CITY OF LEAVENWORTH, KANSAS

WASTEWATER MASTER PLAN UPDATE AND COLLECTION SYSTEM I&I ASSESSMENT

B&V Project Number 168597

November 2010

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TREKK
DESIGN GROUP, LLC

CITY OF LEAVENWORTH, KANSAS
WASTEWATER TREATMENT PLANT
MASTER PLAN AND COLLECTION SYSTEM UPDATE

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Executive Summary

1.1 Background and Purpose

This report serves as an update to the previous, comprehensive Wastewater Treatment Master Plan for the City of Leavenworth prepared by Black & Veatch (B&V) in 2002. In accordance with the current National Pollutant Discharge Elimination System (NPDES) permit, this Master Plan Update will provide a recommendation for the implementation of disinfection facilities and an evaluation of facility improvements to meet the proposed nutrient goal levels. In addition, this report includes an update to the collection system Inflow and Infiltration (I&I) Reduction Program. The contents of this report fulfill the requirements outlined in the current permit, which has been included in *Appendix A*.

1.2 Disinfection Improvements

The Kansas Department of Health and Environment (KDHE) has established disinfection requirements for wastewater facilities that discharge to receiving waters in the State of Kansas. The City's current permit mandates the disinfection of treated effluent from April through October each year with facilities on line and able to disinfect by December 31, 2012.

In compliance with the permit, this study evaluated two alternatives to implement disinfection at the Leavenworth WWTP; (1) Bulk Sodium Hypochlorite, and (2) Ultraviolet (UV) Light. The evaluation consisted of a regulatory review, technology review, bench scale testing of chlorine and UV, conceptual layout development, and an economic and non-economic evaluation. The economic evaluation considered capital costs and operations and maintenance (O&M) costs.

Based on the results of this evaluation, UV disinfection is recommended for implementation at the Leavenworth WWTP. Recommended design criteria and a conceptual layout of the UV Disinfection Facility are included in Chapter 3.0.

1.3 Nutrient Removal Evaluation

The nutrient removal improvements study conducted for this report included the identification and development of a preferred process that could be implemented on the existing WWTP site to accomplish the nutrient removal goals outlined in the permit. In addition, the evaluation addressed the potential for nutrient credit trading through external and internal sources, although, this practice is not currently endorsed by KDHE. The concept of nutrient credit trading is based on the broad view of nutrient reduction on a regional level. Through nutrient credit trading, nutrient removal goals are still achieved from a regional perspective. While this concept has its merits, the evaluation indicated that it is unattractive from an economic standpoint.

The Activated Sludge Process was identified as the process that could be implemented on the existing WWTP site to accomplish the nutrient removal goals outlined in the permit. Chapter 2.0 contains a more detailed description of the activated sludge process. The project team evaluated this process and identified operational changes, biological treatment additions, and physical and chemical treatment additions needed to meet the three levels of nutrient goals. The evaluation also included the development of capital and O&M costs.

It is also important to note that before making a commitment to a specific process, the condition of the existing facilities should be assessed. If the trickling filter media and structures have significant remaining useful life, then other processes may be more economical.

As all wastewater system improvements and operations are financed through user fees, it is important to quantify the financial impact these future improvements would have on the rate payers. The 1995 EPA publication, *Interim Economic Guidance for Water Quality Standards*, cites 2-percent of median household income as a threshold for the total annualized pollution control costs per household at which the bill may become an "unreasonable financial burden". To determine if the nutrient removal improvements will put the City of Leavenworth above the upper level of EPA's threshold for acceptable

pollution control costs that should be borne by a community, it is recommended that further economic analysis be completed prior to design of these facilities.

1.4 Collection System – I&I Assessment and Reduction Plan

The City of Leavenworth, with the assistance from TREKK Design Group, LLC (TREKK) has developed the I&I Assessment and Reduction Plan included in Chapter 4.0 which presents procedures for identifying and cost-effectively reducing extraneous wet-weather induced wastewater flows within the City. The plan also presents a recommended schedule for identifying and eliminating I&I sources by the year 2025.

The City has already completed several I&I related rehabilitation projects identified in the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005). Despite these repairs, the City is still experiencing substantial peak wet weather flow at the WWTP during rain events. This indicates the need for additional I&I elimination.

It is recommended that the City continue with its efforts to identify and eliminate cost effective I&I from their collection system. Through an evaluation of the previous study by Wade, TREKK has developed a prioritized "plan of attack" for eliminating the remaining cost effective I&I from SUB01 and prepared an assessment and reduction plan for the remaining system. These recommendations are included in Chapter 4.0.

Implementation of this improvement plan will require the City to continue with the main line rehabilitation program and initiate a manhole rehabilitation program and a private sector I&I disconnect program. The ultimate success of this improvement plan for reducing wastewater surcharges and backups will depend largely upon the success of the continuing implementation these programs. Partial implementation will not result in satisfactory reductions and transport of peak wet-weather-induced wastewater flows. The recommended improvement plan also entails flow monitoring of the collection system. The previous collection system flow monitoring was conducted as part of the *Wastewater Master Plan* (B&V, 2001). The collection system flow monitoring data is over 10 years old and may not accurately represent current flows in the system.

The total estimated cost to perform the recommended improvements to the mini-basins within Sub-System 01 and additional flow monitoring in the remaining subsystems is approximately $4,063,000.

1.5 Implementation

Chapter 5.0 summarizes implementation recommendations for the proposed disinfection facilities and provides a phasing plan for future nutrient removal facilities at the Leavenworth WWTP. In addition, the implementation chapter discusses other plant improvements to consider, future staffing levels, improvements to plant hydraulics, site considerations, capital and O&M costs, and project schedule.

Capital and O&M costs for implementing UV Disinfection are included in *Table ES-1* and a proposed project schedule is included in *Table ES-2*. Capital and O&M costs for implementing nutrient removal at the three goal levels are included in *Table ES-3*.

Table ES-1
Capital and O&M Costs for UV Disinfection

	UV Disinfection and Generator		3,248,000
CAPITAL COSTS	GENERAL REQUIREMENTS	12%	400,000
	SITEWORK	10%	300,000
	ELECTRICAL & I&C	22%	800,000
	CONTINGENCY	25%	800,000
	CONSTRUCTION SUBTOTAL		**5,548,000**
	ENGINEERING	20%	1,100,000
	TOTAL CAPITAL COST		**6,648,000**
O&M COSTS	Annual O&M Cost		188,000
	20-year PW of O&M		3,074,000
	TOTAL PW COST		**9,722,000**

Table ES-2 Disinfection Compliance Schedule	
Item	**Months**
Testing & Preselection	3 (April 2011)
Detailed Design	9 (January 2012)
Bidding & Award	2 (March 2012)
Construction	11 (February 2013)
Start-up	1 (March 2013)

Table ES-3
Capital and O&M Cost for Various Levels of Nutrient Removal

Phase of Treatment	Facility		Goal Level 1	Goal Level 2	Goal Level 3
Preliminary Treatment	EQ Basin		1,814,500		
Primary Treatment	Fermenter		601,000		
	Gravity Thickener/Fermenter PS		818,000		
	Gravity Thickener		251,000		
Secondary Treatment	BNR		7,663,500		
	Blower Building		1,987,000		
	Final Sludge PS		2,066,000		
	Final Clarifiers		3,992,000		
Tertiary Treatment	Intermediate Pumping Station		1,053,200		
	Filters			4,006,000	
Disinfection	Disinfection				
Solids	WAS Thickening		1,388,500		
	Aerated TWAS Storage		696,000		
Ancillary	Chemical Feed			944,000	
	Additional Lab/Storage Space		393,000		
COST MULTIPLIERS	SUBTOTAL		22,723,700	4,950,000	0
	GENERAL REQUIREMENTS	15%	3,400,000	700,000	0
	SITEWORK	15%	3,400,000	700,000	0
	ELECTRICAL & I&C	25%	6,500,000	1,400,000	0
	CONTINGENCY	30%	10,800,000	2,300,000	0
	CONSTRUCTION SUBTOTAL		**46,823,700**	**10,050,000**	**0**

Table ES-3 Capital and O&M Cost for Various Levels of Nutrient Removal				
Phase of Treatment	**Facility**	**Goal Level 1**	**Goal Level 2**	**Goal Level 3**
	ENGINEERING 20%	9,400,000	2,000,000	0
	TOTAL CAPITAL COST	**56,223,700**	**12,050,000**	**0**
O&M COSTS	Annual O&M Cost	835,000	843,000	919,000
	20-year PW of O&M	13,653,000	13,784,000	15,027,000
	TOTAL PW COST	**69,876,700**	**25,834,000**	**15,027,000**

1.0 Introduction

1.1 Background and Purpose

In 2002, Black & Veatch (B&V) completed a comprehensive Wastewater Master Plan for the City of Leavenworth to identify the most efficient, cost-effective, and appropriate collection system and facility improvements to accommodate existing and future wastewater flows through the year 2020. The plan included flow and rainfall monitoring in the collection system, hydraulic modeling of the collection system interceptors, identification of needed rehabilitation and repair of existing facilities and equipment at the wastewater treatment plant (WWTP), and an analysis of expansion alternatives at the WWTP.

The Leavenworth WWTPs current National Pollutant Discharge Elimination System (NPDES) permit issued by the Kansas Department of Health and Environment (KDHE) under the Schedule of Compliance requires the permittee to complete and submit an updated Wastewater Master Plan by December 1, 2010. The permit requires the updated master plan to include an implementation plan for disinfection of plant effluent as well as an assessment of the feasibility of incorporating nutrient removal facilities and processes into the plant. This Master Plan Update will provide an evaluation of facility improvements to meet the proposed nutrient goal levels, a recommendation for the implementation of disinfection facilities, and a collection system update. The contents of this report fulfill the requirements outlined in the current NPDES permit.

1.2 Facilities Description

The Leavenworth WWTP is located at 1800 South 2nd Street in Leavenworth, Kansas and consists of the following facilities: influent screening and pumping, aerated grit removal, primary clarification, intermediate pumping (settled sewage), trickling filters, final clarification, and sludge dewatering (belt filter press). *Figure 1-1* shows the existing plant process schematic.

EXISTING SCREENING, GRIT, REMOVAL, AND RAW SEWAGE PUMPING STATION
CHLORINE SOLUTION
METERING MANHOLE
MANHOLE
EX 18", 24", AND 36" GRAVITY SEWERS
48" GRAVITY FLOW
36" GRAVITY FLOW
NORMALLY OPEN
NORMALLY CLOSED
VALVE LOCATED INSIDE PUMPING STATION
42" INFLUENT SEWER
UP FLOW INLET
30"
FM
42"
FLOW METER VAULT
GRIT REMOVAL EQUIPMENT
GRIT REMOVAL EQUIPMENT
OUTLET
PREAERATION STRUCTURE
FINAL BASIN SLUDGE DISCHARGE
42"
PRIMARY BASIN NO. 1
24"
36"
PRIMARY BASIN NO. 2
FLOW DIVISION STRUCTURE NO 1
SLUDGE DRAWOFF (TYP)
30"
PRIMARY BASIN EFFLUENT
PRIMARY BASIN NO. 3
PRIMARY BASIN NO. 4
SLUDGE PUMPING STATION
30"
36"
54"
SCUM DISCHARGE
SCUM AND SLUDGE
SLUDGE HOLDING TANKS 1 & 2
54" SETTLED SEWAGE PUMP STATION WETWELL CELL NO 1 INFLUENT
54" PRIMARY BASIN EFFLUENT
54"
38" SETTLED SEWAGE PUMP STATION WETWELL CELL NO 2 INFLUENT
TEMPORARY 24" BYPASS (ABANDONED)
FINAL BASIN SLUDGE DISCHARGE
36" EMERGENCY OVERFLOW
HOLDING TANK OVERFLOW
SPECIAL MANHOLE NO 2
SETTLED SEWAGE PUMPS (4 INSTALLED SPACE FOR 2 FUTURE)
VALVE MH NO. 5
SECOND STAGE TRICKLING FILTER
VALVE MH NO. 7
TRICKLING FILTER INFLUENT
20"
VALVE MH NO. 6
20"
20"
BYPASS
VALVE MH NO. 8
NO 3
36"
SETTLED SEWAGE PUMPING STATION
SPECIAL MH NO. 3
20"
SLUICE GATE NORMALLY CLOSED
FIRST STAGE TRICKLING FILTER
54"
TRICKLING FILTER EFFLUENT
FLOW DIVISION STRUCTURE NO 2
FINAL BASIN NO. 1
42"
FINAL BASIN OUTLET
54"
CHLORINE SOLUTION
CHLORINE CONTACT BASIN
SLUDGE HOLDING TANK PUMP HOUSE
SLUDGE PUMPS (2)
CELL NO 1
CELL NO 2
TRICKLING FILTER EFFLUENT USED FOR BYPASSING SECOND STAGE FILTER, AND PARALLEL OPERATION OF FILTERS
36"
SLUDGE DRAWOFF
54" CHLORINE CONTACT BASIN INFLUENT
FLOW
54"
48"
PLANT EFFLUENT
EMERGENCY OVERFLOW TO FIVE MILE CREEK
TO MISSOURI RIVER
SLUICE GATE NORMALLY OPEN
DIVISION WALL OVERFLOWS WHEN INCOMING FLOW EXCEEDS 10.0 MGD
TRICKLING FILTER EFFLUENT
NO
VALVE MH NO. 1
24"
TRICKLING FILTER INFLUENT
FINAL BASIN INFLUENT
36"
FINAL BASIN SLUDGE, AND SCUM DRAWOFF MANHOLE
FINAL BASIN NO. 2
FINAL BASIN OUTLET
BYPASS OUTLET
SPECIAL MH NO. 4
SPECIAL MH NO. 5
CHLORINE SOLUTION FEED POINT
DEWATERING SLUDGE CONVEYOR
LIME
BELT FILTER PRESS
LANDFILL
BLENDER
VALVE CLOSES WHEN INCOMING FLOW FROM THE SETTLED SEWAGE PUMPING STATION EXCEEDS 10.0 MGD (NORMALLY OPEN)
VALVE OPENS WHEN INCOMING FLOW TO SETTLED SEWAGE PUMPING STATION EXCEEDS 10.0 MGD (NORMALLY CLOSED)
30"
24"
VALVE MH NO. 2
NO 1
NO 2
SECOND STAGE TRICKLING FILTER
VALVE MH NO. 4
VALVE OPENING AND CLOSING REGULATED BY WATER LEVEL IN THE WETWELL OF SETTLED SEWAGE PUMPING STATION
30"
TRICKLING FILTER RECIRCULATION
VALVE MH NO. 3
SLUDGE FILTER BUILDING DRAIN

NOTE:

NOT ALL PIPING AND VALVES ARE SHOWN IN THIS SCHEMATIC.

EXISTING PROCESS SCHEMATIC

NO SCALE

PRELIMINARY - NOT FOR CONSTRUCTION

NO.	BY	CK	APP

REVISIONS AND RECORD OF ISSUE

DATE

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XREF4 ID:
SW: PW FILE: Process Schematic.dgn

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
MASTER PLAN & COLLECTION SYSTEM UPDATE

EXISTING PROCESS SCHEMATIC

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

PROJECT NO.
168597

FIG 1-1

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1.3 Population Projections and Industrial Growth

The City provided population projections out to 2020 and a basis for projecting to 2030. Population has declined somewhat from the 2000 Census figures, and City growth is anticipated to be slower than previously projected in the 2002 Master Plan for the next 10 years. However, Fort Leavenworth, the Veterans Administration, and the penitentiary are expected to add facilities for additional residents and employees. The growth of these industries and population segments will result in some overall population growth. Previous reports used a more optimistic growth projection which resulted in a higher population for 2020 and future buildout. It has also been anticipated that a new development in the Salt Creek Valley could fuel population growth. That development has not yet begun however. For planning purposes, this Master Plan Update will consider the higher projections for ultimate sizing of facilities and space allocations but will provide phasing options to allow intermittent improvements. This will allow the City of Leavenworth some flexibility to meet their needs based on actual population growth.

Table 1-1
Population Data and Projections

Year	Population
2010	34,000
2020	36,380
2030	46,000
2030[1]	53,000

Notes:
1. Includes flow from the annexation of Salt Creek Valley.

1.4 Influent Wastewater Flow

1.4.1 Historical Flow Data

Plant staff records both the influent and effluent flow readings. The influent flow meter was replaced in the Phase 1 Improvements (2004). A magnetic flowmeter was installed in a new vault between the influent pumping station and the preaeration facility. There is recirculation flow from the final clarifiers as well as potable water which is

included in this influent meter reading. The recirculation flow from the final clarifiers is metered which allows staff to subtract this for a more accurate influent reading. The return potable water is not metered separately however; so there is not an easy way to accurately determine what portion of the influent flow is from return potable water.

The effluent flow reading is measured by an ultrasonic level sensor over a weir in Special Manhole No. 2 which combines the flow from the two final clarifiers. This reading does not include any flow from the emergency overflow line.

The influent and effluent flow readings do not correlate well. The effluent reading is used for reporting purposes. It is recommended that an additional investigation be conducted to accurately determine flows.

Data provided by the City from 2008 through the present was analyzed. This data indicated an average daily flow of 4.38 million gallons per day (mgd), maximum month flow of 7.63 mgd, and a peak day flow of 12.39 mgd. Dividing these flows over the current population results in a flow of 129 gallons per capita per day (gpcd). This is a fairly high value, however, the WWTP was originally designed for a similar average daily per capita flow of 125 mgd.

1.4.2 Flow Projections

Table 1-2 presents flow projections for 2020 and 2030 by carrying the calculated 129 gpcd forward with the population projections. It also indicates flows based on an optimistic population projection that might be reached if additional land is annexed.

Table 1-2
Projection of Flows

Year	2010	2020	2030	2030[1]
Population	34,000	36,380	46,000	53,000
Avg Day Flow, mgd	4.36	4.67	5.90	6.84
Max Month Flow, mgd	7.63	8.15	10.30	11.87
Peak Day Flow, mgd	12.39	13.26	16.76	19.34
Peak Hour Flow, mgd	27.5	29.43	37.24	42.91

Notes:
1. Includes flow from the annexation of Salt Creek Valley.

Discrepancies between influent and effluent flow readings raise the question of which peak hourly flow to use for design. Peak hourly flow is significant for disinfection as well as hydraulics. A peak hourly flow rate of 34 mgd has been used in past reports. This was based on a typical peaking factor of 7.57 suggested by a hydraulic model of the collection system for one subbasin. The flow meters at the Leavenworth WWTP have not confirmed that a peak flow of 34 mgd actually reaches the treatment facility. The highest recorded flow from the data provided was 27.5 mgd. The existing collection system trunk sewers likely do not have enough capacity to convey higher flows into the plant. It is also likely that the 7.57 peaking factor is only applicable to that particular subbasin. It is recommended that increased logging and monitoring of plant flows be performed as well as possible flow monitoring of the collection system upstream of the treatment plant. This 27.5 mgd will be used for current peak hourly flow for this report. This results in a peaking factor of 6.28 which could be maintained or possibly improved by an I&I reduction program.

1.5 Influent Wastewater Loads

1.5.1 Recent Data

Three and a half years of historical data (2007 - June 2010) were evaluated to develop influent wastewater characteristics. Within the data set there were two very high influent biochemical oxygen demand (BOD) concentrations that were removed from the evaluation. These data points had extremely high influent BOD concentrations at days when the influent flow was also high. Given the higher influent flow rates, the influent BOD concentration should have been more dilute. The two days in question were:

- May 1, 2007 – Flow 7.54 mgd and 346 mg/L BOD = 21,763 ppd BOD
- April 1, 2008 – Flow 5.26 mgd and 424 mg/L BOD = 18,590 ppd BOD

City laboratory staff were contacted to determine if these two days were associated with some unusual activity. There were no anomalies that were noted in the

laboratory records. The daily influent BOD mass load data is shown in *Figure 1-2*. It is evident from this figure that the two high influent BOD mass loads were not typical and should be removed from the data set.

