Check for Updates" function is also available from the program on the toolbar.

The maintenance agreement also includes technical support services by email or telephone. Technical support has occasionally led to MWH-Soft issuing a software patch update directly to the user if the problem could not be resolved without new programming or new error messages. Additional coding included in such patches is typically added to the next general update for all users.

PHYSICAL FACILITY CHANGES AND CAPITAL IMPROVEMENT PROJECTS

The following paragraphs describe updating the model with information on newly built or planned facilities that have already been placed in a GIS format. The source data may be in the City of Wichita's GIS system for new sewer facilities or in a separate GIS file of planned facilities. The City begins the process of updating the model network by using standard GIS techniques to create separate ESRI GIS Shapefiles that include only the manholes and sewer pipes to be added to the model.

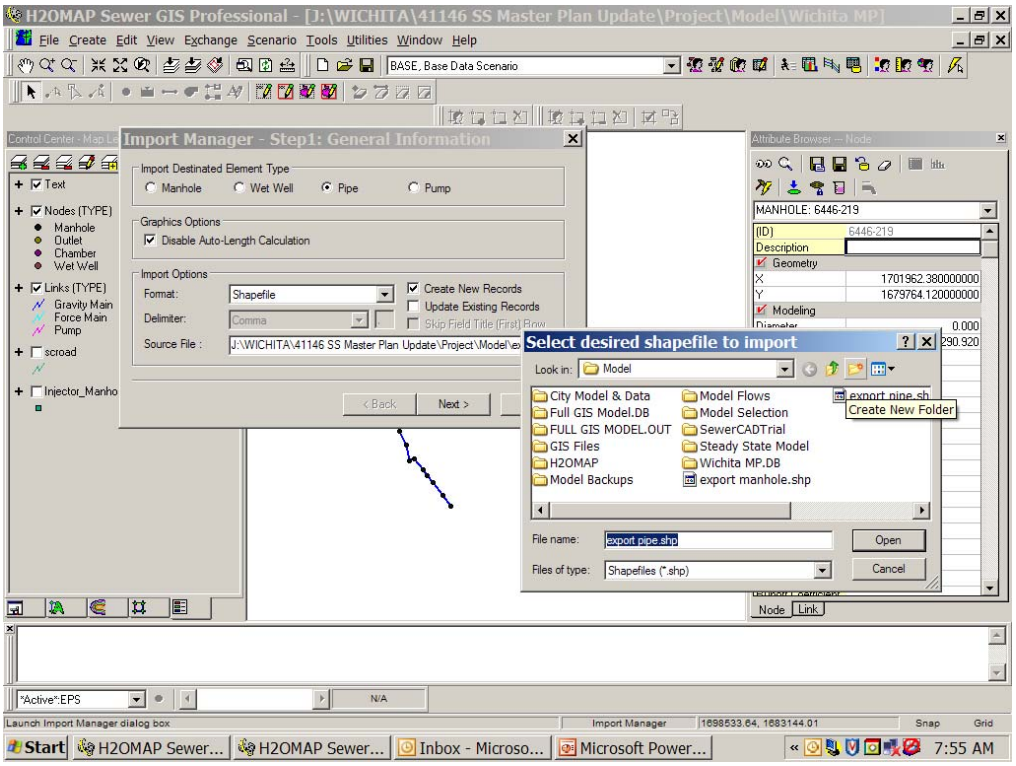
Since the existing model includes all of the sewers that were in the original SewerCAT model, plus any additional sewers 10-inches or larger that were in the GIS when the model was built, model updates should include any new sewers 10-inches or larger. Proposed sewers or smaller existing sewers can also be included up to number of pipes included in the software license.

Minimum information needed to represent facilities in the model includes the following:

- Manholes with their manhole number or ID, diameter, and rim elevation. The subbasin designation is optional but should be imported if available.
- Sewers with their GIS ID, from and to manhole numbers or IDs, upstream invert elevation, downstream invert elevation, diameter, length, and friction coefficient.
- Wet wells for lift stations with an ID, diameter, and the bottom, minimum, initial, and maximum liquid elevations.
- Pumps for lift stations with an ID and pump rated capacity and/or pump curve information.

H20MAP Sewer Pro's menu selection "Exchange – Import Manager" is the primary method used to update the sewer inventory data in the model. The Import Manager can be used to either update records already in the model or add new records to the model. Typically, manhole and sewer pipe information will be imported from ESRI Shapefiles. Data associated with lift stations and wet-wells will typically be added to the model using the "Add Wet Well" and "Add Pump" buttons along with the attribute browser in H20MAP Sewer Pro. Figure K-1 is a screen capture of the Import Manager dialogue box.

Figure K-1. Using Import Manager to Import New Facilities to Model Tables



The Import Manager is relatively simple to operate but needs to be set up correctly and run with care, so as to not overwrite information in error. The data is imported to the model's working directory, so an unsuccessful import can be abandoned by not saving the model. Key items to select include the following:

- Imported sewer inventory data is added to the Base scenario. The user uses the "Scenario Manager" function to activate the Base scenario.
- The user selects the model data type to update is selected by clicking on the box labeled "Manhole", "Wet well", "Pipe", or "Pump".
- The source data format is selected, such as "Shapefile".
- The data source is selected. The display shows the complete path to the data source.
- The ID Mapping field used in the data source is selected. Each manhole, sewer pipe, wet-well and pump has to have a unique ID in the model. The model IDs assigned to manholes should be the City manhole numbers. The model IDs for other element types can be the ID's in the City GIS.

- The checkbox for “Update Existing Records” should be checked if the intent of the import is to replace data for entities that are already in the model. This should be un-checked when the intent is to add new facilities to the model.

The checkbox for “Create New Records” should be checked to import new sewer facilities to the model.

Once the foregoing steps are complete, selecting the “>Next” box opens the “Step 2-Define Data Field Mapping” dialogue box. Figure K-2 is a screen capture of this dialogue box. The available columns in the ODBC data source are displayed (left column) as well as the available fields in the model database (right column). The user “maps” the fields to be imported by selecting the source field on the left and the receiving field on the right, and then selecting the “>” icon resulting in the source field being displayed next to the receiving field. If the source data shapefiles are originally created using the same field names that MWH-Soft Sewer Pro uses, the “Automap>>” button will automatically associate the source and model data.

The final step is to select “Finish” and launch the import. The Manhole shape-file should be imported first. Figure K-3 is a screen capture following import of manholes. The Pipes shapefile should be imported after the manholes are already present in the model, to ensure the model correctly associates the pipes with their up-stream and downstream manholes. Figure K-4 is a screen capture following import of the pipes.

Figure K-2 Mapping Source and Model Data Fields in Import Manager

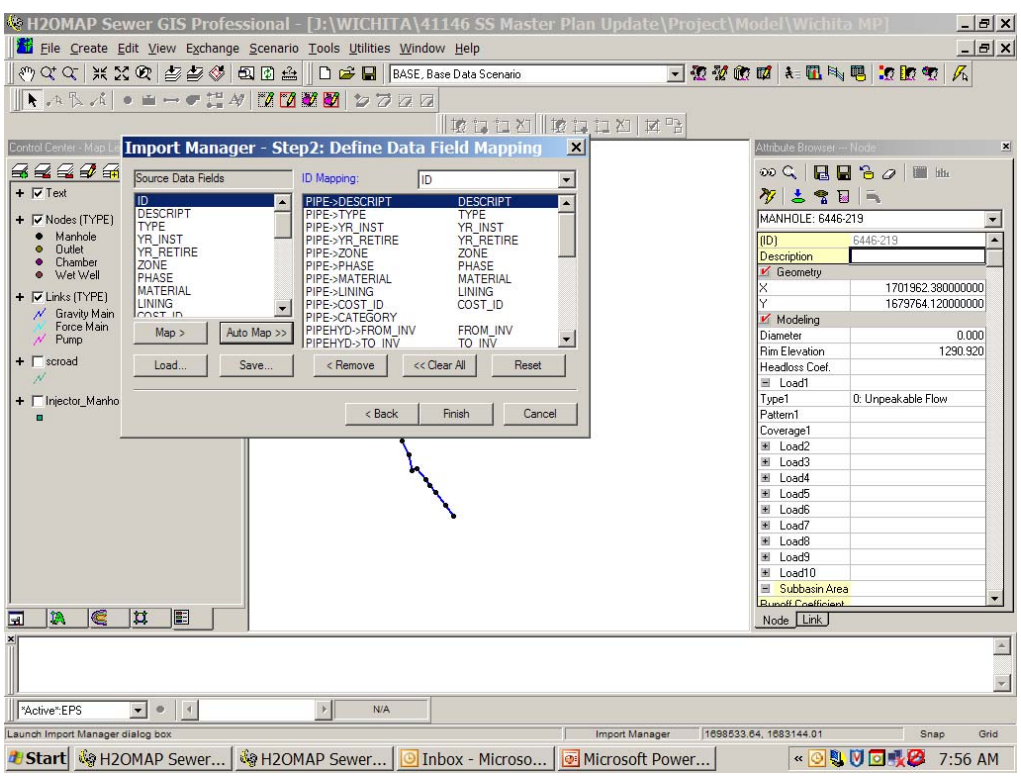


Figure K-3 Manholes Added Using Import Manager

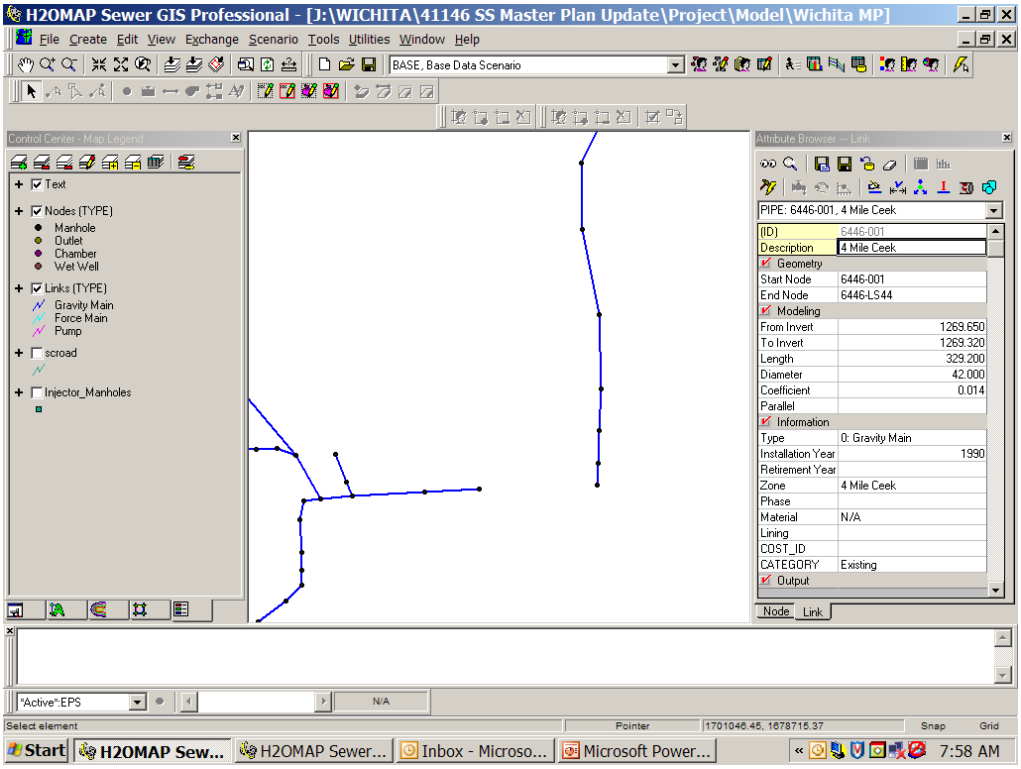
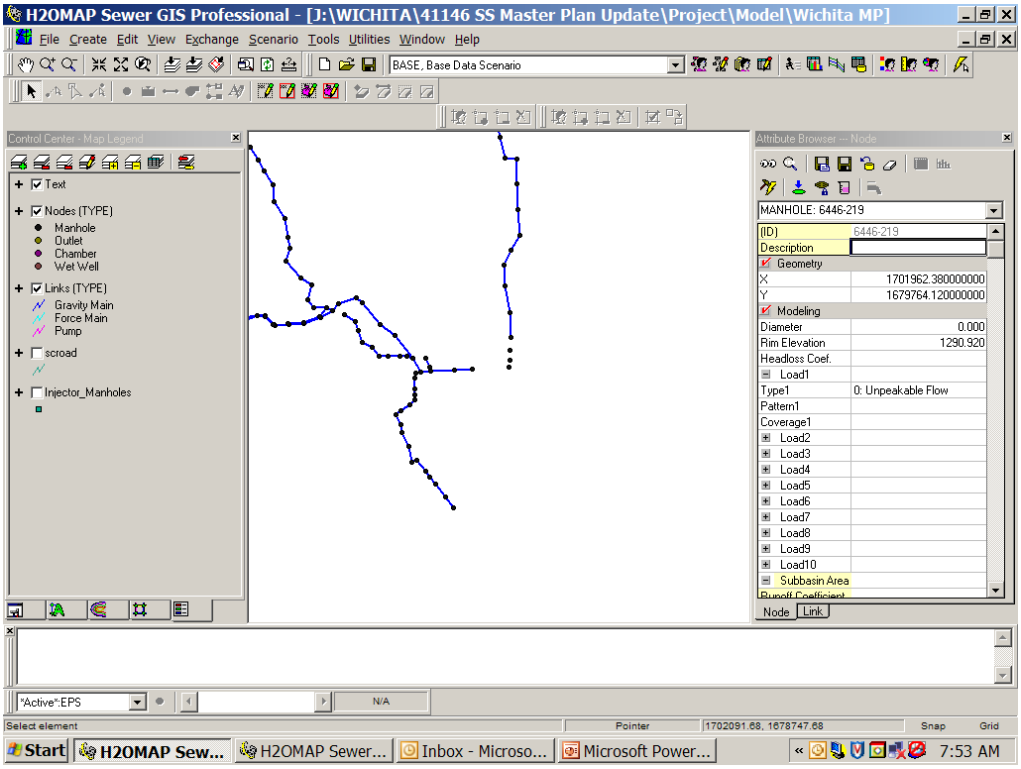


Figure K-4 Sewers Connecting Manholes Added Using Import Manager



After successfully importing new sewer facilities data, the user should check that the new information is placed in the model as expected. Each element should be checked in the Attribute Browser for correct data. Under the Utilities menu selection, the Connectivity and Network Review/Fix sub-menus include a variety of tools that can be used to check the data's connectivity by tracing along network, and to check for orphan (disconnected) manholes or pipes.

MODEL CALIBRATION UPDATES

Model calibration is a process of checking and adjusting the model to match within a reasonable tolerance the dry weather and wet weather flows expected at locations where the flow is known. The peaking factor formula approach used for static analyses in the current model, for the lack of current flow monitoring data, required checking that the desired dry weather flows generated in each sub-basin matched the expected totals, and that the peaking factor formula operated as expected. The proposed flow and rainfall monitoring program recommended in this Master Plan Update will determine for each site the actual average and peak dry weather flows,

infiltration, and inflow as a function of rainfall intensity. This information can be used to update the model for static analyses in either of the following methods:

The peaking factor formula used in the model can be revised to match the actual peak wet weather flow vs. average dry weather flow relationship determined for the 10-year storm at the flow monitoring locations. The H20MAP Sewer Pro software offers only one peaking factor formula for any static analysis. The formula is input from the Run Manager dialogue box, under the Simulation Options – Peaking tab. Specific area peaking factors can be simulated for specific areas by establishing a specific Scenario in the model's Scenario Manager for each monitoring area. The model's Domain Manager is used to select the sewers tributary to a flow monitor and include only those sewers in the analysis.