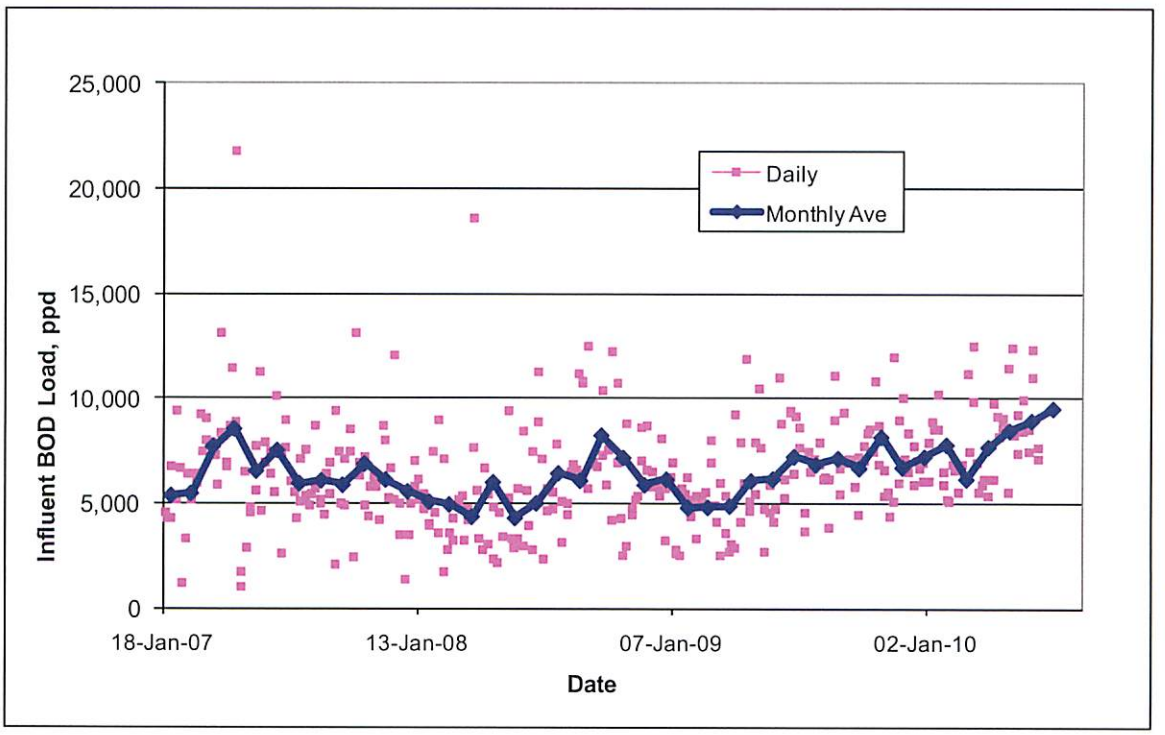


Figure 1-2 Daily Influent Mass Load of BOD

The influent TSS data was also evaluated and several high days with very high TSS mass loads were identified. The daily influent TSS data is shown in *Figure 1-3*. The very high load days can be seen on the graph. City laboratory staff were contacted about these data points. City staff felt that these data were valid. American Water at Fort Leavenworth does discharge their sludge to the sewer for removal in the City's primary clarifier. It was felt that these high influent TSS load days corresponded to sludge wasting from the water plant. If the high solids loading is always due to the discharge of water plant sludge, then the solids removal performance at the primary clarifier should not be impacted as these solids will be easily removed. It is anticipated that primary clarifier effluent quality will remain consistent, but primary sludge production will spike

on those days. The only design consideration is primary sludge pumping and solids storage. Since the long term plan is to continue to store, dewater and haul to a landfill, no further investigation into the high solids loads was warranted. The high BOD loading days were not thought to be related to the water plant sludge. Water plant sludge is non-biodegradable inert material.

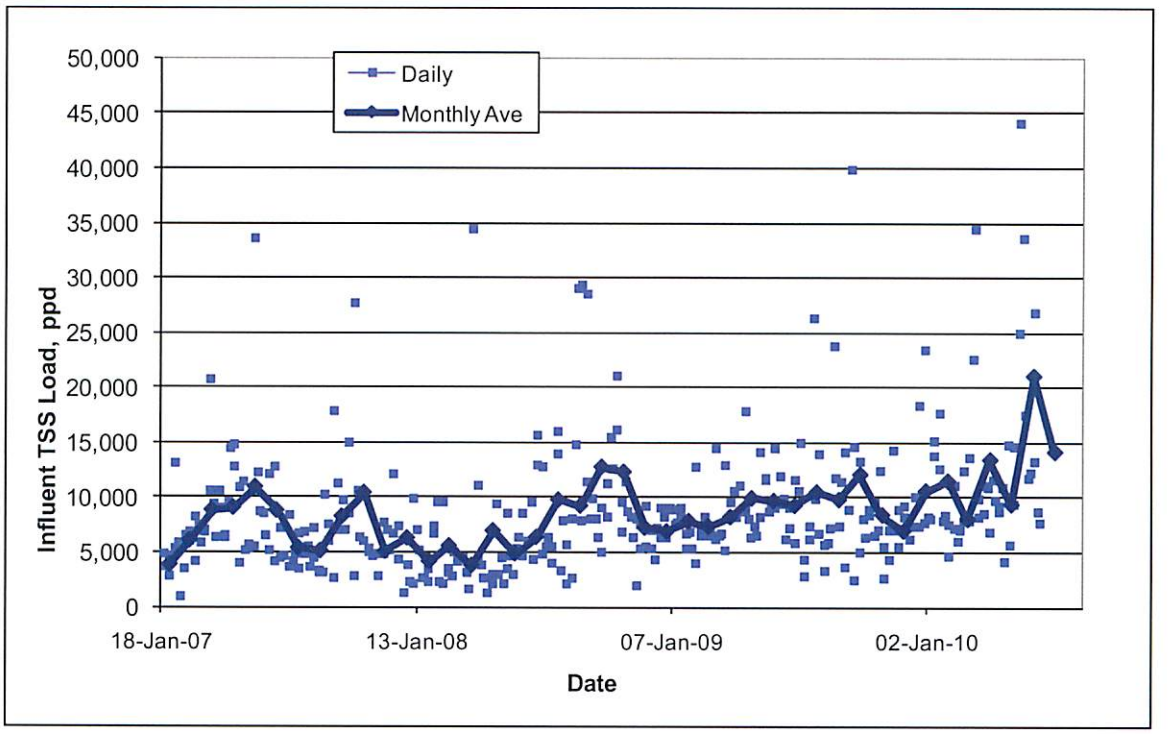


Figure 1-3 Daily Influent Mass Load of TSS

The truncated data set (with removal of the two high BOD data points) is summarized in *Table 1-3*. The Minimum Month condition has been defined for future detailed design to define blower turndown conditions.

Table 1-3 Summary of Historical Data				
Condition	**Annual Average**	**Maximum Month**	**Peak day**	**Minimum Month**
Flow, mgd	4.4	7.6	12.4	3.1
BOD, ppd	6,380	9,520	13,125	4,309
BOD, mg/L	175	150	127	
TSS, ppd	8,650	21,000	44,400	3,750
TSS, mg/L	237	330	426	
TKN, ppd	1,320	1,960	2,260	811
TKN, mg/L	36.2	30.9	21.9	
NH_3-N, ppd	990	1,470	1,690	
NH_3-N, mg/L	27.2	23.2	16.4	
TP, ppd	191	286	328	75
TP, mg/L	5.2	4.5	3.2	

1.5.2 Projected Loads

The current connected population equivalent is 34,000. The load data in *Table 1-3* was used to develop the per capita characteristics of the existing wastewater, which is shown in *Table 1-4*.

Table 1-4 Summary of Per Capita Wastewater Characteristics		
	Annual Average	**Maximum Month**
Flow, gpd/ cap	129	224
BOD, ppd/ cap	0.188	0.280
TSS, ppd/ cap	0.255	0.618
TKN ppd/ cap	0.0389	0.0577
NH_3-N, ppd/ cap	0.0292	0.0433
TP, ppd/ cap	0.00561	0.00841

Using the population projections from *Table 1-1* and the per capita wastewater characteristics shown in *Table 1-4*, the future loadings conditions can be defined. The future wastewater flows and loads are summarized in *Table 1-5*. Flows and loads are also included for the ultimate buildout of the existing plant site. These values represent the maximum possible usage of the land available.

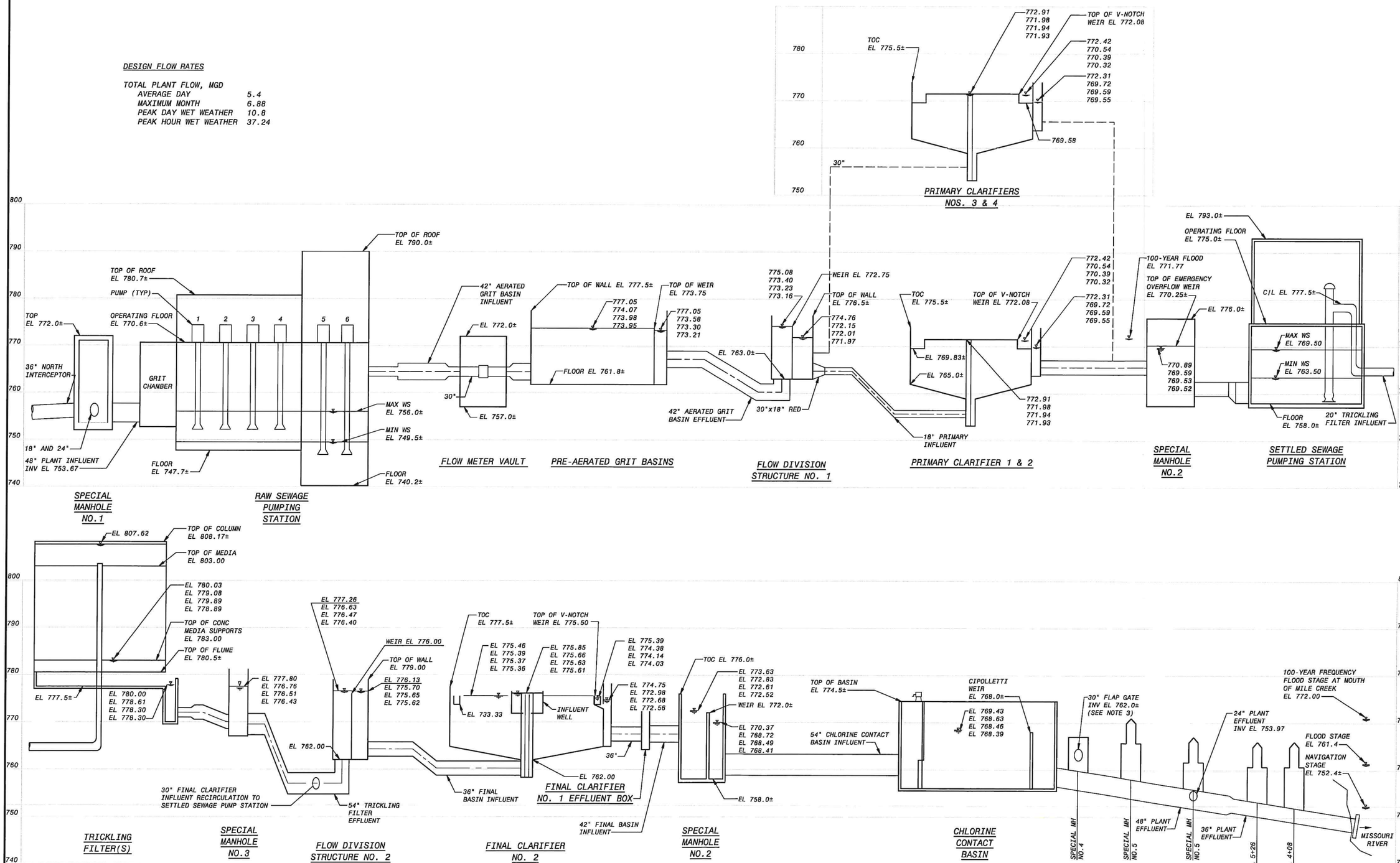
Table 1-5
Future Wastewater Flow and Load Projections

	Annual Average	Maximum Month	Peak Day
2020			
Flow, mgd	4.7	8.2	13.3
BOD, ppd	6,830	10,180	14,040
BOD, mg/L	175	150	127
TSS, ppd	9,260	22,470	47,120
TSS, mg/L	237	330	426
TKN, ppd	1,420	2,100	2,420
TKN, mg/L	36.2	30.9	21.9
NH_3-N, ppd	1,060	1,580	1,810
NH_3-N, mg/L	27.2	23.2	16.4
TP, ppd	204	306	351
TP, mg/L	5.2	4.5	3.2
2030 Conservative Growth			
Flow, mgd	5.9	10.3	16.8
BOD, ppd	8,640	12,880	17,760
BOD, mg/L	175	150	127
TSS, ppd	11,710	28,410	59,950
TSS, mg/L	237	330	426
TKN, ppd	1,790	2,660	3,060
TKN, mg/L	36.2	30.9	21.9
NH_3-N, ppd	1,340	1,990	2,290
NH_3-N, mg/L	27.2	23.2	16.4
TP, ppd	258	387	444
TP, mg/L	5.2	4.5	3.2
Ultimate Buildout of Site			
Flow, mgd	8.1	14.1	23.0
BOD, ppd	11,830	17,630	24,320
BOD, mg/L	175	150	127
TSS, ppd	16,040	38,910	81,610
TSS, mg/L	237	330	426
TKN, ppd	2,450	3,640	4,180
TKN, mg/L	36.2	30.9	21.9
NH_3-N, ppd	1,810	2,730	3,140
NH_3-N, mg/L	27.2	23.2	16.7
TP, ppd	354	530	608
TP, mg/L	5.2	4.5	3.2

DESIGN FLOW RATES

TOTAL PLANT FLOW, MGD

AVERAGE DAY	5.4
MAXIMUM MONTH	6.88
PEAK DAY WET WEATHER	10.8
PEAK HOUR WET WEATHER	37.24



HYDRAULIC PROFILE
HORIZ NO SCALE
VERT 1" = 10'0"

NOTES:

1. WATER SURFACE ELEVATIONS SHOWN ARE BASED ON NAVIGATION STAGE WATER ELEVATION OF MISSOURI RIVER AT EL 752.40.
2. EL XXX.XX (WATER SURFACE @ PEAK HOUR WET WEATHER)
   EL XXX.XX (WATER SURFACE @ PEAK DAY WET WEATHER)
   EL XXX.XX (WATER SURFACE @ MAX MONTH)
   EL XXX.XX (WATER SURFACE @ AVERAGE DAY)
3. OVERFLOW THROUGH 30" FLAP GATE TO 5 MILE CREEK WILL OCCUR AT SPECIAL MANHOLE NO.4 AT ANY FLOW ABOVE 30 MGD WHEN RIVER IS AT NAVIGATION STAGE.

NO.	BY	CK	APP	DATE	REVISIONS AND RECORD OF ISSUE
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XREF3 ID:
XREF4 ID:
SM: PW FILE: Hydraulic Rmf4100dwg

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
MASTER PLAN & COLLECTION SYSTEM UPDATE

EXISTING HYDRAULIC PROFILE

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

PROJECT NO.
168597

FIG 1-4

SHEET
OF

FD5000
D5000

1.6 Plant Hydraulics

The hydraulics at the plant is highly influenced by the Missouri River level. The preliminary hydraulic modeling indicates that when the river is at the 100-year flood level, weirs at the chlorine contact basin, Special Manhole No. 2, final clarifiers, and primary clarifiers are submerged during peak hour flows. Some of these weirs are submerged at the 100-year river level regardless of the flow the plant receives. Therefore, there appears to be two issues: backwater from the river during flood stages, and hydraulic bottlenecks within the plant and outfall pipe. The existing hydraulic profile is included as *Figure 1-4*.

1.6.1 Missouri River Level

Table 1-6 shows the various river levels that were used in the hydraulic modeling. River levels were interpolated from a recent Flood Insurance Survey profile and are at the mouth of 5 Mile Creek.

Table 1-6
Missouri River Flood Elevations

Frequency	Elevation
25-year	770.22
50-year	771.00
100-year	772.00

1.6.2 KDHE Requirements

KDHE has requirements for "Emergency Operation" which includes flooding. The following requirements are from KDHE's "Minimum Standards of Design for Water Pollution Control Facilities".

a. All units shall remain fully operational during the 25-year flood frequency event.

b. All units required to provide primary treatment (pumping, screening, and removal of settleable solids) shall remain fully operational during the 50-year flood frequency event.

c. All structures, electrical, and mechanical equipment shall be protected from damage due to the 100-year flood frequency event.

The City has indicated that the plant is capable of meeting these requirements, however, a 100-year flood frequency event would require a complete plant shutdown similar to what occurred in the Flood of 1993.

There are also requirements in the KDHE standards for standby power. The plant does not currently have backup power for the existing facilities, but the plant does have dual power feeds. The transfer feed switches are currently manually operated, but the City is planning to add automated power switches to transfer feeds in future improvement projects.

1.6.3 Hydraulic Capacity of Existing Facilities

The preliminary hydraulic calculations showed that there are some hydraulic bottlenecks or constraints at the plant. The key areas of concern are as follows:

Influent Bar Screens: Rated capacity is 26.5 mgd, however more flow can be passed through the screen with reduced screening efficiency.

Settled Sewage Pumping Station: Rated capacity is 30 mgd with all pumps running. If more flow comes to the plant, flow in excess of 30 mgd will pass through the emergency overflow pipe to Special Manhole No. 2.

Outfall Pipe: There are some complexities to the outfall pipe that made it difficult to hydraulically model. Specifically, it appears that there are two outfall pipes extending to the Missouri River from the second Special Manhole No. 5. In Workshop No. 1, the City mentioned that they thought the original outfall pipe had been plugged, which agrees with the way the

system was modeled. A key result of the model is as follows: when the Missouri River is at navigation stage (el 752.4), plant effluent will discharge directly to 5-Mile Creek through the flap gate in Special Manhole No. 4 when plant flow exceeds 30 mgd. As the Missouri River rises, more flow will discharge directly to 5-Mile Creek.

1.6.4 Potential Hydraulic Modifications

There are modifications that could help alleviate some of the hydraulic concerns. Some could be completed with the initial disinfection project and have been indicated as such below. The modifications are as follows.

- Raise walls of the chlorine contact basin to increase freeboard (complete with disinfection improvements)
- Modify chlorine contact basin influent piping to reduce headloss (complete with disinfection improvements)
- Add effluent pumping
- Increase primary clarifier capacity by replacing the two shallow units
- Increase Settled Sewage Pumping Station capacity and remove emergency bypass
- Add equalization facilities

2.0 Nutrient Removal Alternatives

2.1 Introduction and Background

The purpose of this chapter in the Master Plan Update is to assess the feasibility of incorporating nutrient removal facilities and processes at the Leavenworth Wastewater Treatment Plant (WWTP) as required by the Kansas Department of Health and Environment (KDHE) in the current NPDES permit. The current permit, included in *Appendix A*, requires the following:

> *"1. The permittee shall conduct studies to assess the cost and feasibility for this facility to meet each of the following effluent nutrient goals as annual averages:*
>
> | *Goal* | *1* | *2* | *3* |
> |---|---|---|---|
> | *Total Nitrogen (as N) – mg/l* | *8.0* | *5.0* | *3.0* |
> | *Total Phosphorus (as P) – mg/l* | *1.5* | *0.5* | *0.3* |
>
> *The studies shall include operational and capital costs for 1) operational changes only, if feasible, 2) biological treatment additions, and 3) physical and chemical treatment additions to meet the stated goals.*
>
> *2. The permittee shall provide the study results to KDHE with the updated Master Plan."*

For the purposes of this study, the three goal levels listed in the above table will be defined as follows:

- Goal Level 1 – 8 mg/L Total Nitrogen (TN) and 1.5 mg/L Total Phosphorus (TP)
- Goal Level 2 – 5 mg/L TN and 0.5 mg/L TP
- Goal Level 3 – 3 mg/L TN and 0.3 mg/L TP

As required by the permit, the project team will evaluate operational changes, biological treatment additions, and physical and chemical treatment additions needed to meet the three levels of nutrient goals. Opinions of probable operation and capital costs will be developed to assist the City in planning to meet the goals and objectives for this study.

2.2 Upgrade of Existing Facilities for Nutrient Removal

The Activated Sludge Process was identified as the process that could be implemented to accomplish the nutrient removal goals outlined in the NPDES permit. This process will be discussed in greater detail in the following paragraphs. In addition, this chapter addresses the concept of nutrient trading through regionalization or wetland treatment.

2.2.1 Activated Sludge Process

The activated sludge process is a proven, versatile technology capable of numerous system enhancements to meet the future Goal Level 1 through 3 requirements.

The existing primary clarifiers have the necessary capacity to handle the future flows. Nitrification will be achieved by controlling the mixed liquor suspended solids (MLSS) concentration and related solids retention time (SRT). The activated sludge system will include an anaerobic zone for biological phosphorus removal, anoxic zone for denitrification, and an oxic zone for nitrification. Four new final clarifiers and related return activated sludge (RAS) and MLSS recycle pumping station will be needed. A blower building will be necessary to deliver the required air for the aeration process in the oxic zones of the nutrient removal basins.