Additional peak inflow/infiltration flows can alternatively be added to the current model in an additional load field such as Flow3, with the Type field set to "Unpeakable Flow". The additional infiltration/inflow assigned to manholes in the upstream sub-basin would be equal to the total inflow/infiltration at the monitor divided by the number of manholes. Calibration would consist of an analysis to check whether the modeled peak wet weather flow was at the monitor location matched the expected total. This approach would test the sewers in the flow monitoring area, but the infiltration/inflow amounts would not attenuate as they flow through downstream sewers. Therefore, if this method is used, each specific monitoring area should be modeled as separate scenarios.

The modeling software also offers two basic methods to simulate variable peak wet weather flows. Either method will allow an overall calibration of the entire model. The run selections are made from the Run Manager dialogue box, under the Simulation Options – Storm tab. The two methods include the Rational formula and Extended Period Simulation (EPS) analyses.

The Rational formula operates in a static analysis. On the Run Manager, the user establishes a minimum time of concentration, and assigns a rainfall intensity-duration-frequency curve, both of which apply to the entire area analyzed. The tributary areas and runoff coefficients then need to be assigned to each manhole tributary to each flow monitoring location, according to the monitoring results. The inflow coefficient value determined in flow monitoring is used for the inflow coefficient. The total tributary area assigned to manholes in a sub-basin must sum to the sub-basin total. Calibration for a rational analysis consists of checking to ensure the expected dry weather and peak wet weather flows at monitoring locations were achieved with a reasonable tolerance. Calibration would be limited to adjusting the

minimum time of concentration for the entire run, or the areas or inflow coefficients assigned in each sub-basin.

H2OMAP Sewer Pro applies the unit hydrograph approach for generation of storm hydrographs during dynamic (EPS) simulations. Unit hydrographs could be natural or synthetic. Natural unit hydrographs are derived from flow monitoring data. Synthetic hydrographs are generated by the software. Synthetic hydrograph options in the model include four different techniques: the SCS dimensionless unit hydrograph; the SCS triangular unit hydrograph; the tri-triangle method; and the Colorado Urban Hydrograph Procedure. These techniques are documented in the model help system and standard engineering references. With any of the EPS simulation techniques, calibration is a more complex process of adjusting input parameters until the model results are reasonably close to the expected peak flows and flow patterns at the monitoring sites. Typically, calibration is performed for actual observed storm events as well as a design storm frequency event.

GROWTH PROJECTION UPDATES

H20MAP Sewer Pro's menu selection "Exchange – ODBC Exchange" is the primary method used to update the existing sub-basin areas flows assigned to manholes in the model. The OCBC exchange sets up a connection between the databases in the model and any ODBC compliant data source. The data source where flows are developed is the spreadsheet "Missing Rim Elevation Assumptions.xls".

Because the growth area sewers were sized in a spreadsheet rather than in the model, the flows from growth area sewers were assigned manually in the model database to the manholes each extension sewer connects to.

Key sheets in the flows spreadsheet include the following:

- Sheet titled "APP-D Flows" includes a table listing basin, sub-basin or outside city area, population and total ADF for each year 2002, 2010, 2020, 2030 and 2050. This information can be updated by the user as needed to include any future changes in population projections or flow parameters. The ADF values are in mgd.
- On the sheet titled "APP-D Flows" a section to the right of the flows table reformats the flows by sub-basin and outside city area, and determines for each area and year the flow in cfs to be assigned to each manhole in the area. The total sub-basin flow is divided by the number of modeled manholes to determine the per-manhole allocation.
- A GIS process was used to assign sub-basin names to the model manholes. The sub-basin names are stored in the model in the "Zone" field in the manhole infor-

mation table. The "DB-Editor" feature was used to access this table, which was copied to a sheet in the flows spreadsheet. A simple Excel pivot-table was used to sum the number of manholes in each sub-basin for use in per-manhole allocation calculation. As new manholes are added to the model in the future, the user should assign the sub-basin name to the "Zone" field, determine the updated manhole count and update the assigned flow per manhole for the affected sub-basin.

- On the sheet titled "MH-ADF-MODEL", all manholes in the model are listed along with their sub-basin ("Zone"). To be used as an ODBC connection, the data is organized in columns and the first row contains the field names. A lookup function assigns the correct ADF to each manhole according to their zone for each year. The flows on this sheet are then imported to the model databases using the ODBC exchange dialogue box.

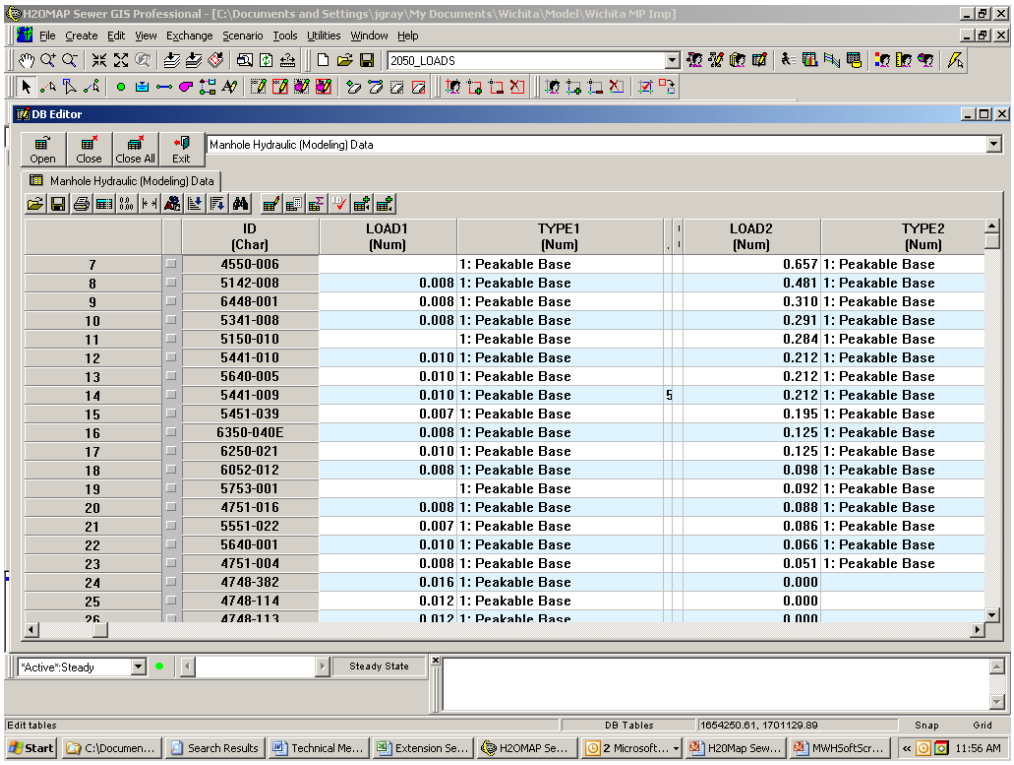
The ODBC Exchange is relatively simple to operate but needs to be set up correctly and done thoughtfully, so as to not overwrite information in error. The data is imported to the model's working directory, so an unsuccessful import can be abandoned by not saving the model. Figure K-5 is a screen capture of the ODBC Exchange dialogue box. Key items to select include the following:

- Imports will be made into the currently active database. Flow information is stored in the Manhole data set. For example, to update the 2050 flows the user uses the "Scenario Manager" function to activate the 2050 scenario and to confirm that the active manhole data set is "2050_ADF"
- The update direction is selected by clicking on the box labeled "ODBC->Internal"; this means that data in an external ODBC source (the spreadsheet) will be imported to the currently active model database.
- The ODBC data source is selected. The display shows the complete path to the data source.
- The ID Mapping field is selected. In this case, the ID Mapping field is "MH-ID", which is the column name for the manhole names.
- Once the ODBC data source and ID Mapping field are selected, the available columns in the ODBC data source are displayed (left column) as well as the available fields in the model database (right column). The user "maps" the fields to be imported by selecting the source field on the left and the receiving field on the right, and then selecting the ">" icon resulting in the source field being displayed next to the receiving field. In the model, existing sub-basin flows are assigned to the "LOAD1" field in the manhole hydraulic modeling data table "MH-HYD". The "TYPE" field can also be imported to set each manhole type as "1: Peakable Flow"

in the model. Alternatively, the "TYPE" field can be set using the model's DB Editor.

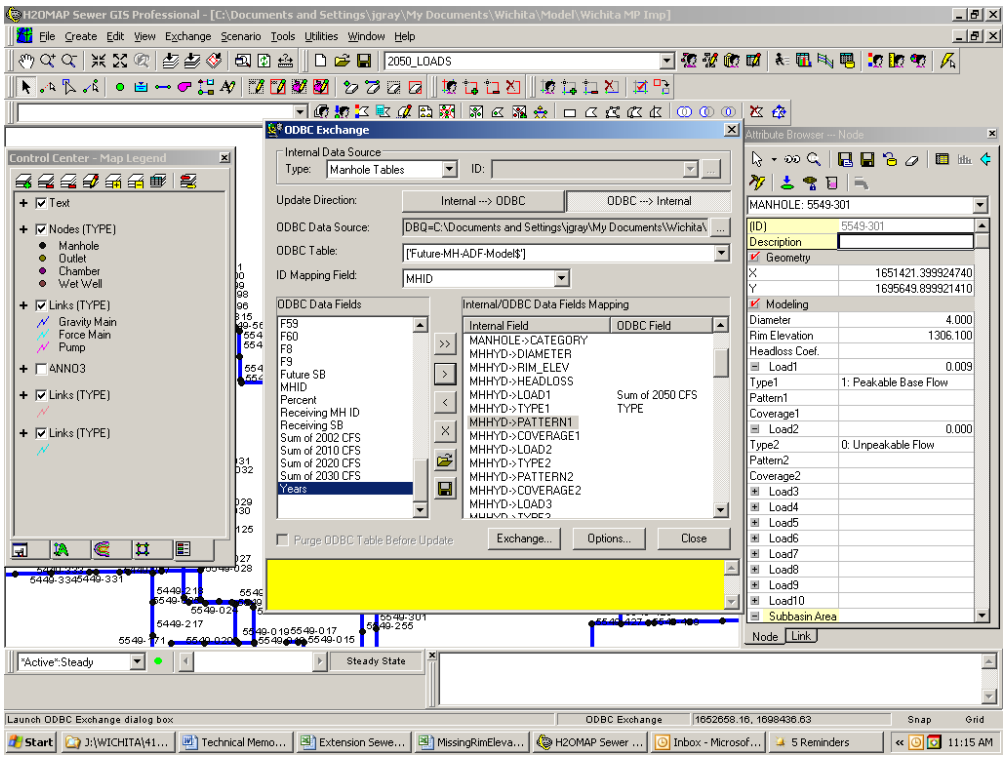
- The Options box must be opened and the selection "Update Existing Records" checked.
- After the foregoing is complete, selecting the Exchange box launches the data import. The data should then be present in the manhole hydraulic modeling data table, and can be accessed using the DB Editor to confirm a successful import.

Figure K-5 Using DB Editor to Edit Flow Data in the Manhole Hydraulic Modeling



	ID (Char)	LOAD1 (Num)	TYPE1 (Num)	LOAD2 (Num)	TYPE2 (Num)
7	4550-006		1: Peakable Base	0.657	1: Peakable Base
8	5142-008	0.008	1: Peakable Base	0.481	1: Peakable Base
9	6448-001	0.008	1: Peakable Base	0.310	1: Peakable Base
10	5341-008	0.008	1: Peakable Base	0.291	1: Peakable Base
11	5150-010		1: Peakable Base	0.284	1: Peakable Base
12	5441-010	0.010	1: Peakable Base	0.212	1: Peakable Base
13	5640-005	0.010	1: Peakable Base	0.212	1: Peakable Base
14	5441-009	0.010	1: Peakable Base	0.212	1: Peakable Base
15	5451-039	0.007	1: Peakable Base	0.195	1: Peakable Base
16	6350-040E	0.008	1: Peakable Base	0.125	1: Peakable Base
17	6250-021	0.010	1: Peakable Base	0.125	1: Peakable Base
18	6052-012	0.008	1: Peakable Base	0.098	1: Peakable Base
19	5753-001		1: Peakable Base	0.092	1: Peakable Base
20	4751-016	0.008	1: Peakable Base	0.088	1: Peakable Base
21	5551-022	0.007	1: Peakable Base	0.086	1: Peakable Base
22	5640-001	0.010	1: Peakable Base	0.066	1: Peakable Base
23	4751-004	0.008	1: Peakable Base	0.051	1: Peakable Base
24	4748-382	0.016	1: Peakable Base	0.000	
25	4748-114	0.012	1: Peakable Base	0.000	
26	4748-113	0.012	1: Peakable Base	0.000	

Figure K-6 Using DB Editor to Edit Flow Data in the Manhole Hydraulic Modeling



Growth projection updates for extension sewer areas that are not specifically in the model are manually entered in cfs to the Load2 field in the Manhole Hydraulic Modeling Data table. The future growth ADF flows accumulated to the points that extension sewers connect to existing modeled manholes are found on the extension sewer sizing spreadsheet.

TRAINING NEEDS

Sewer hydraulic modeling is a complex subject and it is essential that staff involved in the work should have received appropriate training. This Appendix is not intended to be a substitute for such training. Training may be as part of formal education, by in-house or external training courses, open learning or on-the-job training. Records of validated training should be kept. Work should be carried out by, or under the day to day direction of an experienced hydraulic modeler who should have a detailed understanding of the following:

- operational performance requirements for sewer collection systems;
- hydraulics of flow in sewers and sewer ancillary structures;

- urban hydrology;
- the assumptions implicit in the software calculations;
- methods of measurement of flow in sewers and their accuracy; and
- engineering solutions.

The software vendor MWH-Soft provides training in the software in their offices in Pasadena and Denver. The training is available approximately every other month. The current schedules are available on the vendor's website. The vendor also offers to provide the training at a client's site at additional cost. The training includes hands-on use instruction in how to set up models and use the software to simulate sewer systems. The training is performed by experienced instructors. A training workbook is provided. The training fee for the course is $1,600 for the first person. The training fee for additional people is discounted by 50 percent, or $800 for the same course. The fee includes a training handout workbook. The training agenda posted on the vendor's website is listed below to indicate the subjects covered:

A. Introduction to H2OMAP Sewer Training Agenda

1. Day 1 Agenda
    a. H2OMAP Software Layout
    b. H2OMAP Data Model
    c. Defining H2OMAP Sewer Network Components
    d. Establishing Design Criteria
    e. Building the H2OMAP Model
    f. Running Steady State Analysis
    g. Displaying Model Results
    h. Results Contouring, Mapping
    i. Running Design Simulation
    j. Database Customization
    k. Map Annotation
    l. Cost Analysis
2. Day 2 Agenda
    a. Analyze Replacement or Parallel Piping
    b. Running the dynamic model
    c. Graphing, Reporting & Pipe Profiles
    d. Scenario & Facility Management
    e. Query Sets, Facility Sets, Data Sets
    f. Import/Export GIS Data
    g. Network Validation Tools
    h. Storm Modeling"

Model training can also be provided by engineering consulting firms experienced with the software in question and the City's model. Typically, consultant train-

ing focuses on use and understanding of the client's model, as opposed to vendor training which focuses on the software features.