The return solids are brought into the anaerobic zone. In the anaerobic zone, biological phosphorus removal starts with release of captured phosphorus from the phosphorus accumulating organisms (PAOs) in the suspended growth solids. This release of phosphorus stresses the microbes to trigger the critical "Luxury Uptake" of phosphorus in the oxic portion of the system. By stressing the microbes in the anaerobic zone, they

are forced to use all of their stored energy, energy stored in the form of phosphorus chemical bonds, and release ortho phosphorus causing the microbes to be stressed from a lack of energy. To avoid being stressed, the microbes over-react and make more adenosine triphosphate (ATP), the chemical battery inside the PAOs, than usual which results in the uptake of more phosphorus than is usually needed for normal "unstressed" growth.

The key to making the PAOs release phosphorus is making sure there is plenty of their preferred food, volatile fatty acids (VFA) – especially acetic and propionic acids. VFA is formed by anaerobic fermentation in the collection system and within the anaerobic zone. Soluble biochemical oxygen demand (BOD) is converted into VFA by acid forming bacteria, much like the first step in anaerobic digestion. It is possible that there may not be enough soluble BOD in the incoming wastewater, and therefore a fermenter is shown as part of the process. Primary sludge will be fermented in the fermenter to produce VFA for biological phosphorus removal. A gravity thickener will be needed to separate the fermented solids from the VFA rich supernatant and the VFA rich supernatant will be sent to the anaerobic zone.

The first anoxic zone does not affect biological phosphorus removal (BPR), but is essential for total nitrogen control. Anaerobic zone effluent flows into the first anoxic zone, where it is combined with an MLSS recycle stream from the end of the oxic zone. The MLSS recycle stream conveys nitrate formed in the oxic zone back to the first anoxic zone for removal. The MLSS recycle flow rate can be as high as four times the influent flow rate. The high recycle flow rate is needed to control the nitrate concentration to levels that comply with the plant effluent TN permit limit.

Denitrifying organisms rapidly consume soluble BOD in the first anoxic zone. These organisms convert nitrate into nitrogen gas (denitrification). The nitrogen gas vents out of the water to the atmosphere; this location is only one of three in the treatment plant where nitrogen leaves the facility. The other two locations are the plant effluent and the dewatered biosolids.

Controlling the dissolved oxygen (DO) concentration at the end of the oxic zone is important for proper denitrification. Recycling DO into the first anoxic zone results in readily degradable chemical oxygen demand (COD) being consumed to eliminate the DO before denitrification can begin.

Mixed liquor flows from the first anoxic zone into the oxic zone, which acts as a completely mixed treatment system, following first anoxic treatment. The oxic portion of the treatment train is kept aerobic through diffused aeration. The oxic zone serves two basic functions: nitrification (conversion of ammonia to nitrate) and conversion of soluble phosphorus into biomass that can be settled out in the final clarifiers. If these substances are not converted in the treatment process, the receiving waters into which the plant ultimately discharges are impacted by the oxygen requirement for these substances.

Since the existing final clarifiers at Leavenworth have a shallow depth there is another process limitation that needs to be considered. To continue to use the shallow clarifiers, the MLSS concentration of the suspended growth system would have to be limited to under 1,500 mg/L and preferably under 1,000 mg/L most of the time. This low MLSS concentration would be required to prevent carryover of solids if the MLSS concentration is too high. Designing activated sludge system around this low MLSS concentration and a 10 day SRT causes the size of the activated sludge basin to become very large. Therefore, it is recommended that new deep final clarifiers be built to replace the existing shallow clarifiers in order to increase the MLSS concentrations at maximum month winter conditions to 3,500 to 4,000 mg/L. This will consequently reduce the size of the basins, thereby allowing the facilities to fit more efficiently on the site.

This basic activated sludge system design will be able to meet the Goal Level 1 effluent quality from KDHE. With the addition of either a combination second anoxic and re-aeration zone or deep bed denitrification filter, the activated sludge process can be designed to meet Goal Levels 2 and 3. Operating costs will need to be considered with the addition of iron for phosphorus polishing, if needed, and a carbon source such as methanol for additional denitrification.

Table 2-1 provides a list of the various components of the Activated Sludge treatment process. A conceptual, phased site layout showing these components has been included as *Figure 2-1*.

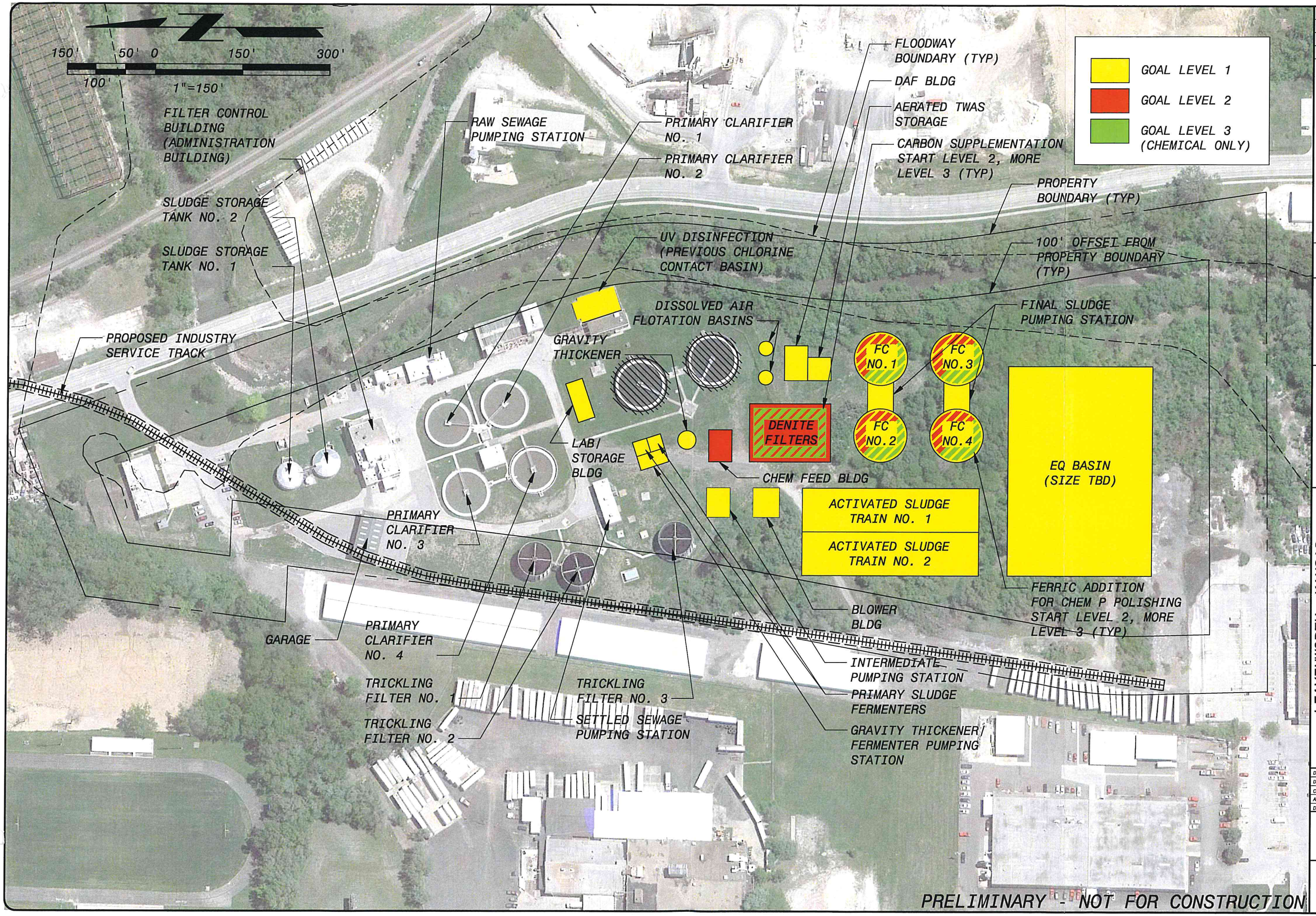
Table 2-1
Treatment Plant Components for the Activated Sludge Process

Equipment/ Component	Goal Level
Primary Clarifiers	1
Primary Sludge Fermenter	1
BNR Basin	
Anaerobic Zone	1
First Anoxic Zone	1
Oxic Zone	1
Second Anoxic Zone[1]	2
Reaeration[1]	2
MLSS recycle	1
Deep Final Clarifiers	1
RAS pumping	1
WAS Pumping	1
Blower Building	1
Denitrifying Filters	2
Chemical Feed Building	2

Note:
1. The second anoxic and reaeration zones can be added in lieu of denitrifying filters.

2.2.2 *Possible Alternative Processes*

It is unclear how soon KDHE will issue a permit requiring biological nutrient removal (BNR) goals or limits. At the KWEA/KsAWWA Joint Conference, KDHE gave a presentation on the Triennial Review. They indicated that ammonia limits are becoming more stringent because of water quality issues with mussels and snails. The question becomes how low the new limits will be and how they will apply to the City of Leavenworth. In other words, how much of a mixing zone will be assigned to the existing outfall. The other issues highlighted at the conference apply to nutrients. It has been shown that progress has been made with conversion to BNR, but it appears that it is



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LEAVENWORTH, KANSAS
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PHASED SITE LAYOUT

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APPROVED:
DATE:

PROJECT NO. 168597

FIG 2-1

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still not sufficient for meeting overall goals. The findings of the Nutrient Innovations Task Group (NITG) state that "current controls efforts are inadequate". The NITG conclusions were that more fully implemented point source controls and accountability for non-point sources is needed. A timeline for changes or conversion to numerical limits instead of goals for Kansas was not presented.

Given the vagueness of the regulatory schedule, it is reasonable to consider alternative methods for meeting nutrient removal goals. Before making a commitment to a specific process, it is recommended that the condition of the existing facilities be assessed. If the trickling filter media and structures have an estimated 10 years or more life, then other processes may be economical. As structures approach the end of their useful life, it will become more economical to abandon those aging structures and build new facilities.

The high cost items are the activated sludge basin and final clarifiers and these two processes are interlinked. Replacing the final clarifiers is a key issue. If the conversion to activated sludge occurs immediately, the two existing shallow final clarifiers must be replaced. The activated sludge system will operate at a higher SRT than can be accomplished with the existing shallow clarifiers, and consequently, the operating MLSS concentration will be initially in the 2,500 mg/L range and up to 3,500 mg/L at design loads. This higher operating MLSS concentration is the reason that the two existing shallow final clarifiers must be replaced.

Depending on the time period and age of the existing facilities, activated sludge could be lower cost than other processes which might continue to utilize the trickling filters. While the activated sludge system equipment is significant in terms of capital costs (i.e. MLSS recycle pumps and additional blowers) it is likely a lower expense when compared to the cost of a new structure required for maintaining the existing trickling filters (i.e. intermediate pumping station).

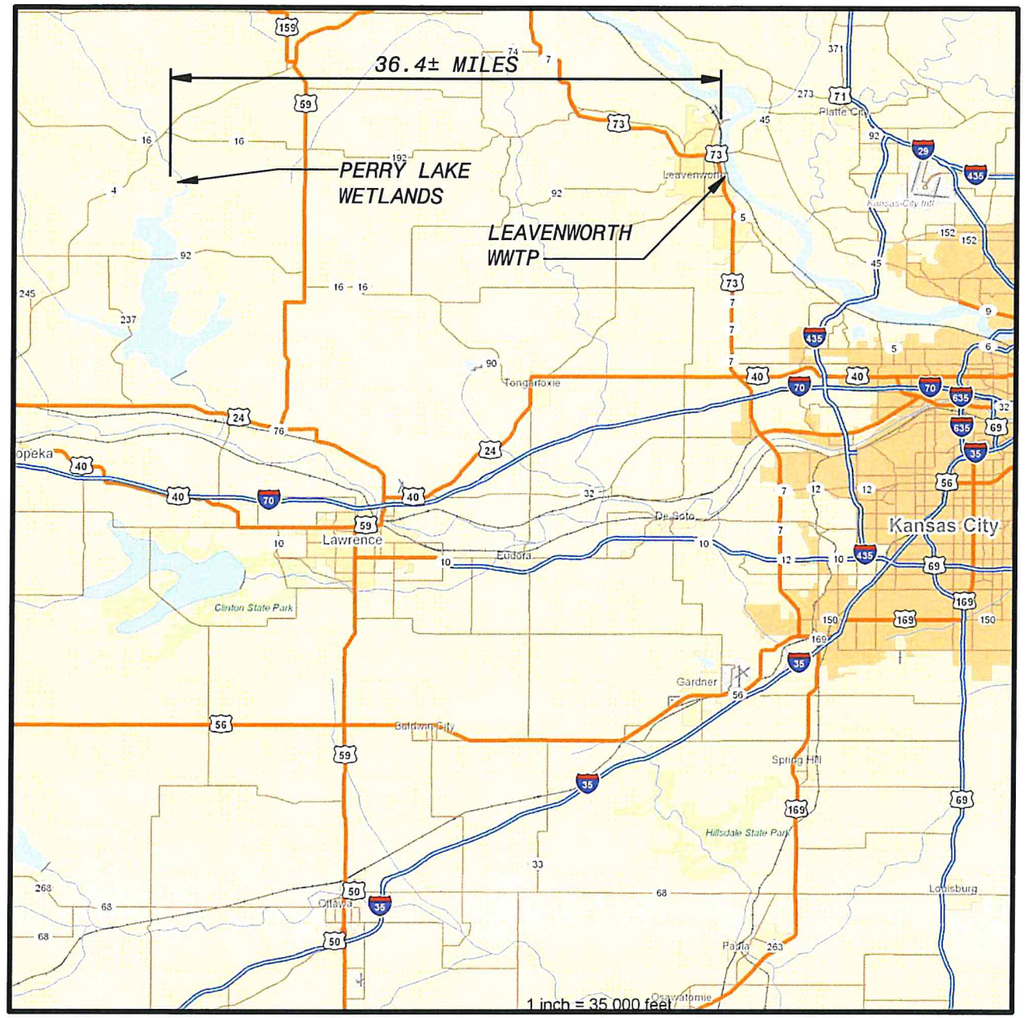
2.3 Nutrient Credit Trading

There are several potential alternatives for nutrient trading, however, at this time KDHE has not endorsed nor developed rules for any type of nutrient trading. There are possible external and internal nutrient trading possibilities. The external trading would involve the City of Leavenworth and at least one other outside community. This could be similar to one of the successful nutrient trading policies used on the East Coast. The other opportunity is internal nutrient trading. While the nutrient trading concept is similar, the trading is all practiced within the confines of the City of Leavenworth. Each approach will be discussed separately in the following paragraphs.

2.3.1 External Trading

The concept of external trading assumes that "Community A" has invested in nutrient control that has gone beyond what the regulators are requiring. In essence, "Community A" has removed more nutrient mass from the watershed, making it possible for "Community B" to do less nutrient removal if they can buy the excess removal, or nutrient credits, from the first community. By investing in nutrient removal, "Community A" has created a market to sell nutrient credits to other communities. It is assumed that KDHE will require all communities to eventually install nutrient removal processes; however, the nutrient credit system can allow communities to delay investment in nutrient removal until a time that it is more fiscally prudent for them to make this large investment.

Point Source Control. This argument for credit trading is usually associated with upgrading a WWTP for nutrient control. Designing for nutrient removal Goal Level 2 or 3 will usually go beyond what KDHE requires for initial conversion to BNR systems and result in removing more nitrogen and phosphorus than required. These nutrient credits can be sold to other communities. Connecticut has been practicing this type of credit trading for nitrogen for several years, and this program has been considered successful by the State and the EPA.



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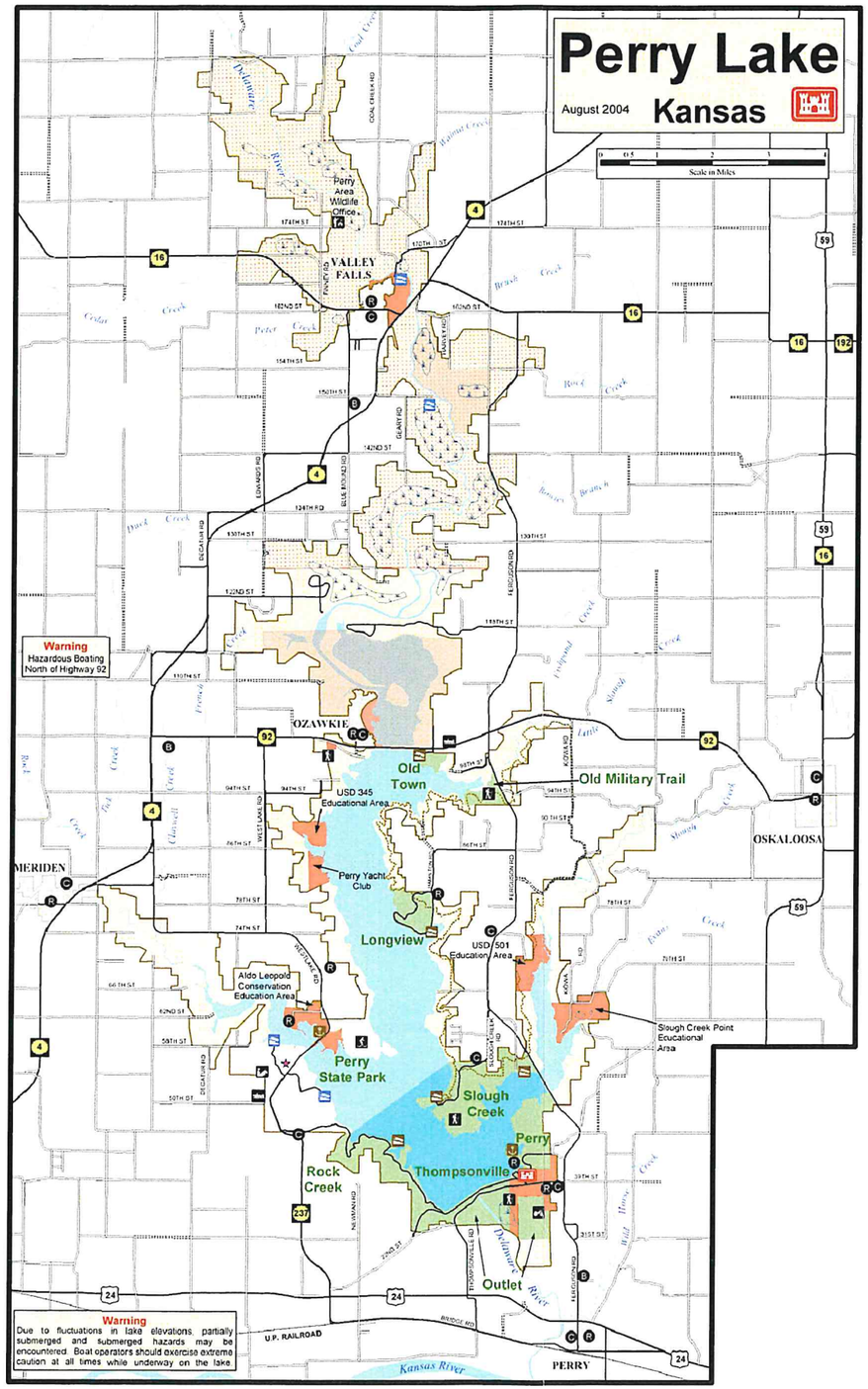
1"=10 MILES