The City of Wichita should maintain a file of collected training materials for reference, periodic review, and use by staff new to the model.

Training of staff new to the model or retraining of current staff will periodically be required in order to maintain a good level of competence. The need for retraining will increase if the model is not used for extended periods of time. If the model is used on a regular basis, such as a monthly or more frequent need to evaluate potential developments, retraining should not be required until such time that staff believes a general update is needed. If the model is not used for extended periods of time, retraining is likely to be needed before staff is comfortable with the software.

APPENDIX L

Treatment to Limits of Technology

APPENDIX L

Treatment to Limits of Technology

INTRODUCTION

The wastewater treatment facility upgrades presented in the preceding sections address the technology-based Biological Nutrient Removal (BNR) requirements proposed by KDHE to effluent limits of 8 mg/L for Total Nitrogen (TN) and 1.5 mg/L for Total Phosphorous (TP). These limits have been proposed by KDHE to achieve a 30% reduction for nitrogen and phosphorous in wastewater effluent. In addition, the Environmental Protection Agency (EPA) is developing further treatment limits, referred to as the Limits of Technology (LOT). This section will address the additional treatment processes, equipment, and costs to achieve the LOT nutrient removal levels for each facility.

LIMITS OF TECHNOLOGY EFFLUENT CONCENTRATIONS

The Limits of Technology (LOT) nutrient removal levels for Kansas are being developed by KDHE as an ultimate treatment goal in an effort to protect receiving waters. While the BNR limits are 8 mg/L for TN and 1.5 mg/L for TP, the LOT limits are more stringent, with nutrient removal to 3 mg/L of Total Nitrogen, and 0.3 mg/L Total Phosphorous. These limits are intended to represent the current treatment limitations of developed technology, as the ultimate nutrient reduction achievable.

MODIFICATIONS REQUIRED TO MEET LIMITS OF TECHNOLOGY

Section 13 of this Master Plan outlines the facility upgrades needed to meet the required BNR limits. To achieve the LOT goals for nutrient removal, the treatment plants must be modified with additional biological and chemical treatment processes above and beyond the upgrades needed to meet the BNR requirements. Biological basins will need to be added to the outlined BNR treatment processes to further re-

duce the Total Nitrogen present, and chemical treatment will be required to further reduce the Total Phosphorous concentration.

Plants No. 1 and No. 2

Two options are presented in Section 13 of this Master Plan to upgrade the Plant No. 1 and No. 2 system to meet BNR limits, both of which will require a complete change in the current treatment process. Option A includes the use of membranes, and requires new anaerobic, anoxic, and aeration basins, in addition to the membranes. Option B utilizes clarification and filtration, requiring new anaerobic, anoxic, and aeration basins, in addition to the clarifiers and filters.

Further facility upgrades will be required at Plants No. 1 and No. 2 to achieve the LOT, beyond those outlined for BNR. The modifications required for LOT are discussed below, and are illustrated in Figure L-1 for Option A, and Figure L-2 for Option B.

Option A: BNR with Membranes

The proposed BNR design includes three treatment trains, each with a capacity of 18 MGD, for a total treatment capacity of 54 MGD. In addition to the improvements required to achieve BNR limits, each of the three treatment trains will require the addition of a second stage anoxic/aerobic treatment process following the initial aeration basin for nitrogen removal. Chemical treatment will also be required for each train as flow enters the second stage anoxic basin for nitrogen and phosphorous removal. Methanol will be added in this location as a carbon source for nitrogen removal, and alum will be added to facilitate phosphorous removal. The LOT upgrades will require a 50% increase in anoxic treatment basin capacity and a 6% increase in aeration basin capacity above the additional basin volumes required to achieve BNR limits.

Option B: BNR with Clarification and Filtration

The proposed BNR design includes two primary treatment trains with a capacity of 18 MGD each, and three treatment trains with a capacity of 6 MGD each, for a total treatment capacity of 54 MGD. Significant improvements will be required to achieve BNR limits. In addition to the BNR improvements, each of the five treatment trains will need the following upgrades to meet the LOT requirements:

- Second stage anoxic/aerobic treatment process following the initial aeration basin;
- Addition of methanol prior to the second stage anoxic basin;
- Rapid mix basin for the addition of alum and polymer after the Primary clarifier;
- Flocculation basin;
- Final clarifier.

Nitrogen removal will be achieved with the anoxic/aerobic treatment process and the methanol addition, while phosphorous removal will be addressed with the alum and polymer addition, flocculation, and clarification prior to the filters. The LOT upgrades will require doubling the anoxic basin capacity of the BNR design and an average 7% increase in the available aeration basin volume.

CCWRQF

The BNR design upgrades proposed for the CCWRQF include the addition of a second 2 MGD treatment train, identical to the existing process. In addition to doubling the biological treatment capacity for BNR limits, each of the two treatment trains will also require improvements to the following units and processes to meet the LOT requirements, as illustrated in Figure L-3:

- Second stage anoxic/aerobic treatment process following the initial aeration basin;
- Addition of methanol prior to the second stage anoxic basin;
- Rapid mix basin for the addition of alum and polymer after the Primary clarifier;
- Flocculation basin;
- Final clarifier.

The anoxic/aerobic treatment process with methanol addition will be used to achieve nitrogen removal, while the addition of alum and polymer, flocculation, and final clarification will address phosphorous removal. The LOT improvements required will result in a 50% increase in anoxic basin volumes and a 3% increase in aeration basin capacity above the additional basins required for the BNR design.

Four Mile Creek Treatment Facility

The upgrades designed to achieve BNR limits for the Four Mile Creek facility include the addition of a second 3 MGD treatment train to parallel the existing 3 MGD process, a third clarifier, and the addition of filtration and disinfection. Achieving the

LOT will require the addition of the following units and processes to both treatment trains, as illustrated in Figure L-4:

- Second stage anoxic/aerobic treatment process following the initial aeration basin;
- Addition of methanol prior to the second stage anoxic basin;
- Rapid mix basin for the addition of alum and polymer after the Primary clarifier;
- Flocculation basin;
- Final clarifier.