VICINITY MAP



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COLLECTION SYSTEM UPDATE

VICINITY MAP

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FIG 2-2
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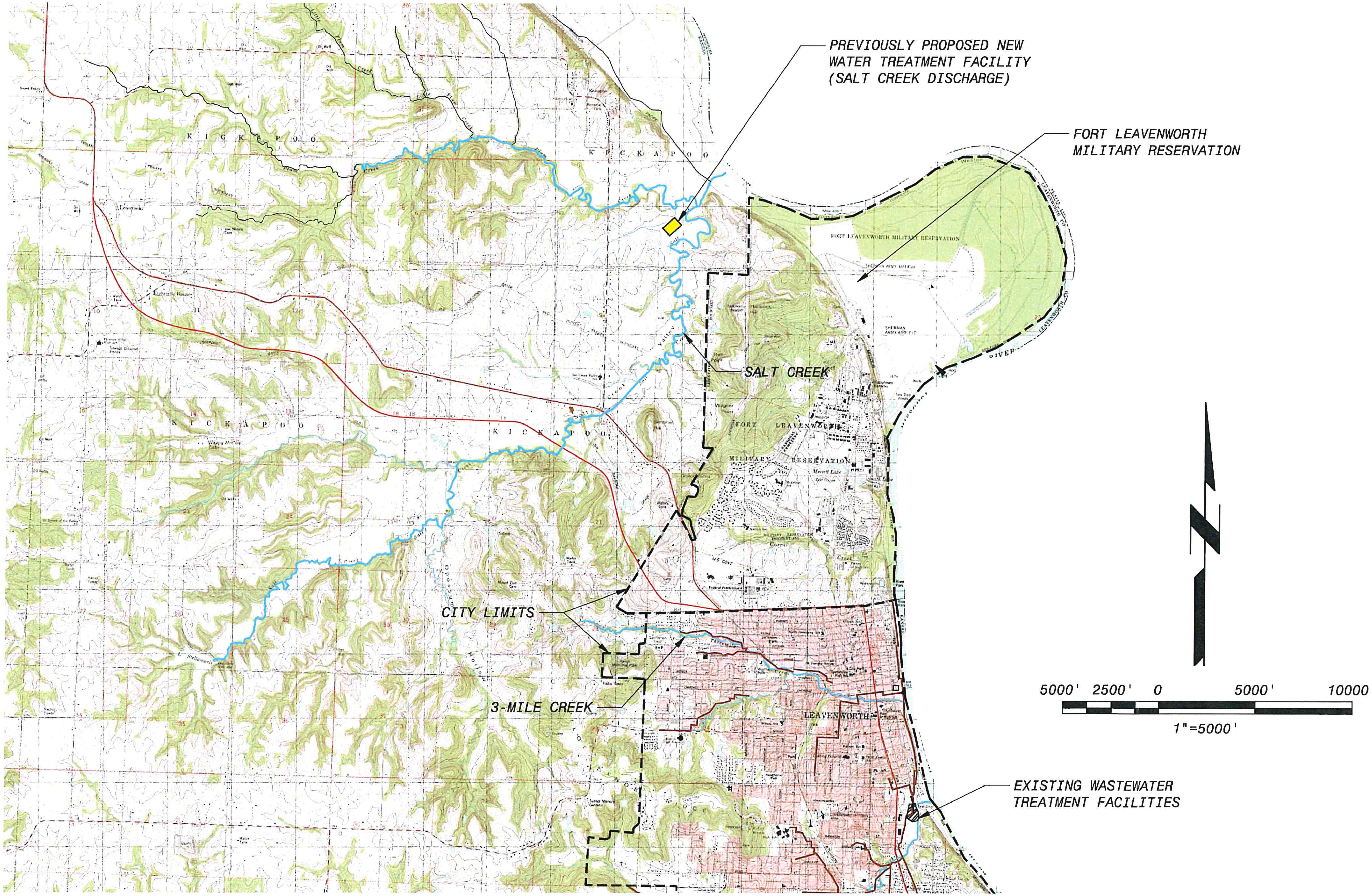
Non-Point Source Control. Non-point source control is more difficult to quantify but is just as important to achieve the reductions in nutrients to the Gulf of Mexico desired by the regulatory community. Programs to reduce the nutrient run-off from farmland have proven to be successful. Therefore, reducing the contribution from non-point sources may in some communities result in greater overall reduction of nutrients than from point source discharges.

The use of wetlands and other nutrient control approaches can reduce the mass of nutrients to a receiving stream. Quantification may be more difficult, but can be accomplished. It may be necessary to define a sampling program and get both KDHE and the EPA buy-in to prove the nutrient reduction from these non-point source control programs. These alternative control approaches can offset or replace the nutrient control required at a WWTP. Again, removing more nutrients than needed to meet local nutrient reduction goals can create a surplus of nutrient credits to sell to others.

The wetland treatment alternative was discussed at Workshop No. 1. The wetlands under consideration are located north of Perry Lake (which is approximately 36.4 miles west of the City of Leavenworth). *Figure 2-2* shows a vicinity map of Perry Lake. There are several reasons to consider wetlands for nutrient reduction, and a few of them are:

- Green technology
- Perceived lower cost – not necessarily true
- Better for environment
- Excellent public perception
- Opportunity for showpiece facility incorporating public water park / feature / wildlife refuge
- May get permitting concessions with wetland treatment – annual limits versus monthly average values
- Opportunity to impact / treat non-point source runoff and create more room for credit trading



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LOCATION MAP

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FIG 2-3

PRELIMINARY - NOT USED FOR CONSTRUCTION

Other considerations for wetland treatment include:

- Start-up Issues – Unlike other biological systems, wetlands for nutrient removal take time to mature. It may be 3 growing seasons before performance is meeting permit.
- Wetlands crops must be harvested even if it is only grass. Nitrogen can be denitrified (vented to atmosphere) but phosphorus must be physically removed as part of a crop. As plants die, phosphorus is released back to the water.
- Berms are not maintenance free
    - Must mow regularly to keep weeds down and must inspect regularly
    - Muskrats and other burrowing animals are a danger to berm integrity
    - Must hunt / trap unwanted burrowing animals or berms will fail
- Winter operation – May have to hold water till ice cover melts to ensure permit compliance.

Several scenarios were reviewed for various treatment goals and populations. In general, the different scenarios required between 2,900 and 16,600 acres of wetlands for adequate nutrient removal. One key issue is that to keep the wetlands sizes down, a mechanical WWTP is needed ahead of the wetlands. Under some scenarios considered, the mechanical WWTP was needed for removal of BOD and TSS, and for others the mechanical plant must nitrify. The need for mechanical treatment, the large amount of land required, and the distance from the plant (36.4 miles) make this alternative fairly unattractive from a cost standpoint.

2.3.2 Internal Trading

Internal trading of credits can be used if a community has more than one WWTP. The key to the successful argument with KDHE is to get them to recognize that the

nutrients are a regional issue and not a point source water quality issue. If KDHE will view Leavenworth as being within a bubble and what is important is the total mass load discharged from Leavenworth as a community, then one treatment plant can be designed to remove nutrients to a higher level while the other plant removes nutrients to a lesser degree. This approach will allow communities to invest in their new treatment facilities and continue to operate their older facilities with minimal additional investment. The issue here is fiscal spending responsibility. Prematurely replacing existing facilities may not be justifiable during these difficult economic times, and upgrading aging facilities may not be a sound fiscal investment either. The existing facilities may reach the end of their useful life before the newer add-on processes.

Leavenworth operates a trickling filter facility that has considerable remaining life or treatment value. There are other process methods to remove nutrients, but the City cannot afford to replace the facility at this time. Therefore, this Master Plan Update will describe reuse of those existing facilities for their useful life.

The City has been considering a second wastewater treatment plant site in the Salt Creek Watershed. *Figure 2-3* shows the location of the previously proposed new treatment facility in the Salt Creek watershed. A second facility opens up the possibility of internal nutrient trading. The new facility at Salt Creek could be designed to remove more nutrients, meeting Goal Level 2 or 3, which would reduce the amount of nutrient mass to be removed at the existing trickling filter facility. Black & Veatch developed a mass balance model to determine an optimum flow split and quality of treatment at the two facilities.

The mass balance model uses the same raw wastewater quality and assumes a level of treatment at the new and existing facilities. The model then mathematically recombines the two flows into a single discharge to the environment. This is shown schematically but is not necessarily physically recombined. The model was run to examine Goal Level 1, 2 and 3. The basic model shell is shown in *Figure 2-4*. The model includes a flow split between the existing facility and the new facility. The effluent quality out of the new and existing facility is selected and the model calculates the total

effluent mass for comparison to the allowable effluent mass based upon a set permit limit or goal level.

Several observations come to light from this mass balance. The first observation is that the new facility must be designed to produce an effluent quality better than Goal Level 1, which is 8 mg/L TN and 1.5 mg/L TP, in order to offset the higher levels of nutrients being discharged by the existing plant. The second observation to address is that the existing facility must be upgraded to remove some nitrogen for the flow split to be reasonable. The effluent from the existing plant must have less than 15 mg/L TN for the existing plant to treat at least 1 mgd of primary effluent. Removal of TN also implies that the facility must also be upgraded to fully nitrify, with less than 1 mg/L ammonia as N in the effluent stream. The existing plant must also continue to discharge an effluent TP of 2.5 mg/L or less. If needed, iron can be added to the primary clarifiers to reduce the TP concentration to the existing facility. The limiting factor is TN control.

Figures 2-5, 2-6 and 2-7 show the results of the mass balance for a 4.4 mgd base flow which is comparable to the current average flow. These three figures show that as the effluent from the new facility is pushed to lower nutrient concentrations, more flow can be processed at the existing facility. If the new facility is designed to meet Goal Level 3, the flow split between the new and existing facility is approximately 60/40 (2.6 mgd to the new facility and 1.8 mgd to the existing). Additional runs were made to examine design flows to 5.5 mgd average flow as shown in *Table 2-2*.

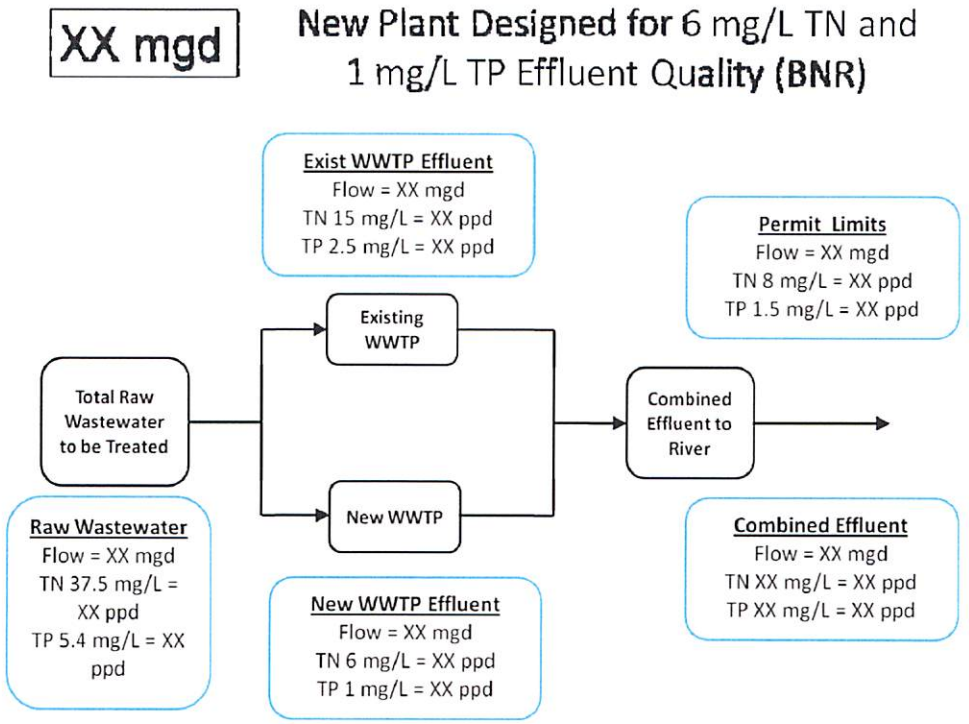


Figure 2-4 Mass Balance Model for Effluent Credit Trading for Two Leavenworth Treatment Facilities

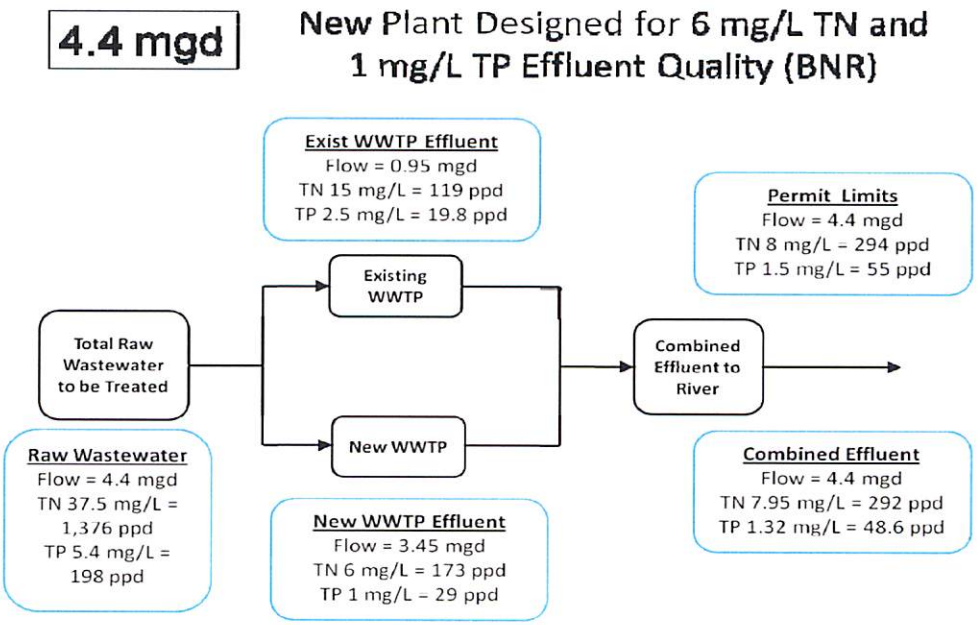


Figure 2-5 Mass Balance Model for a 4.4 mgd Design Flow – New Plant at 6 mg/L TN and 1 mg/L TP

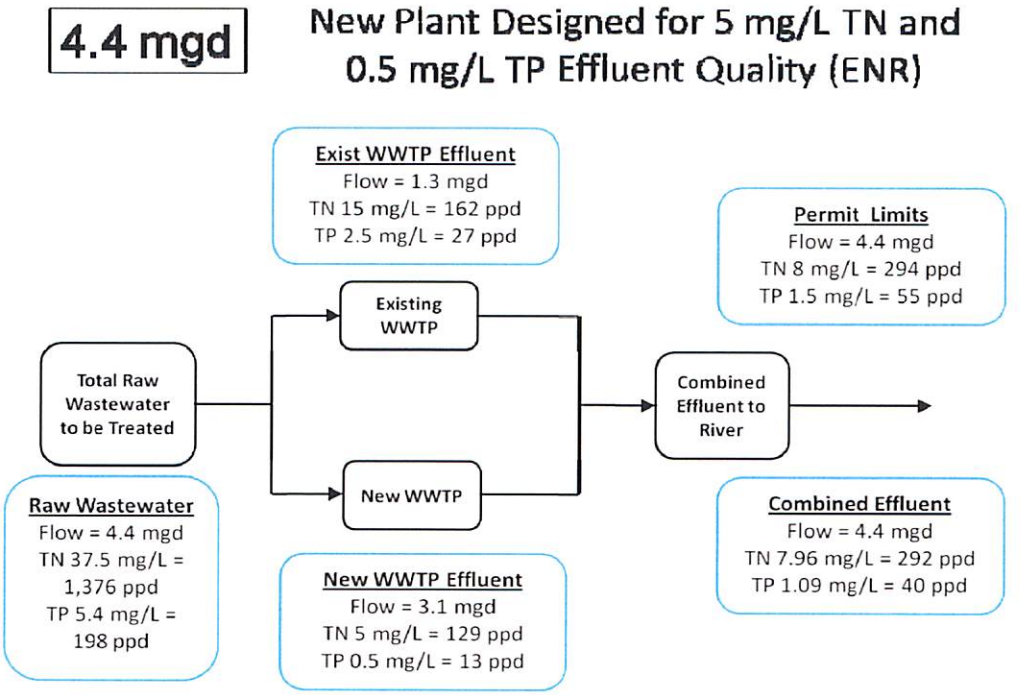


Figure 2-6 Mass Balance Model for a 4.4 mgd Design Flow – New Plant at 5 mg/L TN and 0.5 mg/L TP

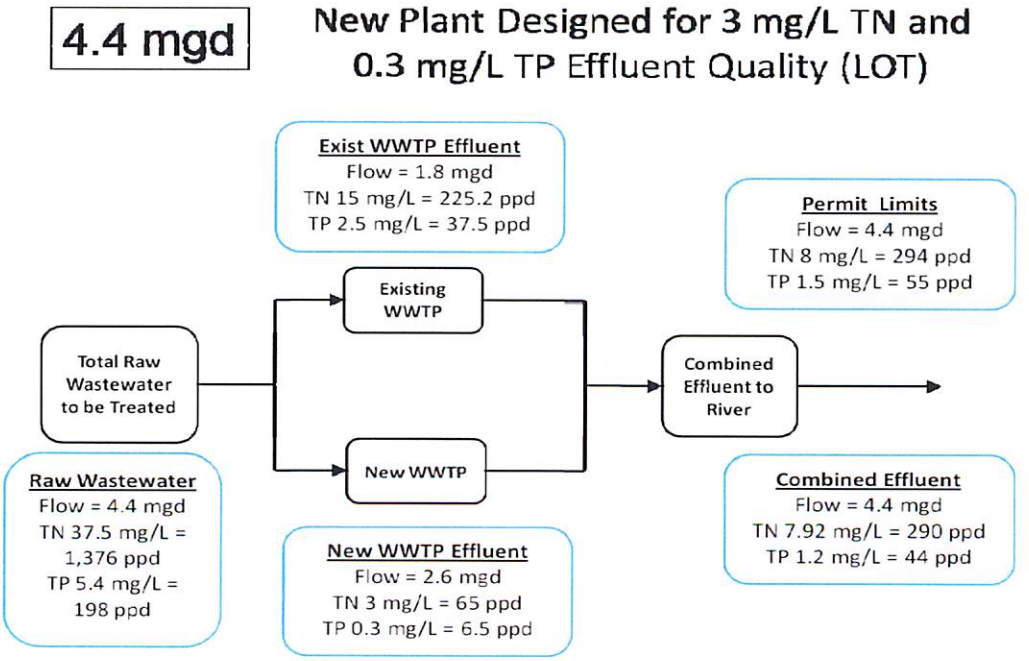


Figure 2-7 Mass Balance Model for a 4.4 mgd Design Flow – New Plant at 3 mg/L TN and 0.3 mg/L TP

Table 2-2
Summary of Results from the Nutrient Credit Trading Model

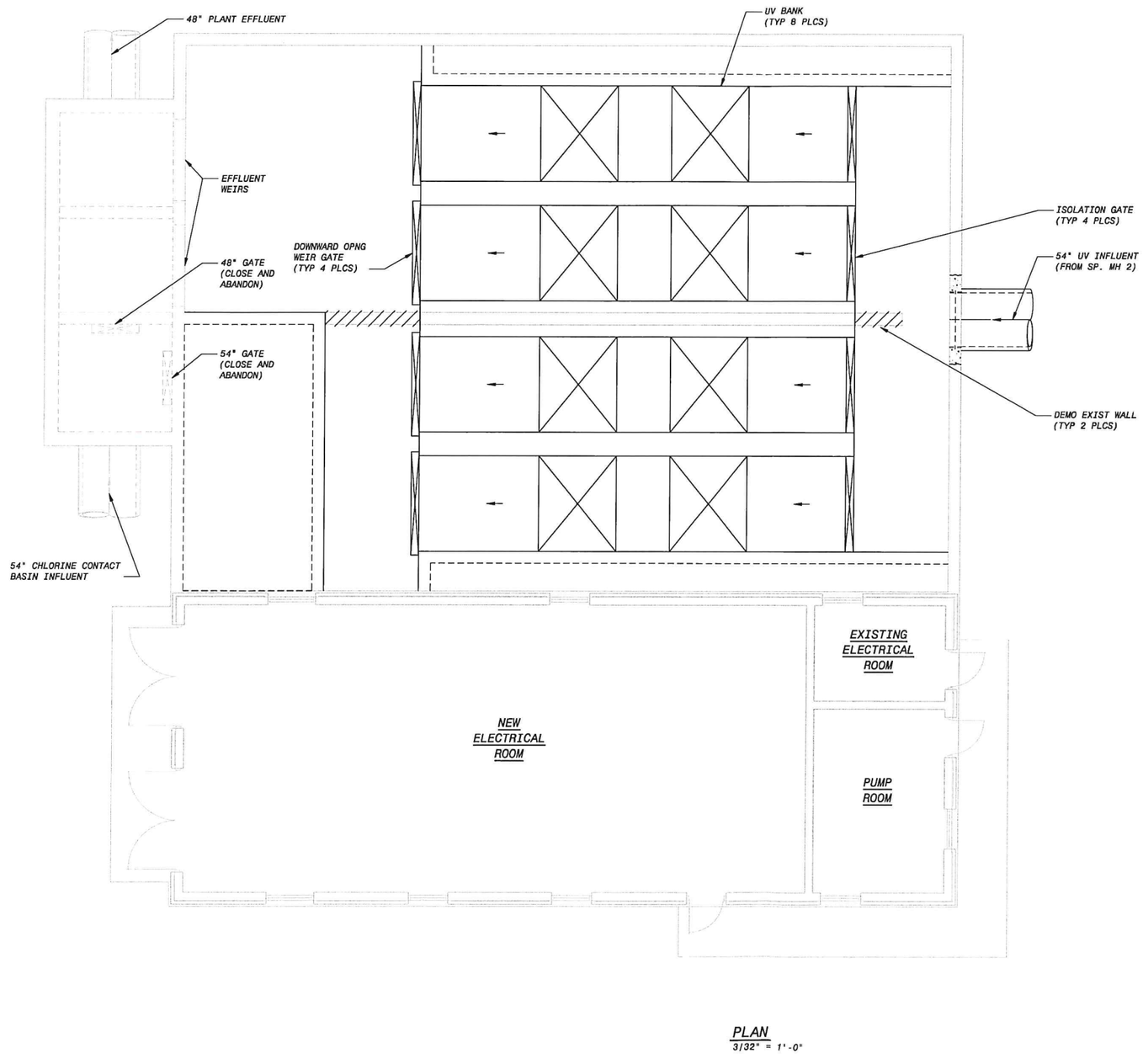
Design Flow	Existing WWTP[1]	New WWTP		
mgd	mgd	mgd	TN, mg/L	TP, mg/L
4.4	0.95	3.45	6	1
4.4	1.3	3.1	5	0.5
4.4	1.8	2.6	3	0.3
4.75	1.05	3.7	6	1
4.75	1.35	3.4	5	0.5
4.75	1.95	2.8	3	0.3
5	1.1	3.9	6	1
5	1.5	3.5	5	0.5
5	2.05	2.95	3	0.3
5.5	1.2	4.3	6	1
5.5	1.65	3.85	5	0.5
5.5	2.25	3.25	3	0.3

Notes:
1. Existing WWTP must be upgraded to fully nitrify and remove TN to 15 mg/L or less

In summary, the key issues for internal nutrient trading between two plants are:

- Existing WWTP must have some upgrades to remove ammonia to less than 1 mg/L as N
- Existing WWTP upgrades must also include nitrate removal to produce an effluent of less than 15 mg/L TN
- Existing WWTP must continue to reduce the TP concentration to less than 2.5 mg/L as P
- The new WWTP must be designed to reduce nutrients to less than 6 mg/L TN and 1 mg/L TP
- As new WWTP effluent TN and TP concentrations are reduced from Goal Level 1 to Goal Level 2 to Goal Level 3, the new WWTP design flow capacity is reduced

As the new WWTP produces a lower TN and TP concentration, more flow can be processed through the existing WWTP. Basically, as the new WWTP effluent quality improves, the new WWTP design flow capacity requirement is reduced. Even though the capital cost for the new WWTP increases as the effluent quality is improved (designed to produce lower concentrations), the size of the facility can be reduced.