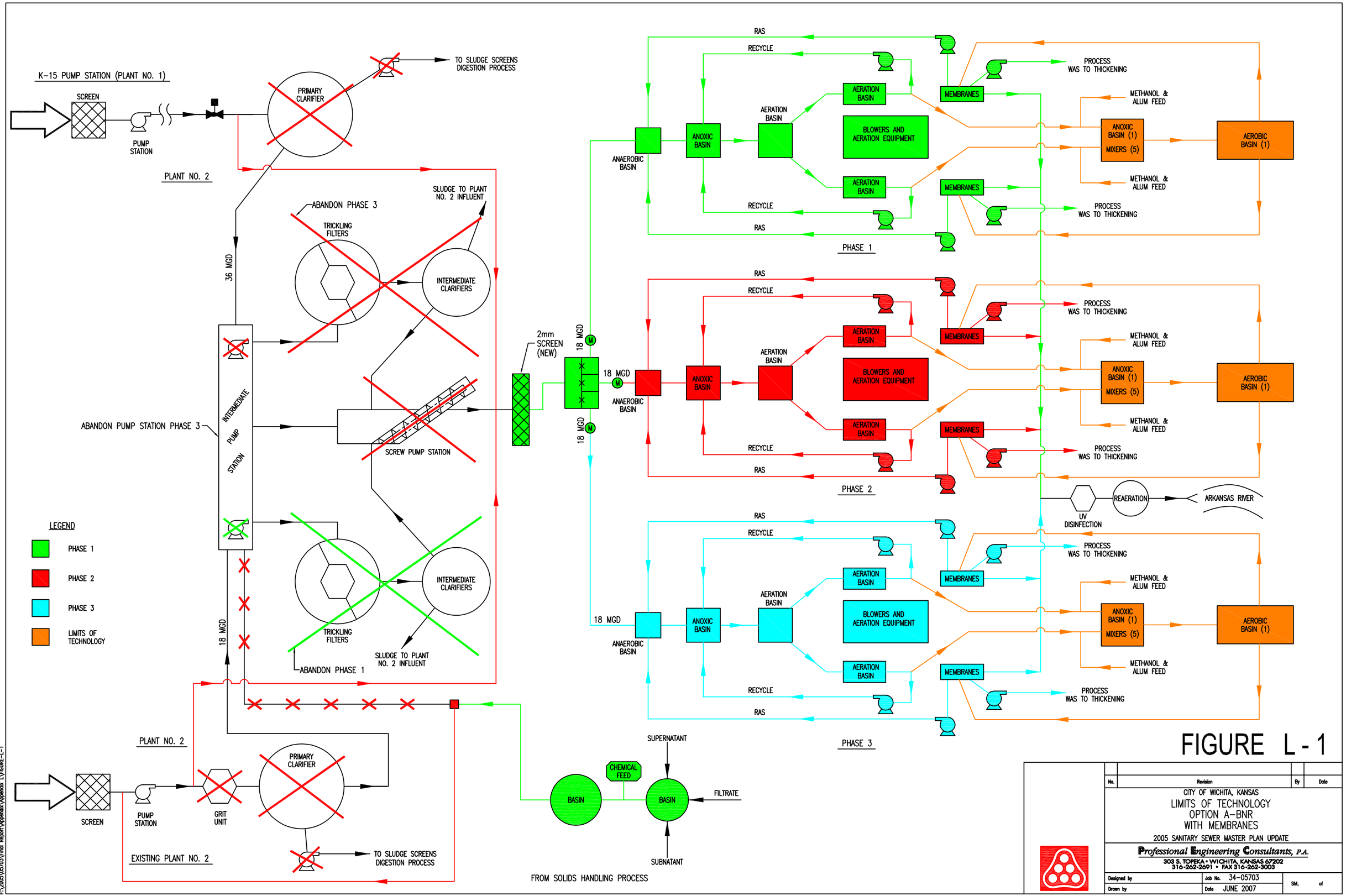
Nitrogen removal will be achieved with the anoxic/aerobic treatment process and the methanol addition, while phosphorous removal will be addressed with the alum and polymer addition, flocculation, and clarification prior to the filters. The LOT upgrades will require anoxic basin capacity to be doubled and aeration basin volumes to be increased by 5% above the improvements required to achieve BNR limits.

COST ESTIMATES

The estimated additional costs associated with plant upgrades to meet LOT are summarized below in Table 1.

Table 1. Limits of Technology Cost Estimates

Treatment Facility	*Plant Capacity (MGD)*	*LOT Modification Additional Costs*
Plants No. 1 and 2 (Membranes)	54	$59,007,000
Plants No. 1 and 2 (Clarification & Filtration)	54	$94,063,000
CCWRQF	4	$5,614,000
Four Mile	6	$6,044,000


K-15 PUMP STATION (PLANT NO. 1)
SCREEN
PUMP STATION
PRIMARY CLARIFIER
TO SLUDGE SCREENS DIGESTION PROCESS
PLANT NO. 2
ABANDON PHASE 3
TRICKLING FILTERS
SLUDGE TO PLANT NO. 2 INFLUENT
INTERMEDIATE CLARIFIERS
36 MGD
ABANDON PUMP STATION PHASE 3
INTERMEDIATE PUMP STATION
SCREW PUMP STATION
2mm SCREEN (NEW)
18 MGD
ANAEROBIC BASIN
ANOXIC BASIN
AERATION BASIN
BLOWERS AND AERATION EQUIPMENT
MEMBRANES
RAS
RECYCLE
PROCESS WAS TO THICKENING
METHANOL & ALUM FEED
ANOXIC BASIN (1)
MIXERS (5)
AEROBIC BASIN (1)
PHASE 1
PHASE 2
PHASE 3
UV DISINFECTION
REAERATION
ARKANSAS RIVER
LEGEND
PHASE 1
PHASE 2
PHASE 3
LIMITS OF TECHNOLOGY
ABANDON PHASE 1
PLANT NO. 2
PRIMARY CLARIFIER
GRIT UNIT
EXISTING PLANT NO. 2
TO SLUDGE SCREENS DIGESTION PROCESS
BASIN
CHEMICAL FEED
SUPERNATANT
FILTRATE
SUBNATANT
FROM SOLIDS HANDLING PROCESS
FIGURE L-1
No.
Revision
By
Date
CITY OF WICHITA, KANSAS
LIMITS OF TECHNOLOGY
OPTION A-BNR
WITH MEMBRANES
2005 SANITARY SEWER MASTER PLAN UPDATE
Professional Engineering Consultants, P.A.
303 S. TOPEKA • WICHITA, KANSAS 67202
316-262-2691 • FAX 316-262-3003
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Job No. 34-05703
Date JUNE 2007
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Plot Scale 1:1.9741 10-23-2007 9:58:42 AM by JBB
F:\2005\05703\Final Report\Appendix L\FIGURE-L-1

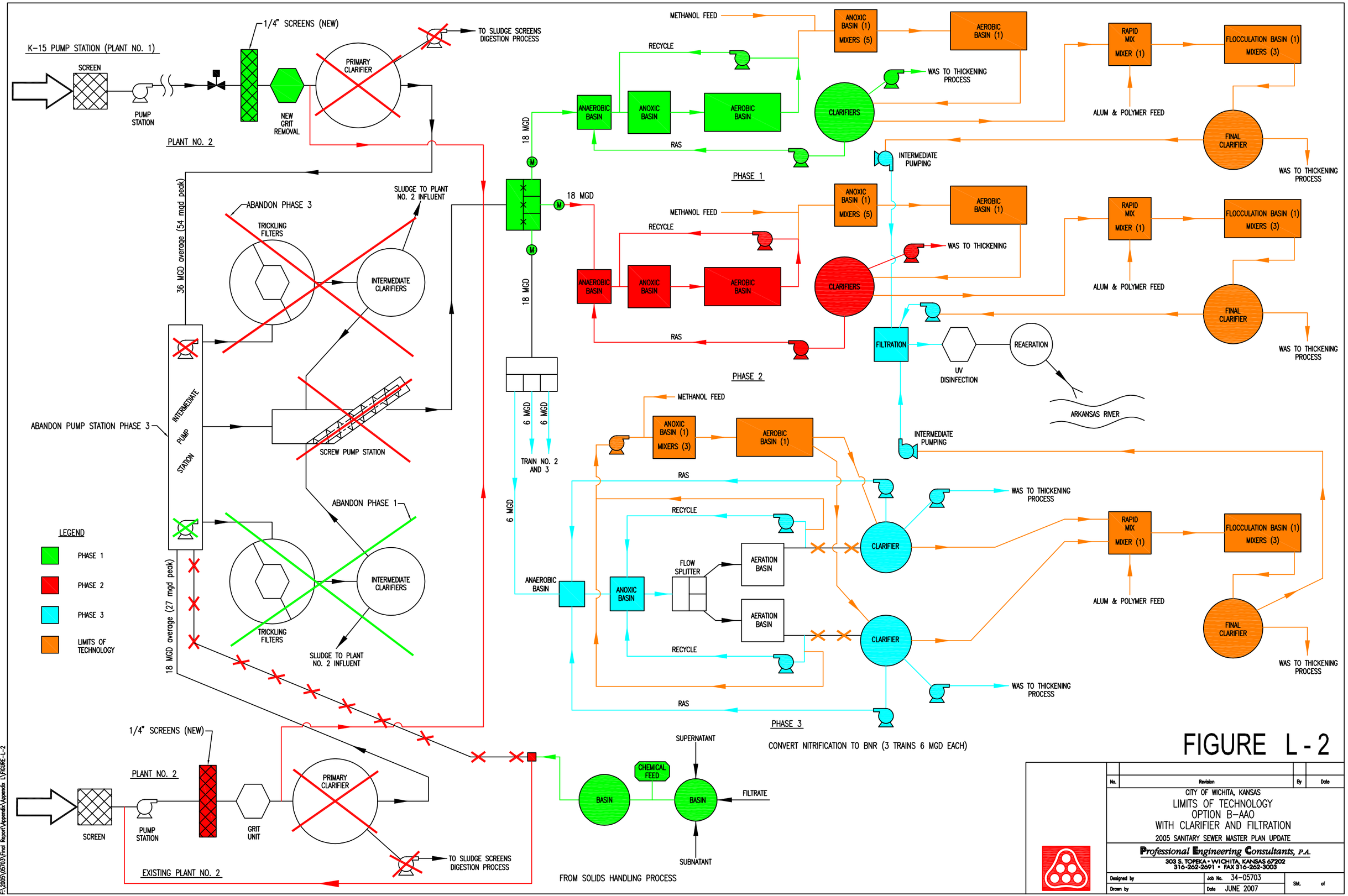

FIGURE L-2

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

LIMITS OF TECHNOLOGY
OPTION B-AAO
WITH CLARIFIER AND FILTRATION

2005 SANITARY SEWER MASTER PLAN UPDATE

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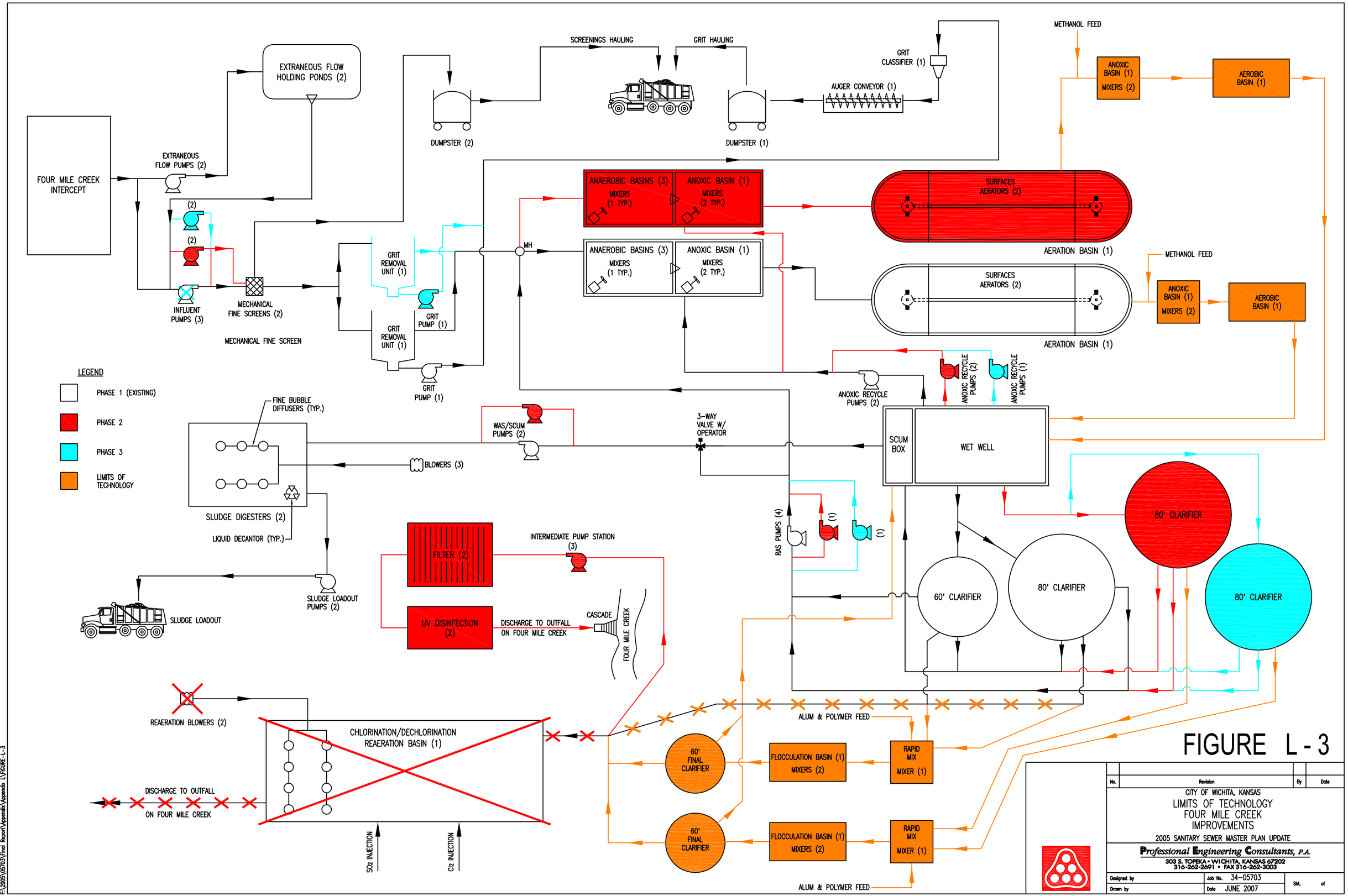
F:\2005\05703\Final Report\Appendix L\FIGURE-L-2