PLAN
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UV LAYOUT

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FIG 3-17

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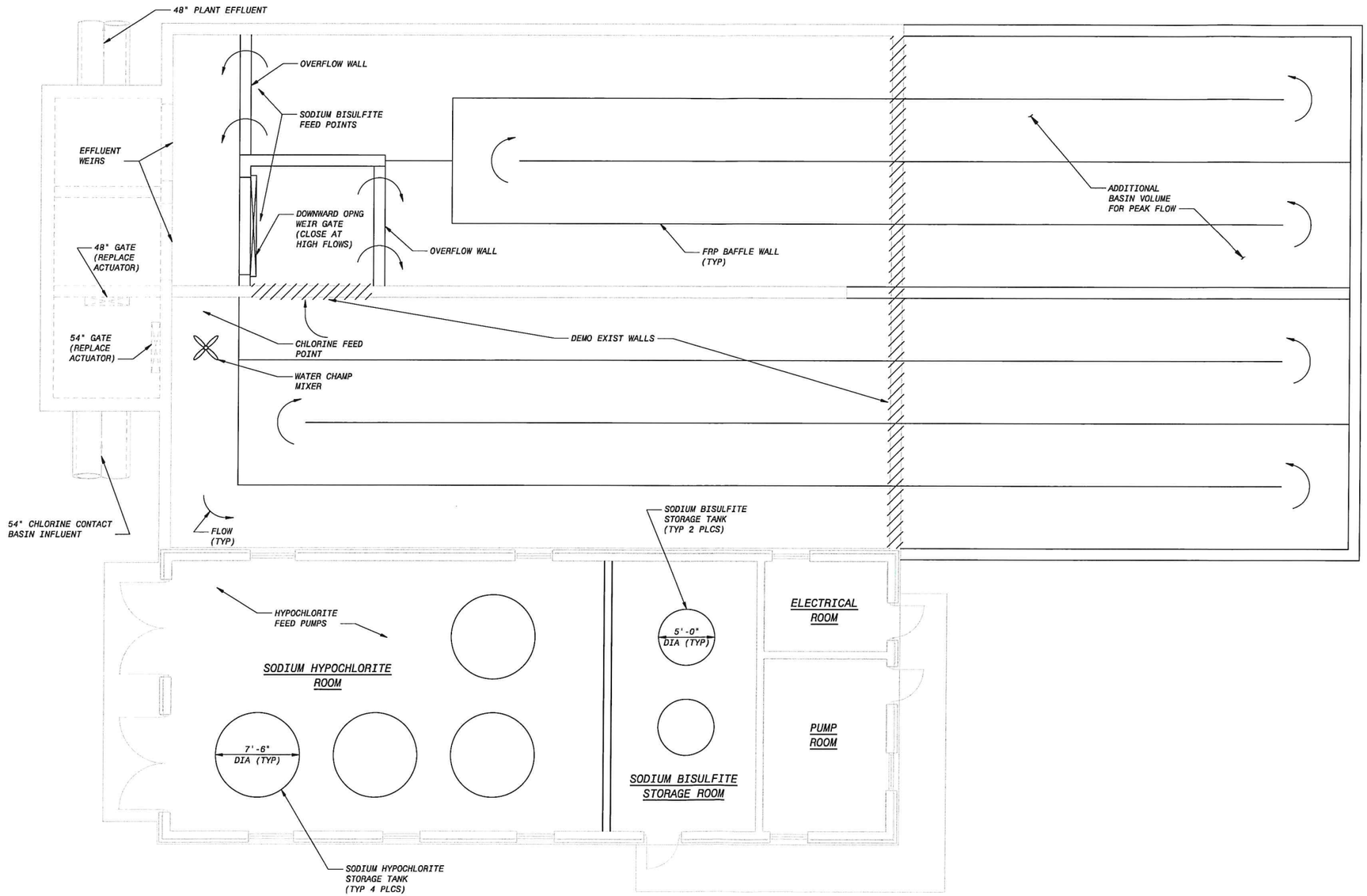

PLAN
3/32" = 1'-0"

PRELIMINARY - NOT FOR CONSTRUCTION

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Kansas City, Missouri

LEAVENWORTH, KANSAS
MASTER PLAN & COLLECTION SYSTEM UPDATE

CHLORINE CONTACT BASIN LAYOUT

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

PROJECT NO.
168597

FIG 3-18

SHEET OF

FD5000
DS5000

3.0 Disinfection Alternatives

3.1 Purpose of Study

The Kansas Department of Health and Environment (KDHE) has established disinfection requirements for wastewater facilities that discharge to receiving waters in the State of Kansas. The City's current permit mandates the disinfection of treated effluent from April through October each year with facilities on line and able to disinfect by December 31, 2012. The purpose of this study is to provide a recommendation for implementing disinfection facilities.

The objectives of this assessment include:

- Review of sodium hypochlorite disinfection
- Review of UV disinfection
- Evaluation of non-economic factors of the disinfection alternatives
- Presentation of the results of alternatives evaluation and cost comparisons
- Selection of recommended disinfection approach

3.2 Background

The purpose of this section is to present disinfection regulatory requirements, results of previous studies, and provide a basis for selection of the disinfection alternatives to be considered for further study.

3.2.1 Disinfection Regulatory Requirements

The Leavenworth WWTP has an existing chlorine contact basin and building for storage of chlorine gas cylinders. The basin has not been used since its construction and the building is now being used for storage. KDHE has established two sets of effluent disinfection requirements for the WWTP. The Escherichia coli (E. coli) limit indicated in the final permit is a monthly geometric mean of 160 cfu/100 mL from April through October and 2,358 cfu/100 mL from November through March. The permit requires the final limits for E. Coli for the current WWTP be met by December 31, 2012.

3.2.2 Future Regulations

A review of future regional and federal regulations pertaining to disinfection was made to ensure flexibility of the disinfection system to be installed at the plant. Currently, the permit lists a monthly geometric mean for the final E. coli limitations based on the schedule of compliance for both winter and summer seasons. Regionally, the EPA is requiring that States establish either weekly maximum or maximum not to exceed levels. In addition, the EPA is requesting that States examine (lower) the risk values that have been used to establish bacteria permit limits.

Nationally, the EPA will be proposing new guidance for the establishment of bacteria limits in NPDES permits in 2012. Early indications are that limits will be established for Enterococci (instead of E. coli), partly due to the fact that the EPA proposed Enterococci in 1986, and States did not adopt the guidance. In addition, new analytical testing requirements may be proposed by the EPA in 2012 that use DNA fingerprinting.

It is recommended that the City purchase analytical testing equipment to conduct bacteria testing on site. At this time, there appears to be room in the existing laboratory for this analytical equipment. The plant staff will need to receive training and opportunities for conducting these tests before the disinfection facility becomes operational in 2012.

3.2.3 Design Flow Rates

Table 3-1 presents the design flow rates that were used in the disinfection evaluations, which were based on population growth projections and historical peaking factors.

Table 3-1 Design Flow Rates for Disinfection Evaluations			
	2010	**2020**	**2030**
Population	34,000	36,380	46,000
Flow			
Average Day, mgd	4.36	4.67	5.90
Max Month, mgd	7.63	8.15	10.30
Peak Day, mgd	12.39	13.26	16.76
Peak Hour, mgd	27.50	29.43	37.24

3.3 Technology Overview

This section presents the various disinfection technologies evaluated to meet the disinfection needs of the City of Leavenworth. The following technologies were considered for providing disinfection of effluent at the WWTP:

- Ultraviolet light
- Bulk sodium hypochlorite and sodium bisulfite

3.3.1 Ultraviolet Light

Ultraviolet (UV) disinfection differs from chlorine disinfection in that it is a physical, not a chemical, disinfectant. UV radiation is electromagnetic energy lying within the spectrum of sunlight, but which is outside the wavelength range of visible light. UV light between the wavelengths of 235 and 270 nanometers (nm) has been found to exhibit biocidal action on bacteria and viruses present in water, wastewater, and process water. This biocidal action is the basis for using UV radiation as a physical disinfectant in the municipal wastewater industry.

UV radiation is readily absorbed by deoxyribonucleic acids (DNAs) in certain pathogens found in municipal wastewater. When this energy is absorbed, the pathogen's molecular structure is altered, resulting in an inability to replicate. While this effect can be reversed (referred to as reactivation) under certain conditions, UV radiation has been proven effective in the disinfection of municipal wastewater.

Over the past several years, UV disinfection systems have gained popularity resulting in the industry continually researching new applications of the state-of-the-art

technology. Since 1990, more sophisticated and reliable UV systems that operate much more cost effectively have been marketed to the municipal wastewater industry and have been installed in many plants, as effluent chlorine residual limits become tighter. There are many viable UV systems available on the market today, with new systems and changes in the technology occurring almost on a daily basis as the market responds to user demands. The systems may be broken down into the four major classifications as shown in *Figure 3-1*. These classifications are based on the type and source of UV light and type of output.

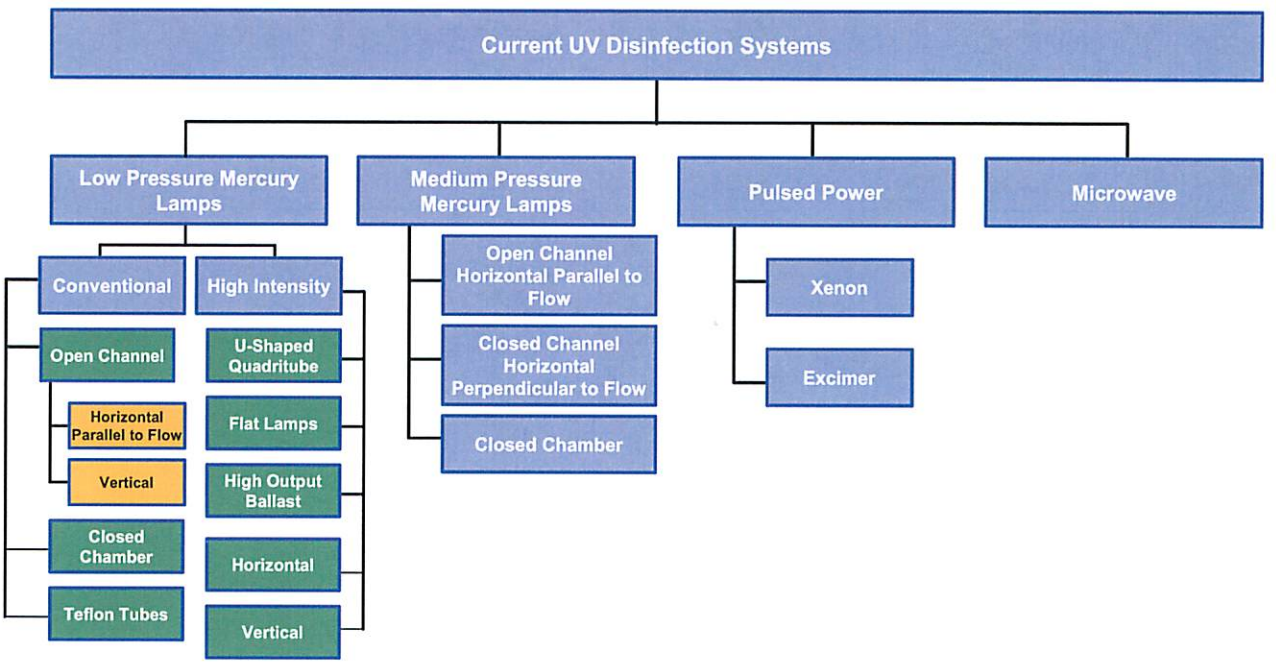


Figure 3-1 Current UV Disinfection Systems

3.3.2 Low Pressure, High Intensity Lamps

A newer technology which has become popular is the low pressure, high intensity (LP-HI) lamp introduced by three manufacturers in the last decade. This lamp configuration bridges the gap between low and medium pressure systems, requiring about one-third the number of bulbs compared to conventional low pressure systems, but three

times as many as medium pressure systems. Self-cleaning features are available on these systems.

All the major vendors (Trojan Technologies, Wedeco, and Ozonia) supply low pressure, high intensity systems. A low pressure, high intensity system is shown in *Figure 3-2.*

Figure 3-2 LP-HI UV System

3.3.3 Bulk Sodium Hypochlorite and Sodium Bisulfite

Sodium hypochlorite (NaOCl) is a liquid disinfection agent that has proven to be reliable in the inactivation of fecal coliforms, E. coli, and bacterial pathogens. It typically achieves performance levels equal to that of chlorine gas. Its effectiveness can be attributed to the fact that sodium hypochlorite disassociates in solution to form hypochlorous acid, which is the same disinfecting agent formed when chlorine gas is introduced into solution. A drawback is that sodium hypochlorite is a corrosive liquid, and therefore, operators must take handling precautions and regularly maintain the feed equipment.

Sodium hypochlorite can be delivered in bulk quantities at a concentration of 10 to 15 percent by weight, although 12.5 percent is most common. A 12.5 percent solution contains 1 pound of chlorine per gallon of solution. Liquid sodium hypochlorite will cause a slight increase in the pH of the finished water. The feed system consists of bulk storage tanks, metering pumps, and a calibration column used to pace the metering

pumps. Contact tanks are sized to provide adequate retention time for disinfection once the proper dose of sodium hypochlorite has been added. The Leavenworth WWTP already has existing contact basins for chlorine disinfection. There are no existing chlorine gas cylinders or bulk storage tanks on site. The existing chlorine contact basin has a limited capacity of 24.92 mgd at 15 minutes of detention time. Additional tank volume will need to be built to treat future peak flows.

The main drawback of sodium hypochlorite is its relatively high chemical cost compared to the cost of chlorine gas and its tendency to degrade over time as a function of product concentration, temperature, and exposure to sunlight. Degradation decreases the strength of the hypochlorite and consequently the effectiveness of disinfection.

Because its solution strength degrades over time, bulk quantities should not be stored for periods longer than 60 days. Storage tanks are typically sized to provide 15 to 30 days of storage for average flow conditions. Containment around the storage tanks is required for the event of a spill or leak. Storage in an air-conditioned environment and additional monitoring of the stored product is recommended to maintain product quality and proper dosing. Dilution of the delivered product reduces the rate of degradation and is typically recommended if storage time will exceed 15 to 30 days, depending on the temperature. However, dilution water requires a water softening system.

There are a number of issues associated with the use of sodium hypochlorite, one of which is crystallization. This can occur if the temperature of the storage tanks is not regulated. To minimize the formation of crystals, sodium hypochlorite tanks should be installed indoors.

Typically when a WWTP uses bulk sodium hypochlorite, dechlorination with bulk sodium bisulfite ($NaHSO_3$) is required. This chemical is typically delivered by tanker truck and stored in bulk tanks as a concentrated aqueous solution. Common delivery concentration is 38 percent sodium bisulfite. This concentrated solution is either diluted in mixing tanks and then fed to the system with metering pumps or fed directly with metering pumps. Since sodium bisulfite is a liquid solution, it is considered safer than sulfur dioxide, and the storage and feed systems are relatively simple. However,

sodium bisulfite is still classified as a hazardous material and must meet design requirements for secondary containment as listed in the codes. Sodium bisulfite is also prone to freezing during cold weather (freezing point is approximately 40° F) and requires heat tracing and insulation on tanks and pipes where exposed to the weather.

Use of bulk sodium hypochlorite is widely accepted as a safer disinfection alternative to chlorine gas. While the sodium hypochlorite chemical costs are high in comparison to chlorine gas, operational costs associated with compliance with Risk Management Plans (RMPs) and Process Safety Management (PSM) required for chlorine gas are eliminated for a bulk sodium hypochlorite system. Sodium hypochlorite is a corrosive liquid; however, chlorine in gaseous form is toxic and has a high tendency for dispersion, posing much greater safety risks to facility operators and the surrounding public.

Capital costs for the sodium hypochlorite system will be highly influenced by the cost to construct the necessary contact basins. Sodium hypochlorite chemical costs are higher than other systems such as chlorine gas and will be sensitive to rising fuel prices. Even considering these costs, sodium hypochlorite systems have been deemed cost competitive with other disinfection alternatives in evaluations completed by Black & Veatch (B&V). It is recommended that bulk sodium hypochlorite be carried forward as a disinfection alternative for further study and considered as a viable disinfectant.

3.4 Disinfection Testing Results

A series of bench-scale chlorine and UV disinfection tests were carried out at the B&V research facility between September 29 and October 21, 2010 to determine the optimum dosage of disinfectant required. Bench scale testing prior to design is important, since the design dose is highly dependent on effluent water quality. Typical design UV doses for municipal wastewater range from 20 - 45 mW-s/cm^2 and chlorine dose from 8-12 mg/L, which must be verified during the preliminary design stage through bench scale testing.

By far, the most important water quality parameter for designing the disinfection process is transmittance. Transmittance is a measure of how much UV light at a specific wavelength is absorbed by the wastewater. Suspended solids can shield organisms from exposure to the disinfectant, and color and organics can absorb the disinfectant, reducing its effectiveness to reach the micro-organisms. Conversely, the disinfection potential of a given disinfectant increases at higher transmittance.

3.4.1 Sample Collection and Bench-Scale Testing

Primary and trickling filter effluent grab samples were collected twice a week for four weeks and delivered to the B&V research facility where they were tested for UV and chlorine dose.

The plant has an online transmittance sensor, located after the final clarifier, which measures transmittance readings every two minutes. A summary of results is presented in *Figure 3-3*.

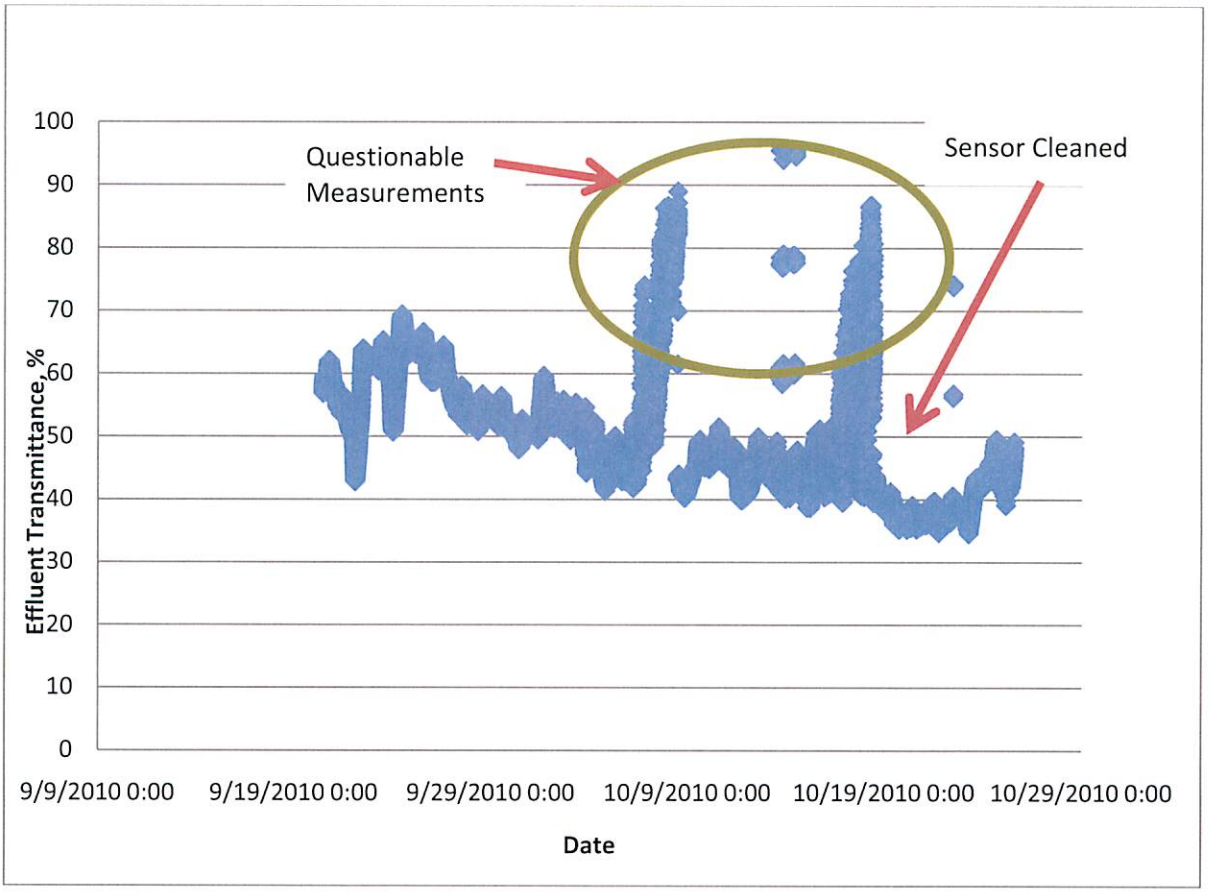


Figure 3-3 Leavenworth Secondary Effluent Transmittance Data

The average effluent UV transmittance measured at the plant was 48 percent with a T10 at 38 percent (10 percent of transmittance measurements observed were at 38 percent or below). The lowest transmittance measured by the sensor was 34 percent. A frequency analysis of effluent transmittance has been included as *Figure 3-4*.

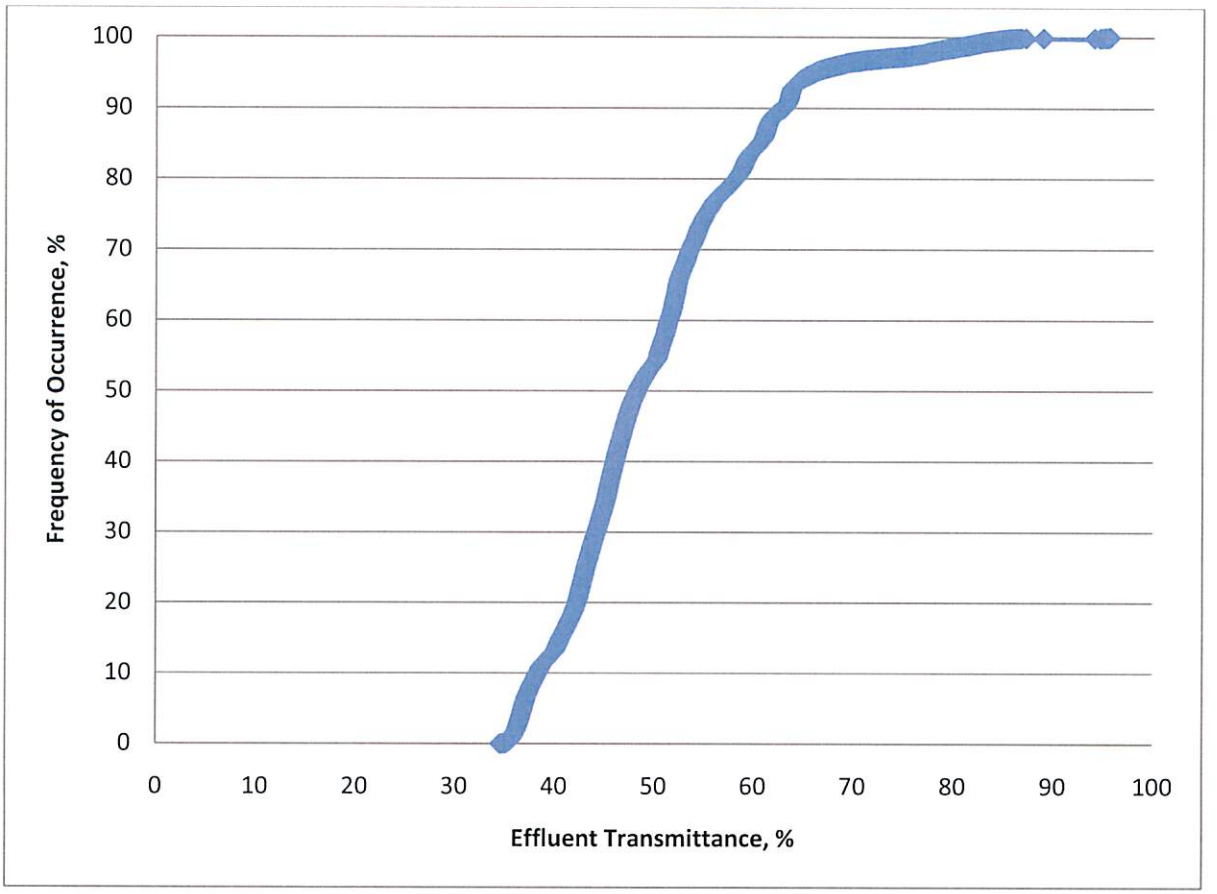


Figure 3-4 Frequency Analysis of Effluent Transmittance from On-line Sensor

Transmittance of the samples was also measured at the B&V facility with the help of a Spectrophotometer (shown in *Figure 3-5*). The average transmittance measured at the B&V research facility at a wavelength of 254 nm was 43 percent.

Figure 3-5 Spectrophotometer to Measure UV Transmittance

3.4.2 Bench Scale UV Test

The dose of UV light is calculated as the product of intensity and exposure time. For a given set of UV lamps, the intensity remains the same throughout the test; therefore, the time of exposure must be changed to vary the UV dose.

After the secondary effluent wastewater was treated with a predetermined amount of UV light, the samples were delivered to a local laboratory for bacterial analysis. During the bench-scale testing it was ensured that the composite samples were kept well mixed. However, if there were more solids in the UV influent, one of the grab samples may have contained more suspended solids than the others thereby interfering with the UV dose. The results from the lab were analyzed and are presented in *Figures 3-6 and 3-7.*

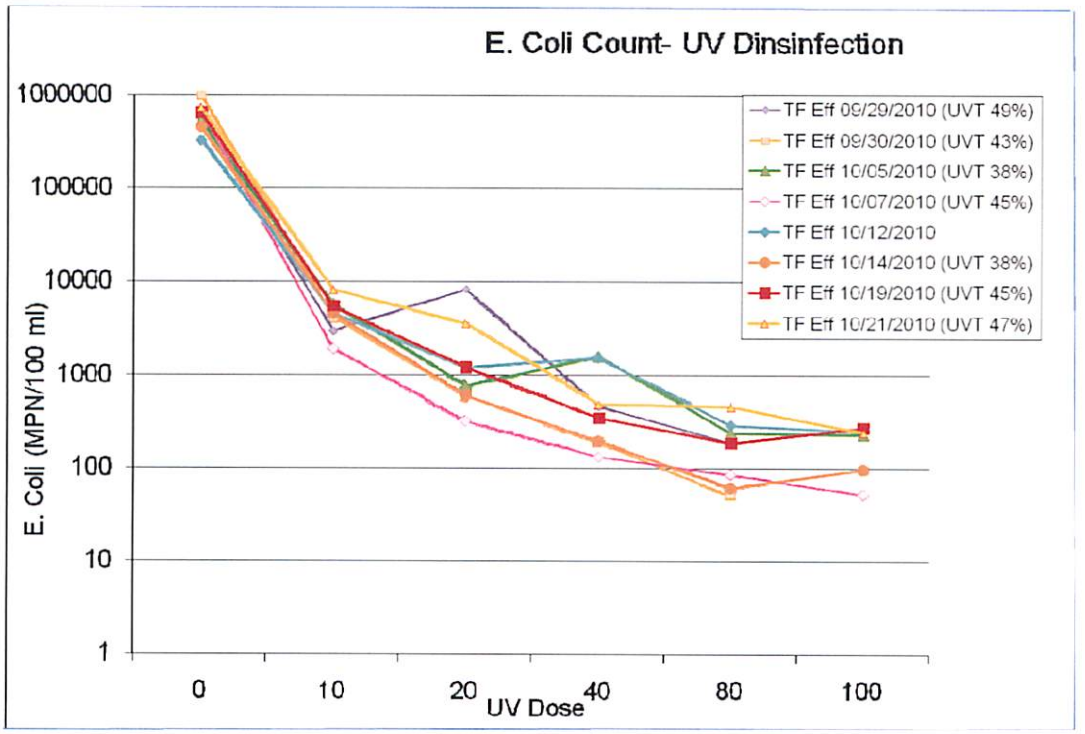


Figure 3-6 E. Coli Concentration in the UV Treated Samples

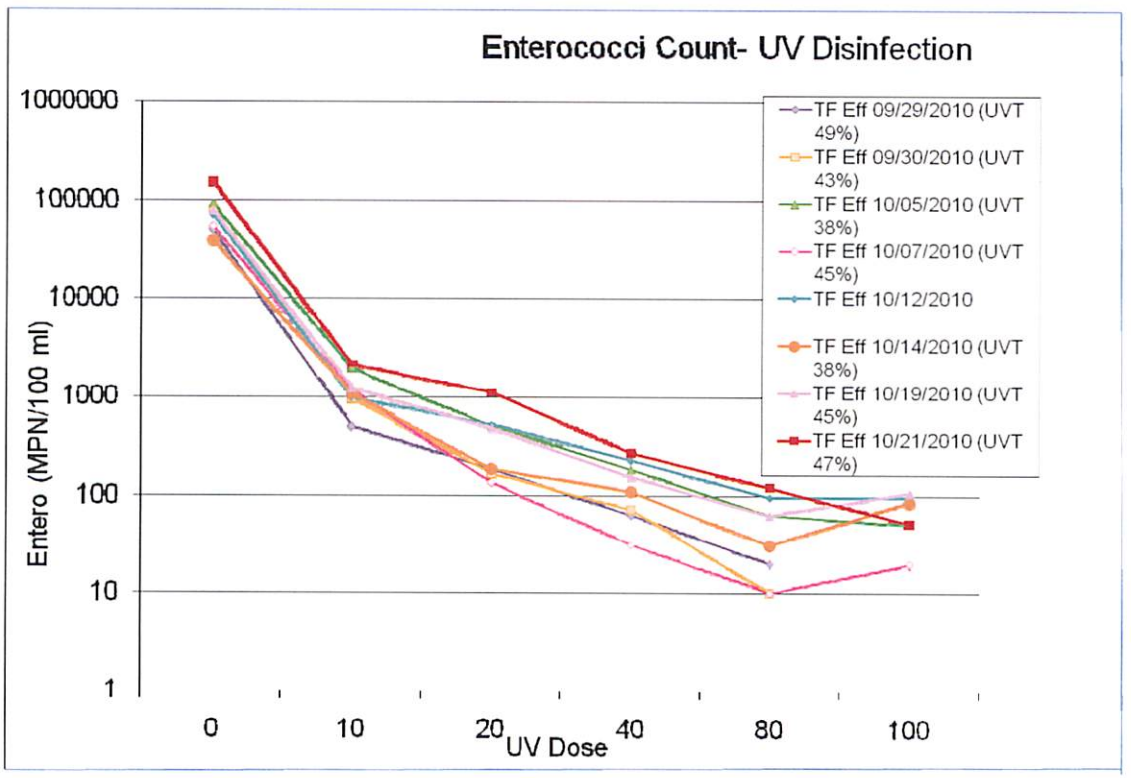


Figure 3-7 Enterococci Concentration in the UV Treated Samples

After the results from the first week of testing were analyzed, the UV dose was increased from 80 mW-s/cm^2 to 100 mW-s/cm^2 as the desired degree of disinfection was not achieved. This was helpful in reducing the concentration of E.Coli below the permit limits. However, in order to achieve the desired degree of disinfection with respect to Enterococci, the trickling filter effluent was filtered and then exposed to UV light. The results from this analysis are summarized in *Figure 3-8*. This figure compares the concentration of Enterococci before and after filtration. At higher doses of UV light, there is a significant reduction in the bacteria concentration in the filtered effluent sample as there were not as many solids to interfere with the UV dose.

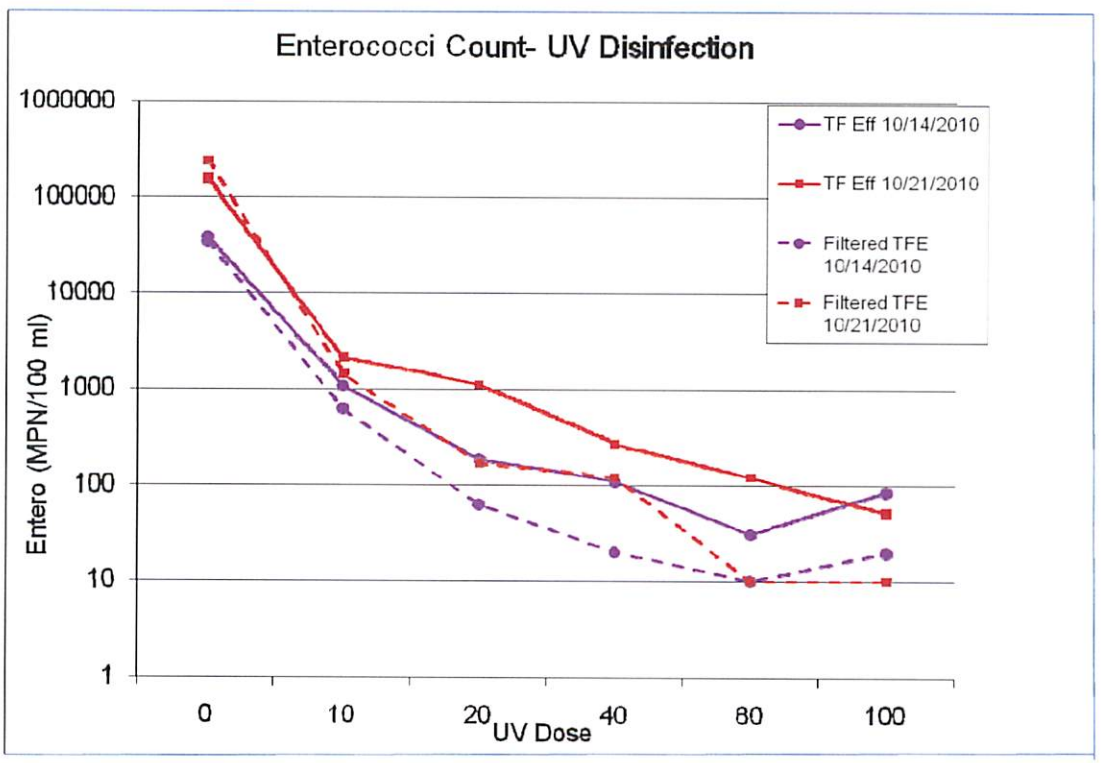


Figure 3-8 Comparing Enterococci Concentration for Filtered and Unfiltered Samples

3.4.3 Bench Scale Chlorine Test

Similar to the UV dose calculation, the chlorine dose is figured by concentration and the contact time. Following Ten State Standards, most of the chlorine systems use a dose range of 8-12 mg/L. For the City of Leavenworth, a dose of 8 mg/L was initially used and the chlorine decay was observed over a time period of 16 minutes. HACH's total chlorine determination method was used to analyze the samples for residual chlorine. The tested samples were later sent to a local laboratory for bacterial analysis, and the results are summarized in *Figure 3-15* below.

After the first week of testing, the chlorine dose was increased to 10 mg/L to achieve a better degree of disinfection. The chlorine decay curves for primary and trickling filter effluent samples are presented in *Figures 3-9, 3-10, 3-11, 3-12, 3-13,* and *3-14* while the bacterial concentrations for a dose of 10 mg/L chlorine are presented in *Figure 3-15*. Although a better bacterial kill was observed at the higher chlorine dose, it was not adequate to reduce the Enterococci concentration to below the permit limits.