FOUR MILE CREEK INTERCEPT
EXTRANEOUS FLOW PUMPS (2)
EXTRANEOUS FLOW HOLDING PONDS (2)
(2)
(2)
INFLUENT PUMPS (3)
MECHANICAL FINE SCREENS (2)
MECHANICAL FINE SCREEN
GRIT REMOVAL UNIT (1)
GRIT REMOVAL UNIT (1)
GRIT PUMP (1)
GRIT PUMP (1)
DUMPSTER (2)
SCREENINGS HAULING
GRIT HAULING
DUMPSTER (1)
AUGER CONVEYOR (1)
GRIT CLASSIFIER (1)
METHANOL FEED
ANOXIC BASIN (1) MIXERS (2)
AEROBIC BASIN (1)
ANAEROBIC BASINS (3) MIXERS (1 TYP.)
ANOXIC BASIN (1) MIXERS (2 TYP.)
MH
SURFACES AERATORS (2)
AERATION BASIN (1)
METHANOL FEED
ANOXIC BASIN (1) MIXERS (2)
AEROBIC BASIN (1)
ANOXIC RECYCLE PUMPS (2)
ANOXIC RECYCLE PUMPS (2)
ANOXIC RECYCLE PUMPS (1)
LEGEND
PHASE 1 (EXISTING)
PHASE 2
PHASE 3
LIMITS OF TECHNOLOGY
FINE BUBBLE DIFFUSERS (TYP.)
WAS/SCUM PUMPS (2)
3-WAY VALVE W/ OPERATOR
SCUM BOX
WET WELL
BLOWERS (3)
SLUDGE DIGESTERS (2)
LIQUID DECANTOR (TYP.)
RAS PUMPS (4)
(1)
(1)
80' CLARIFIER
60' CLARIFIER
80' CLARIFIER
80' CLARIFIER
FILTER (2)
INTERMEDIATE PUMP STATION (3)
SLUDGE LOADOUT PUMPS (2)
SLUDGE LOADOUT
UV DISINFECTION (2)
DISCHARGE TO OUTFALL ON FOUR MILE CREEK
CASCADE
FOUR MILE CREEK
REAERATION BLOWERS (2)
CHLORINATION/DECHLORINATION REAERATION BASIN (1)
DISCHARGE TO OUTFALL ON FOUR MILE CREEK
SO2 INJECTION
Cl2 INJECTION
ALUM & POLYMER FEED
60' FINAL CLARIFIER
FLOCCULATION BASIN (1) MIXERS (2)
RAPID MIX MIXER (1)
60' FINAL CLARIFIER
FLOCCULATION BASIN (1) MIXERS (2)
RAPID MIX MIXER (1)
ALUM & POLYMER FEED
FIGURE L - 3
No. Revision By Date
CITY OF WICHITA, KANSAS
LIMITS OF TECHNOLOGY
FOUR MILE CREEK
IMPROVEMENTS
2005 SANITARY SEWER MASTER PLAN UPDATE
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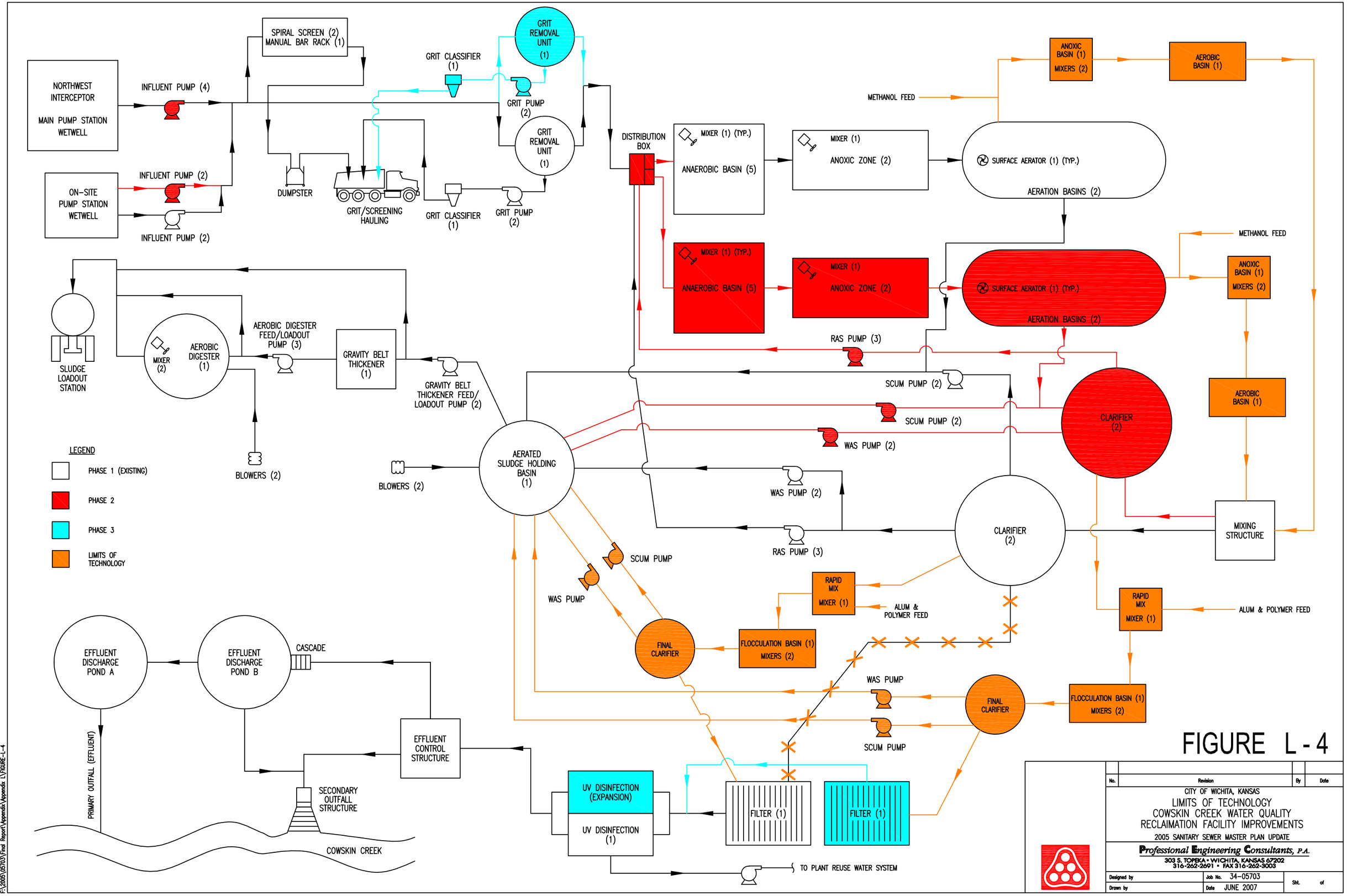

FIGURE L-4

No.	Revision	By	Date

CITY OF WICHITA, KANSAS

LIMITS OF TECHNOLOGY
COWSKIN CREEK WATER QUALITY
RECLAIMATION FACILITY IMPROVEMENTS

2005 SANITARY SEWER MASTER PLAN UPDATE

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APPENDIX M

Fairway Meadows Lagoon

APPENDIX M

Fairway Meadows Lagoon

The Fairway Meadows Lagoon is located in the SE ¼ of the SE ¼ of the NW ¼ of Section 34, Township 28 in Sedgwick County, Kansas. It is a nondischarging lagoon, constructed approximately 30 years ago, and comprised of three cells as shown below. Cell dimensions are listed in Table 1. The service area is the development immediately surrounding the lagoons. This represents approximately 150 homes as of 2007.

Table 1. Cell Surface Area and Depth

Cell	*Surface Area (acre)*	*Average Depth (ft)*
1	1.8	4.0
2	1.8	4.0
3	1.6	4.0
Total	5.2	

Figure 1. Service Area of Fairway Meadows Lagoon

There are two lift stations, one to the north at E. 63rd St. and one to the southwest of the lagoons. The influent pumps are Fairbanks Morse submersibles which are in reasonably good condition. Repair and maintenance has been minimal since the City of Wichita took over operation in 2001. The northern lift station directs flow to the second lift station. From here, it reaches a splitter box approximately midway between cells 1 and 2. Typically, influent is routed to either cell 1 or cell 2, but they are capable of being run in parallel. At a depth of approximately 4 feet, flow passes to cell 3 through overflow boxes located on the western side of cell 3. The influent concrete splitter box shows some signs of deterioration, but this is not excessive, and the overflow boxes are in fairly good condition.

There are muskrat burrows in several places around the embankments, and turtles have also been observed. Plans have been made to complete riprap around all the lagoons, but at the current time this exists only on the southern edge of cell 3.

Chemicals are usually applied in the spring for odor mitigation. Multiple doses were applied in 2007 after neighborhood complaints, resulting in an upset to cell 1. Possible causes for the odor during this season were extended cold weather and ice cap buildup on the lagoons. Biological activity is just beginning to recover and flows are being directed to cell 2.

The NPDES permit is based upon lagoon surface area of 5.8 acres and a design population equivalent of 625. With the exception of the recent upset to cell 1, color and surface tension qualities indicate the lagoon is not overloaded. Considering an average household size of 2.7, flows of 65 gallons per capita per day, and an average organic strength of 200 mg BOD/L, calculations show there is sufficient surface area to accommodate domestic wastewater flows into the future. Sludge index tests of cells 1 and 2 were performed within the last few years, and did not reveal much build up.

Using the above assumptions with 150 current households, the lagoons receive 9.6 million gallons per year (MGY). Average annual net evaporation for this area is 20 inches or 2.8 MGY for these lagoons. Allowable seepage of 1/8 inch per day is equivalent to 6.5 MGY. The difference of 0.3 MGY between evaporation plus seepage and the influent is likely due to smaller actual flows, but seepage tests have not been conducted.

Professional Engineering Consultants, P.A.

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