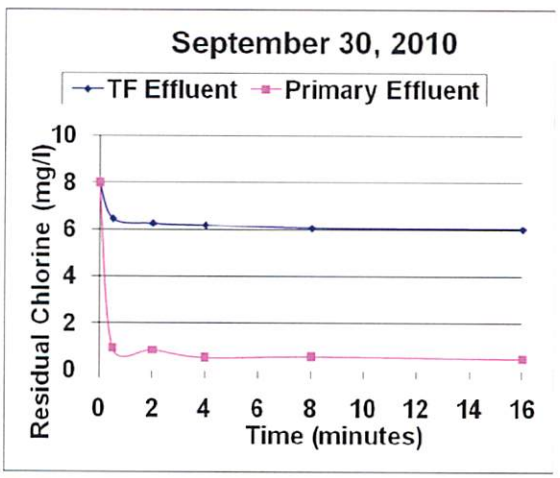


Figure 3-9

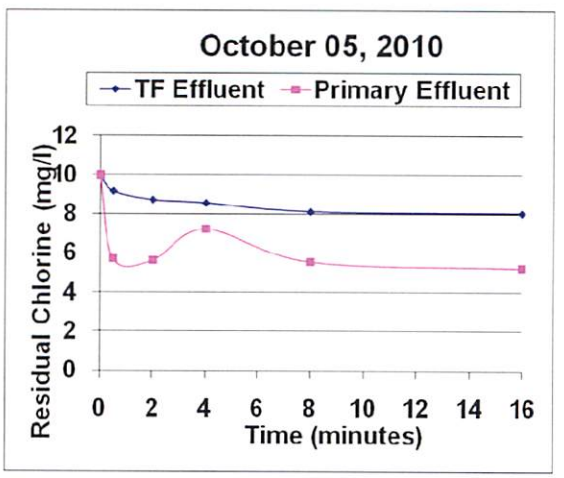


Figure 3-10

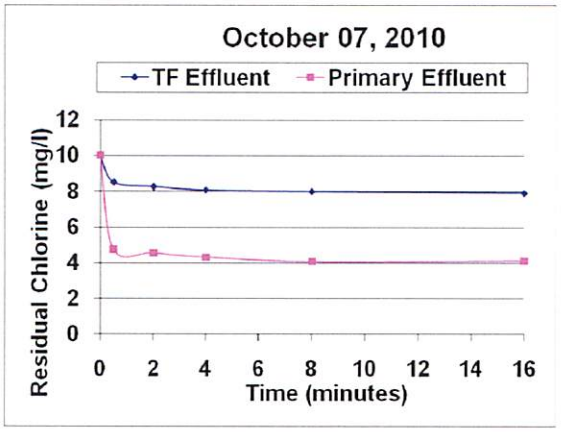


Figure 3-11

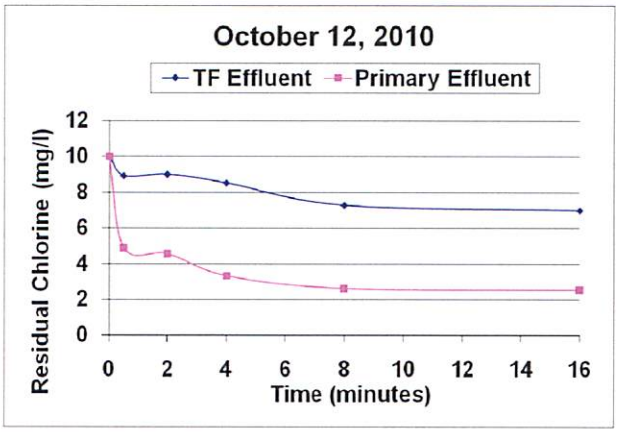


Figure 3-12

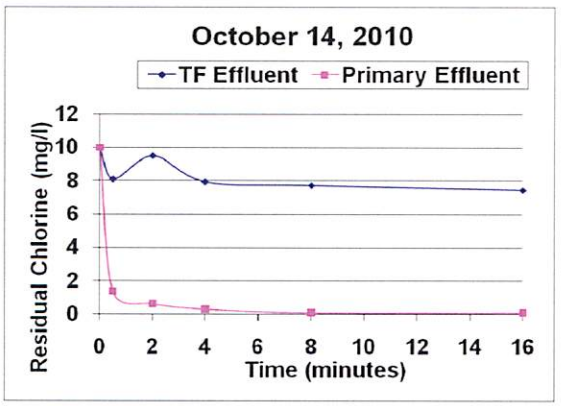


Figure 3-13

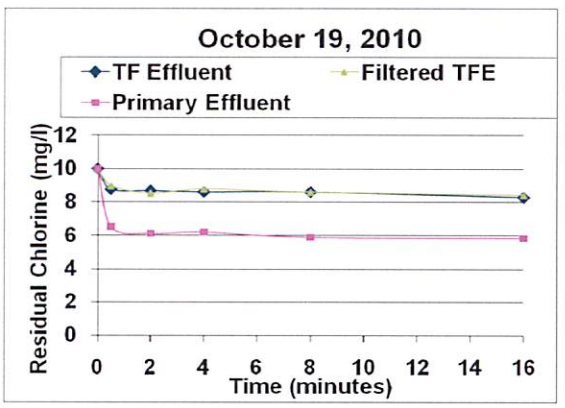
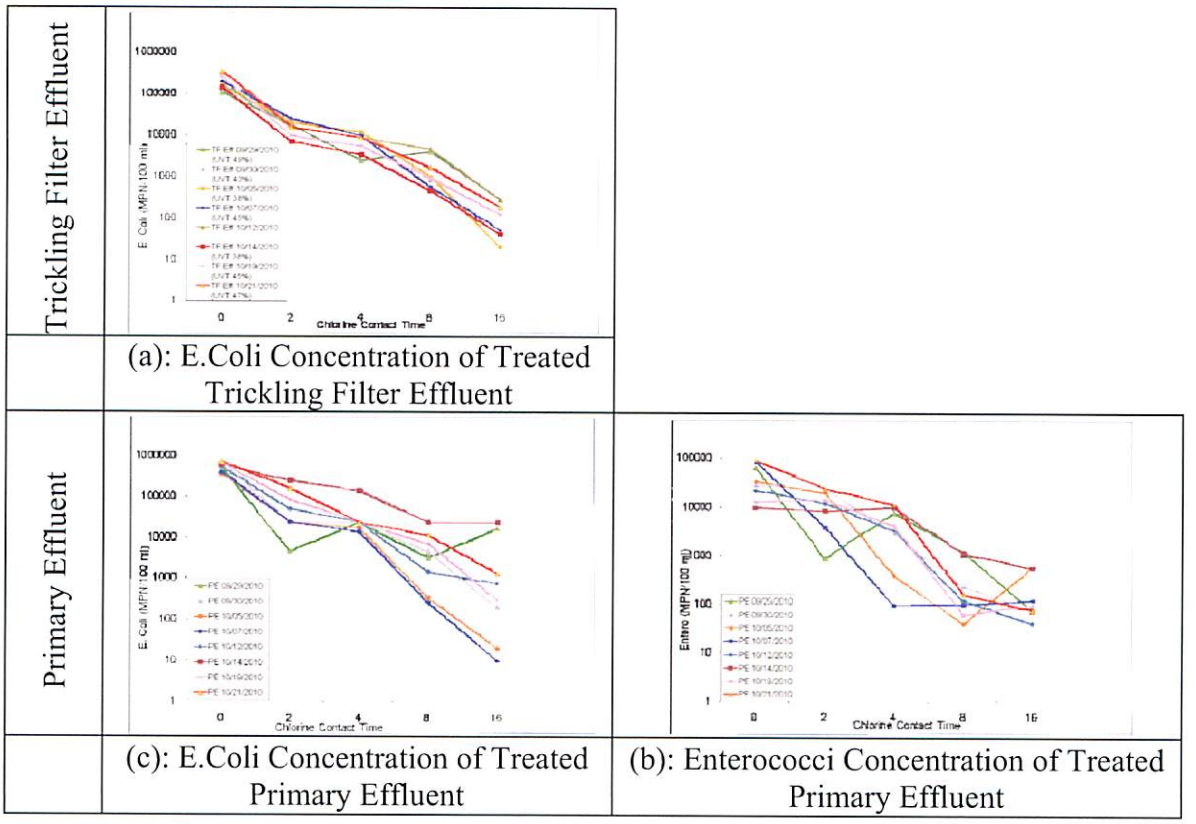


Figure 3-14



(a): E.Coli Concentration of Treated Trickling Filter Effluent

(c): E.Coli Concentration of Treated Primary Effluent

(b): Enterococci Concentration of Treated Primary Effluent

Figure 3-15 Bacterial Analysis for Treated Primary and Trickling Filter Effluent

In the third phase of the chlorine bench-scale testing, the final effluent samples were filtered and then dosed with 10 mg/L of chlorine. The decay curve was plotted and samples were sent to a local laboratory for bacterial testing. The bacterial analysis is presented in *Figure 3-16* and compared to decay curve for unfiltered samples. As there are fewer solids in the filtered effluent exerting chlorine demand, better bacterial kill was observed.

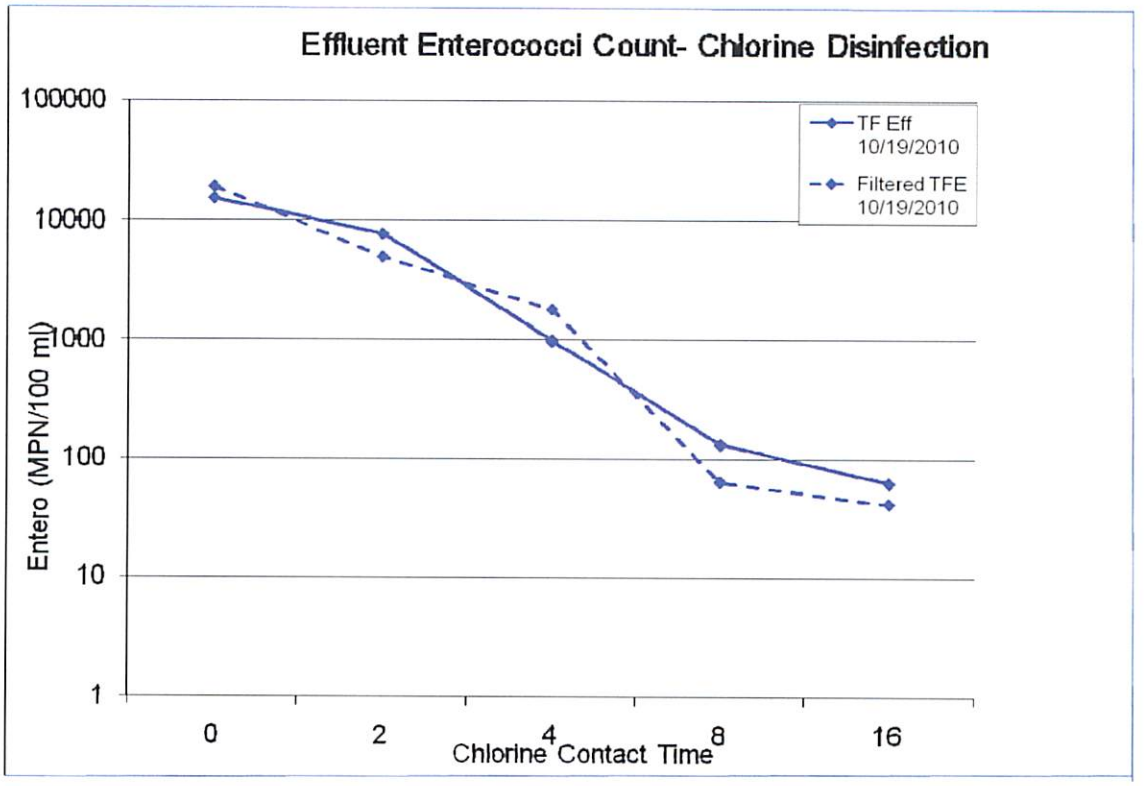


Figure 3-16 Comparing Enterococci Concentration for Filtered and Unfiltered Samples

Additional studies were completed to address the water quality found during the bench scale studies. One of the issues that was discovered during the bench scale study was an infestation of carp in the final clarifiers. It is believed that the presence of carp resulted in finer particles being discharged over the final clarifier weirs as well as higher bacteria counts. The City is currently in the process removing the carp from the clarifiers. In addition, studies were completed to determine if the addition of chemical prior to the final clarifier could result in an increase in effluent transmittance. The bench scale testing demonstrated that filtering the sample prior to disinfection improved the bacterial kill rate, however, it was determined that polymer could be used in lieu of filtration with similar results. The results of the chemical addition studies indicated that a small addition of polymer added before the clarifier would increase the transmittance to 50 percent.

3.5 Disinfection Alternatives

3.5.1 Alternative 1 - Ultraviolet Disinfection

Alternative 1 utilizes a single UV disinfection facility sized to treat a peak hour design flow of 37.24 mgd. The proposed facility layout is shown in *Figure 3-17.*

3.5.2 Design Criteria

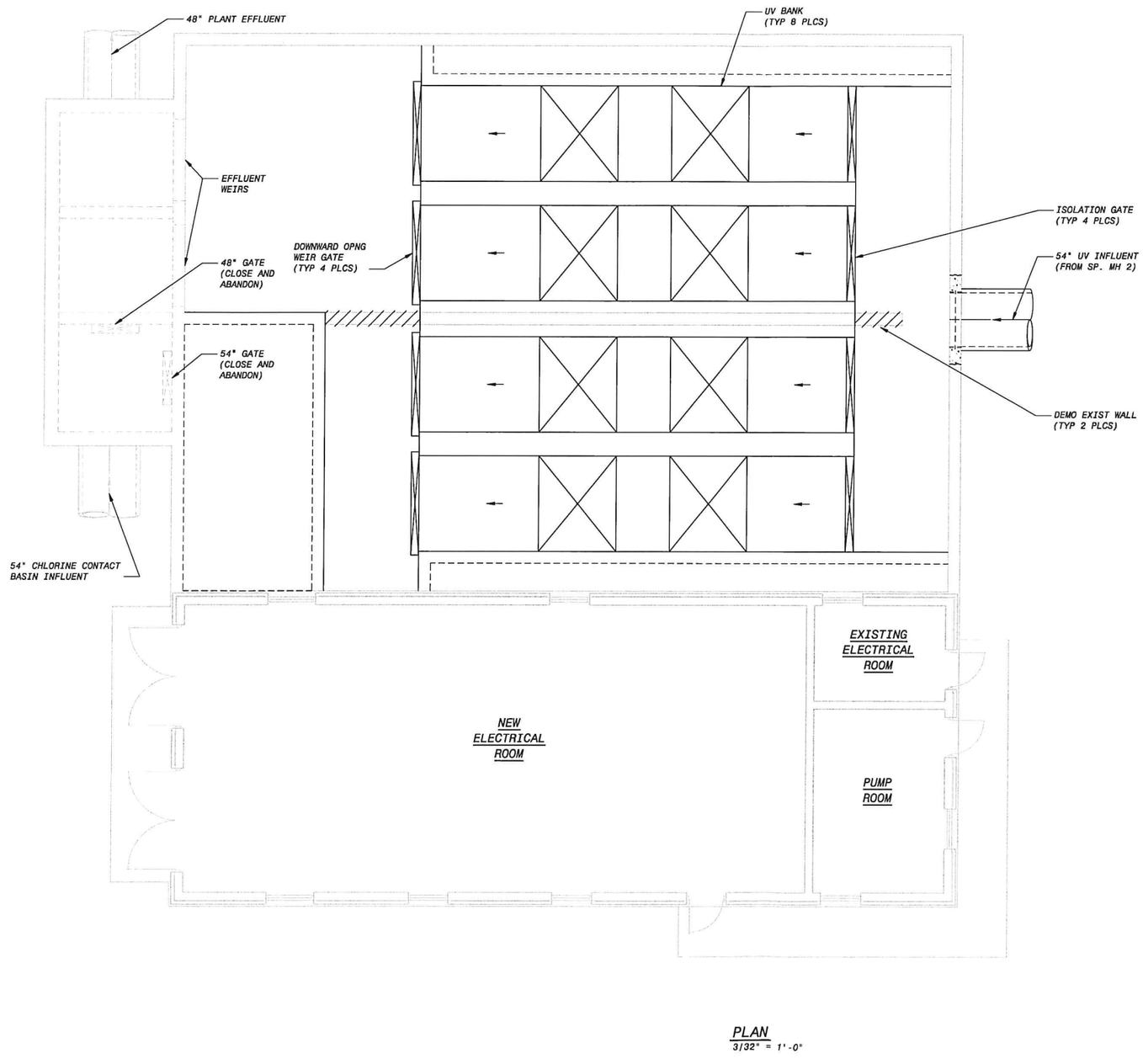
Table 3-2 summarizes the preliminary design conditions for the proposed UV disinfection alternative. Peak and average flows are based on the flow projections agreed to at Workshop No. 1. These flow projections are shown in Chapter 1.0 of this report. A design value for transmittance of WWTP flows was determined to be 50 percent from the pilot-scale testing. The TSS criterion is based on KDHE permit requirement of 30 mg/L. The maximum average particle size of 30 to 40 microns is based on typical values for wastewater treatment facilities utilizing a trickling filter secondary treatment process.

Table 3-2
Alternative 1 – Design Criteria

Peak Flow, mgd	37.24
Average Flow, mgd	5.90
Minimum Flow, mgd	4.00
UV Transmittance, percent	50
Total Suspended Solids, mg/L	30
Maximum Average Particle Size, microns	30-40

3.5.3 Facility Sizing

The Trojan 3000+ system was selected as the basis for sizing this alternative. This horizontal LP-HI system would be installed in an open-channel arrangement. *Table 3-3* summarizes the proposed UV system design.



PLAN
3/32" = 1'-0"

PRELIMINARY - NOT FOR CONSTRUCTION

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XREF4 ID:
SN: PW FILE: UV Plan.dwg XREF5 ID:

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Corporation
Kansas City, Missouri

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MASTER PLAN &
COLLECTION SYSTEM UPDATE

UV LAYOUT

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Table 3-3 Alternative 1 – UV Equipment Sizing	
Number of Channels	3
Number of Banks per Channel	2
Total Number of Banks	6
Number of Modules per Bank	25
Number of Lamps per Module	8
Total Number of UV Lamps	1,200
Approximate Power Consumption at Peak Flow, kW	300
Notes: 1. The design information in this table is based on equipment by Trojan Technologies. Other manufacturers may vary. 2. The sizing is based on 2030 peak flow of 37.24 mgd at 50-percent transmittance.	

3.5.4 Alternative 2 – Combined Bulk Sodium Hypochlorite and Sodium Bisulfite Disinfection

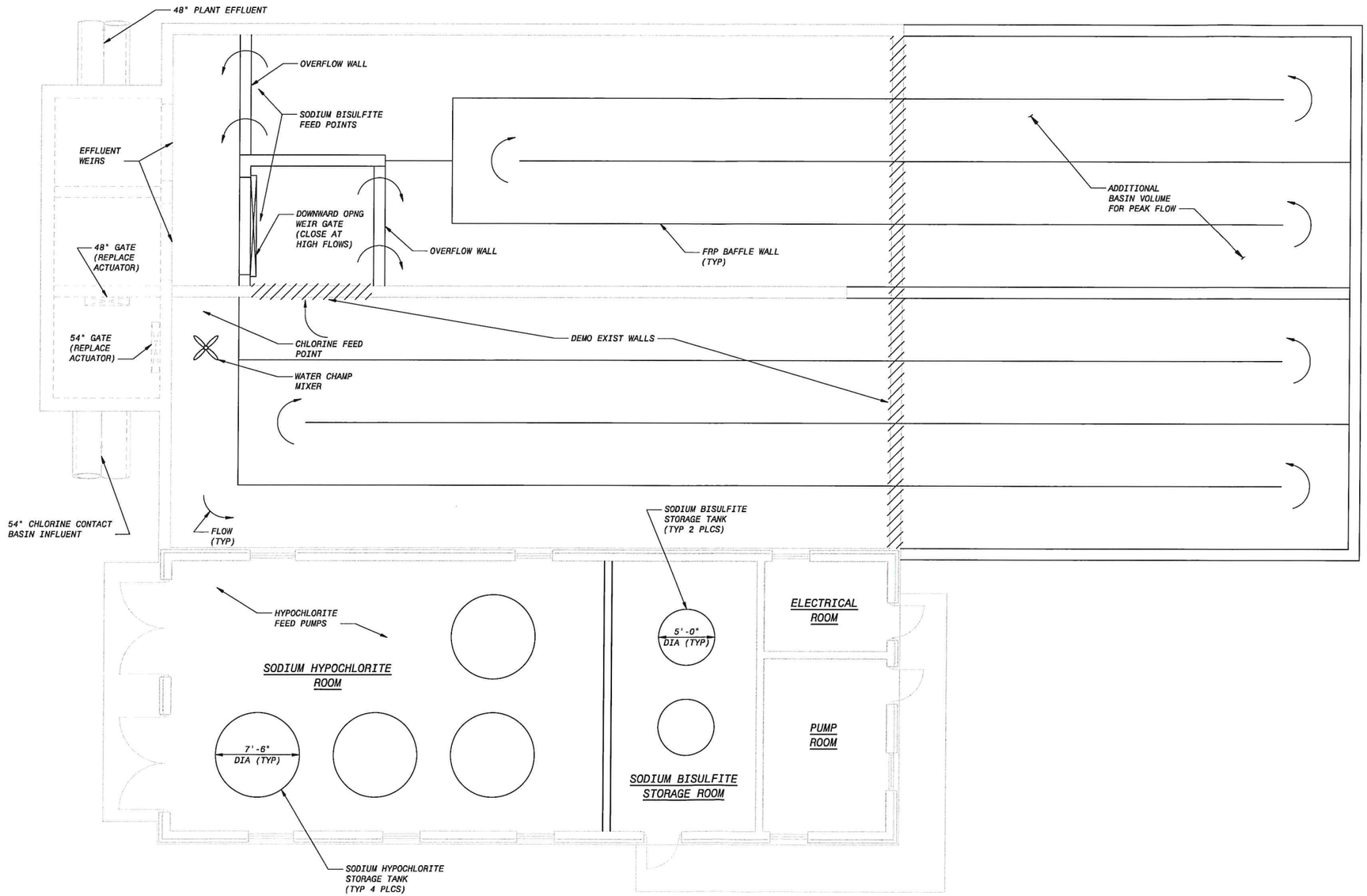
Alternative 2 utilizes a single bulk sodium hypochlorite and sodium bisulfite disinfection facility sized to treat peak flows from the WWTP (37.24 mgd). The proposed facility is shown in *Figure 3-18.*

3.5.5 Design Criteria

Table 3-4 summarizes the design criteria used for the proposed combined bulk sodium hypochlorite and sodium bisulfite systems.

Table 3-4
Alternative 2 – Design Criteria

	Flow, mgd	Chlorine Dose, mg/L	Chlorine Residual, mg/L	12.5% Sodium Hypochlorite Dose, mg/L	12.5% Sodium Hypochlorite Use, gpd	38% Sodium Bisulfite Dose, mg/L	38% Sodium Bisulfite Use, gpd
Peak/Maximum	37.24	12	8	12.6	500	12.92	966
Average	5.90	10	6	10.5	416	9.69	115
Minimum	4.00	8	4	8.4	333	6.46	52



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3/32" = 1'-0"

PRELIMINARY - NOT FOR CONSTRUCTION

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USER: CRA46417 SM: PW FIL: Chlorine Chmbrs Basin Plan.dwg

BLACK & VEATCH Corporation
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3.5.6 Facility Sizing

Disinfection by sodium hypochlorite is comprised of two primary components: chlorine dose and contact time. Ten State Standards has established design parameters for each component. Ten State Standards requires a minimum of 15 minutes of retention time at the peak hourly flow. B&V typically recommends 15 days of storage at average flow for the disinfection chemical to minimize degradation of the chemical from extended storage. For a trickling filter plant, the peak dose would need to be 10 mg/L based on Ten State Standards, however, testing indicated a higher dose is required, and therefore the results of the testing were used to develop chemical storage requirements. *Table 3-5* summarizes the storage requirements for the alternative as well as the contact basin capacity.

Table 3-5
Alternative 2 – Facility Sizing

Design Flowrates	
Average Flow, mgd	5.90
Peak Flow, mgd	37.24
Sodium Hypochlorite System	
Sodium Hypochlorite Solution Strength, percent	12.5
Sodium Hypochlorite Dose (Storage), mg/L	10.0
Daily Storage Requirements (Average), gpd	500
Daily Storage Requirements (Peak), gpd	3,137
Storage Tanks	
Number of Storage Tanks	4
Total Storage Volume, gal	12,600
Days of Storage (Average)	27
Days of Storage (Peak)	4
Sodium Bisulfite System	
Sodium Bisulfite Solution Strength, percent	38
Daily Storage Requirements (Average), gpd	115
Daily Storage Requirements (Peak), gpd	725
Storage Tanks	
Number of Storage Tanks	2
Total Storage Volume, gal	2,900
Days of Storage (Average)	44
Days of Storage (Peak)	4

Table 3-5 Alternative 2 – Facility Sizing	
Contact Basin	
Number of Cells	2
Sidewater Depth, ft	11
Number of Passes per Cell	4
Width of Each Pass, ft	5.5
Length of Each Pass, ft	100
Volume of Each Cell, gal	194,000
Total Contact Basin Volume, gal	388,000
Contact Time at Peak Flow, min	15
Contact Time at Average Flow, min	47

3.5.7 Economic Evaluation

Estimated project costs were developed for each disinfection alternative. Overall project costs include electrical and instrumentation and controls (22 percent), site work (10 percent), contractor general requirements (12 percent), contingencies (25 percent), and engineering, legal, and administration costs (20 percent).

A conceptual cost estimating methodology was employed to develop preliminary capital costs for the alternatives considered. Building areas required for the various treatment alternatives were estimated based on facilities needed to provide the required treatment dosages and previous B&V project experience. Costs for buildings and structures were based on average unit prices appropriate for the geographical region and recent projects with similar structures. Costs for a back-up generator were also added to the UV system to provide a reliable standby power source. Equipment installation was estimated at 40 percent of the equipment cost for bulk sodium hypochlorite and 20 percent for the UV equipment. Project costs for each alternative facility are presented in *Table 3-6.*

Estimates of operation and maintenance (O&M) costs were determined for each alternative. O&M costs were based on labor at $33 per hour, $0.10 per kilowatt-hour for electricity, $1.60 per gallon of 12.5 percent sodium hypochlorite, and the cost for 38 percent sodium bisulfite was $1.50 per gallon. For the UV system, lamp replacement

costs were developed based on 12,000 hours of operation and $260 per lamp. A summary of the O&M costs for each facility is given in *Table 3-6*.

A present worth analysis was completed based on a 20 year service life, 5 percent discount rate, and 3 percent inflation. Due to its lower operating costs, UV emerges as the most cost effective technology.

Table 3-6
Economic Evaluation of Disinfection Alternatives

	Sodium Hypochlorite	Ultraviolet Disinfection
Construction Costs		
Chlorine Contact Basins and Building Modifications	$1,435,000	---
UV Disinfection Equipment and Building	---	$3,068,000
Back-up Generator	---	$100,000
Polymer feed System	$80,000	$80,000
General Requirements (12%)	$200,000	$400,000
Sitework (10%)	$200,000	$300,000
Electrical and I&C (22%)	$400,000	$800,000
Contingency (25%)	$600,000	$800,000
Total Construction Cost	**$2,915,000**	**$5,548,000**
Engineering, Legal, and Administration (20%)	$600,000	$1,100,000
Total Project Cost	**$3,515,000**	**$6,648,000**
Annual Operating Costs		
Chemicals - Disinfection	$333,000	$1,000
Chemical - Polymer	$38,000	$38,000
Materials	$2,000	$75,000
Power	$500	$42,000
Labor	$26,000	$32,000
Present Worth of O&M	**$6,532,000**	**$3,074,000**
Total Present Worth	**$10,047,000**	**$9,722,000**

3.5.8 Non-Economic Considerations

3.5.9 Non-Economic Criteria

Many important factors beyond cost affect a facility planning decision. A discussion of several non-economic criteria for the various alternatives is provided in the following sections. A summary of the non-economic advantages and disadvantages of the disinfection technology alternatives is also provided.

3.5.9.1 Safety. The safety of the surrounding community and plant personnel is one of the paramount factors to consider when selecting a disinfection technology. The following sections present safety considerations of disinfection technologies.

3.5.9.2 Risk to Public. The most common means for a disinfection technology to introduce risk to the public is through the regular transportation of chemicals through the community. The disinfection facility will be located within the site of the existing WWTP; which is within close proximity to the general population. In Alternative 2, trucks delivering chemicals will need to pass directly through this general population, so the risk associated with an accidental spill or release must be considered. Sodium hypochlorite is a corrosive liquid. While the consequences associated with the spill of a liquid chemical are less than for a gas, the risks associated with bulk sodium hypochlorite transportation should still be considered. In addition, the risk associated with a technology also plays an important role in its overall public acceptance.

3.5.9.3 Operator Safety. Operator safety is also an important consideration. Sodium hypochlorite is a corrosive chemical that requires safe-handling procedures. While eye exposure to UV light must be addressed through training and personal protective equipment, UV poses a lesser risk to operators since chemical handling is minimal.

3.5.9.4 Security. Security of facilities and transported chemicals is a current national focus area. None of the alternative technologies under consideration introduce significant risks associated with security of the facility or the surrounding community.

3.5.9.5 Impacts on Environment. The major purpose of a disinfection system is to protect public health and the environment. Therefore, the issue of disinfection by-products formation and the impacts of these compounds on the environment need to be addressed. This is discussed in Section 3.5.9.7.

3.5.9.6 System Reliability. The disinfection process should be assessed by its ability to consistently meet the level of treatment required by the permit. Each of the technologies evaluated has been proven in the wastewater treatment industry and will be able to meet the applicable permit requirements.

3.5.9.7 Disinfection Byproduct Formation. While current regulations do not limit the release of disinfection byproducts, such as trihalomethanes (THMs), these chemicals may be limited by future water quality regulations. The use of sodium hypochlorite for disinfection has the potential to form disinfection byproducts. Disinfection byproducts can be removed once formed, but removal involves constructing an additional treatment step after disinfection such as activated carbon adsorption. UV disinfection does not form any byproducts, and therefore, offers the greatest protection against potential future disinfection byproduct regulations.

3.5.9.8 Environmental Compatibility. Disinfection approaches need to support the use-designation and downstream uses of the receiving stream. Bacteria disinfected with UV light can go through photoreactivation. In photoreactivation, bacteria disinfected by UV can repair the components in their DNA strand when exposed to higher wavelengths of UV light such as sunlight. To minimize the impact of photoreactivation, UV doses should be within recommended ranges and all structures downstream of the UV system

should be covered before the compliance/sampling point. Chemical disinfection with sodium hypochlorite actually oxidizes the bacteria, and regrowth should be minimal if chlorine is applied with adequate contact time.

3.5.9.9 Operability and Maintenance. The ease with which the facilities may be operated and maintained is a significant factor for consideration. Plant personnel desire a facility that is straightforward to operate and requires minimal routine maintenance. When comparing the overall complexity of operating a process, day-to-day operator activities must be considered as well as the need for any additional training. LP-HI UV systems require very little maintenance since lamp cleaning is now typically automated. Lamp life ranges from 12,000 to 18,000 hours depending on the manufacturer, and therefore, operators do not have to change lamps frequently. Operating and maintaining a bulk sodium hypochlorite system is relatively simple as the system consists of metering pumps and storage tanks, system components which operations and maintenance personnel are already familiar.

3.5.9.10 Familiarity of Equipment. Use of UV disinfection would require additional personnel training. A number of municipalities in Kansas already utilize UV disinfection systems, and therefore, resources would be available to assist staff.

3.5.9.11 Viability. Long-term stability and availability of disinfection supplies should be considered when selecting a disinfection technology. Use of a chemical treatment system such as bulk sodium hypochlorite introduces the risk that chemical supply could become limited. This could happen for a number of reasons including market demand, a shortage of production materials, or a natural disaster. As UV treatment does not require chemicals, UV has a clear advantage when measured against this criterion.

3.5.9.12 Shelf Life of Chemical. Sodium hypochlorite naturally degrades with time and has a limited shelf life based on the temperature of the stored chemical. Chemical

degradation increases with temperature and is amplified at higher solution strengths. Shelf life is not an issue with UV disinfection as there is no chemical utilized that can degrade. Indoor storage facilities would be provided for all disinfection chemicals utilized, minimizing the impact of degradation.

3.5.9.13 Cost Stability. Recent trends have indicated that the cost for bulk sodium hypochlorite can increase quite rapidly due to market demands. This is a function of the cost to manufacture the chemical and transportation fuel costs. Other chemicals delivered to the site, such as sodium bisulfite would also be impacted by fuel prices.

UV operating costs are highly dependent upon power costs. Nationwide, power costs are quite stable, primarily because power rate increases are regulated by state boards. Thus, it is anticipated that increases in power costs, while they will occur, will be less frequent and more stable than increases in chemical costs. As a result, UV likely provides the highest level of O&M cost stability of the technologies considered.

3.5.10 Non-Economic Evaluation

Table 3-7 presents a summary of select advantages and disadvantages used for comparison of the disinfection technologies.

Table 3-7
Advantages/Disadvantages of Disinfection Technologies

Disinfection Method	Advantages	Disadvantages
UV	• Minimal public/operator safety threat • Lower space compared to other alternatives • Dechlorination not required • No chemical hazards • No potential for disinfection byproduct formation • Independent of chemical supply market	• Chemical disinfectants may still be needed for process control/non-potable water system • Lamps require regular cleaning and replacement (although cleaning is often automated) • Potential for photoreactivation of effluent

Table 3-7
Advantages/Disadvantages of Disinfection Technologies

Disinfection Method	Advantages	Disadvantages
Bulk Sodium Hypochlorite	• Minimal public safety threat • Additional uses such as process control and chlorine residual for non-potable water system • Easy to operate and maintain • Familiar equipment technology	• Moderately corrosive • Safety risks with transportation, storage and handling • Requires OSHA safety program • Disinfection byproduct formation possible • Dechlorination required • Solution strength degrades with time • Instability of chemical price

3.6 Conclusions and Recommendations

The following alternatives were considered for disinfection of effluent from the WWTP:

- Alternative 1 – UV disinfection
- Alternative 2 – Bulk sodium hypochlorite disinfection and sodium bisulfite dechlorination

Based on an evaluation of each of the alternatives that considered project capital investment, O&M costs, net present worth, and non-economic factors, Alternative 1 is recommended for implementation at the City of Leavenworth WWTP.

Due the fact that improvements for nitrification will likely occur within the next 10 years, as well as the fact that UV technology changes approximately every 10 years, it is recommended that the City install the UV system for 2020 flow with 50 percent transmittance. By using this approach, the UV system should have sufficient capacity beyond the design period since nutrient removal with activated sludge will increase the transmittance to 65 percent which effectively increases the system capacity. Furthermore, since UV equipment design is based on the peak hourly flow, it is important to consider adding equalization or completing I&I improvements to reduce the impact of wet-weather on the disinfection facilities.

It is recommended that the City proceed with the installation of a UV disinfection system with the design criteria as shown in *Table 3-8*.

Table 3-8
Recommended UV Equipment Sizing

Number of Channels	2
Number of Banks per Channel	2
Total Number of Banks	4
Number of Modules per Bank	32
Number of Lamps per Module	8
Total Number of UV Lamps	1,024
Approximate Power Consumption at Peak Flow, kW	256

Notes:
1. The design information in this table is based on equipment by Trojan Technologies. Other manufacturers may vary.
2. The sizing is based on 2020 peak flow of 29.43 mgd at 50-percent transmittance.

The NPDES permit requires that the disinfection system be operational by December 31, 2012. A suggested compliance schedule is included in the Executive Summary.

4.0 I&I Assessment and Reduction Plan

4.1 Introduction

The City of Leavenworth, Kansas is under no mandatory requirement to develop an I&I Assessment and Reductions Plan; however the City understands the benefits of a structured comprehensive program for their wastewater utility. The City, with the assistance from TREKK Design Group, LLC (TREKK) has developed this I&I Assessment and Reduction Plan which presents procedures for identifying and cost-effectively reducing extraneous wet-weather induced wastewater flows within the City. This Plan also presents a recommended schedule for identifying and eliminating I&I sources by the year 2025.

4.2 Background

The City of Leavenworth operates and maintains an extensive wastewater management system that includes approximately 133 miles of sanitary sewer and one wastewater treatment facility. The collection system can be further separated into 5 sub-systems, SUB01, SUB02, SUB03, SUB04, and SUB05. Fort Leavenworth comprises approximately 1,892 acres of developed land located within Sub-systems SUB02 and SUB03.

The oldest parts of the City's wastewater system were constructed during the early 1900s and have been expanded over the years to accommodate residential, commercial, and industrial growth. Common construction materials included vitrified clay pipe with hot-poured jute joints and brick manholes.

The City completed a comprehensive Wastewater Master Plan in 2001 (Black & Veatch). Collection system flow monitoring determined that I&I is excessive, with peak wet to dry weather flows ranging between 2:1 and 15:1 at the monitoring sites. The master plan recommended that a sanitary sewer evaluation study (SSES) be conducted, beginning with sub-system SUB01 and established an initial budget of $460,000 to conduct this SSES. After discussing several options with City staff, it was decided that

before engaging in a comprehensive and long-term SSES in SUB01, a smaller scale "pilot" SSES would be conducted.

In April of 2002, Wade & Associates, Inc. completed the pilot study and submitted the pilot SSES report to the City. The pilot study area focused on a small mini-basin, located within SUB01, containing approximately 20,000 linear feet of sanitary sewer or 3 percent of the City's sanitary sewer collection system. This report identified excessive I&I in the pilot study area and recommended that a comprehensive long-term SSES be implemented in SUB01.

Wade & Associates, Inc. completed Phase I of the Wastewater Collection System I&I Study/SSES in September of 2003. Phase I of the SSES included flow monitoring of SUB01, which was sub-divided into 6 mini-basins. Seven flow monitors were placed at the outlet of each mini-basin, and one overflow line, for a 60-day monitoring period to establish preliminary I&I rates, mini-basin severity rankings, peak flow rates, and rainfall responses. Severity rankings were based on ratio of peak flow to dry weather flow. Mini-basins were then assigned a severity ranking and sorted from the most severe to the least severe. The SSES of SUB01 made the following recommendations:

- Pipeline Rehabilitation (I&I Reduction Program) – A total of 183 sanitary sewer line segments (approximately 46,300 ft) were targeted for rehabilitation to remove excessive I&I and restore structural integrity.
- Manhole Rehabilitation (I&I Reduction Program) –The final manhole rehabilitation schedule included 547 manholes with an estimated cost of $0.8 million. An additional 132 manholes were recommended to be repaired as part of the Pipeline Rehabilitation Program.
- Relief/Replacement Sewer Program (Capacity Improvements) – The study identified approximately $3.2 million of capital improvements to increase hydraulic capacity within the SUB01 system in order to accommodate and contain the 5-year, 60-minute design storm event. Improvements include approximately 9,700 linear feet of either pipe upsizing (replacement) or parallel sewer construction. These improvements also are necessary to

meet the 20-year planning period outlined in the 2001 Wastewater Master Plan.

- 4th Street Corridor Improvement Project (Capacity Improvements) – Wade & Associates, Inc. identified a separate project for the 4th Street Corridor Improvements. The project would remove several connections that currently exist between the storm and sanitary sewer systems. Under this project, approximately 2,300 feet of corridor improvements will include a new 15" sanitary sewer, replacement of the existing 41"x62" storm sewer with a new 60" conduit, and complete street historic restoration and reconstruction. Approximately $6.4 million was budgeted for the corridor improvements, of which $0.7 million was budgeted for the new sanitary sewer.
- Private-Sector I&I Reduction/Abatement Program (Optional Program) – The study recommended the removal of private-sector I&I through, 1.) the elimination of defective service laterals, 2.) disconnecting driveway drain, stairwell, and area drains, 3.) capping or repairing cleanouts, and 4.) disconnecting downspouts.

4.3 I&I Assessment

As previously mentioned, the City completed an SSES of SUB01 to identify and assess the extent of I&I in the sub-system system. The City should continue to conduct these assessments on the remaining sub-systems in the order of the I&I priority rankings established in the *Wastewater Master Plan* (B&V, 2001). Previous and future studies will generally follow the guidelines as established in the *Existing Sewer Evaluation & Rehabilitation* (WEF Manual of Practice FD-6) and ASCE Manual and Report on Engineering Practice (No. 62, 1994). The program may consist of these six (6) key components. They are summarized as follows:

- Administration
- Public Relations

- I&I Quantification (flow analysis)
- I&I Identification
- Cost-Effectiveness Analysis
- Final Recommendations and Implementation Plan

4.4 Administration

Progress meetings shall be regularly scheduled to review the project goals, objectives and schedule. Public hearings and Council meetings may be required to discuss the project and answer questions from the public and/or City. Field data shall be properly administered on a daily basis to ensure quality data to accurately evaluate the existing conditions and make proper recommendations.

4.5 Public Relations

During the data collection process, structures identified for inspection may be located in backyards on private property. In the event that these structures are inaccessible, a door notification will be left for the property owner. The notification will contain an explanation and the need to conduct the inspection along with a telephone number enabling residents to contact the City for more information and to schedule a convenient time to reschedule. Prior to smoke testing, notification to all property owners will be done by placement of door hangers on homes and businesses. The notice will include general information about the testing; including instructions to fill infrequently used plumbing traps with water and a tablespoon of cooking oil to prohibit smoke from entering buildings via service lines. Telephone numbers will be provided enabling residents to contact the City for more information or with any special needs and concerns they may have.

4.6 I&I Quantification

4.6.1 Flow Monitoring

Collection system flow monitoring will be conducted on the study basins by continuously and simultaneously measuring flows tributary to each basin. Monitoring will be conducted for a base period of 60-days during the spring or fall.

Flow meters capable of continuously recording flow depth and velocity measurements under free flow, surcharge, and reverse flow conditions will be employed. Data will be logged at 15-minute intervals.

The flow monitoring activities will include site hydraulic calibration measurements, installation of flow meters, weekly servicing of flow meters (including performance checks and collection of recorded data), as well as removal of flow meters. The flow monitoring process will be conducted using a two-person crew.

4.6.2 Rainfall Monitoring

Rainfall-monitoring activities will be performed concurrently with flow monitoring activities at multiple locations for a 60-day base period.

Rain gauges capable of continuously recording rainfall measurements to 0.01-inch will be used. Data will be logged at 15-minute intervals and the rain gauge electronic logger clock will be synchronized with the flow meter electronic logger clocks.

4.6.3 Flow Data Analysis

Flow and rainfall data collected will be analyzed to determine rates for the following:

- Average daily and peak hourly dry-weather flows
- Peak high groundwater infiltration flows
- Peak wet-weather inflow flows
- Peak wet-weather total flows

Dry weather flows will be determined from flow data collected during periods of dry weather and low groundwater. Infiltration will be determined from flow data collected during periods of dry-weather and high groundwater, as well as, additional data. Inflow will be determined from flow and rainfall data collected during wet-weather.

4.7 I&I Identification

4.7.1 Manhole Inspections

Manhole inspections will be conducted to identify I&I sources and structural/maintenance defects in the manholes. Manhole inspections will be accomplished using a two-person crew. Manholes less than 15 feet deep shall be inspected from the topside (Surface) using survey rods, digital cameras, mirrors and high powered spotlights. The inspections of manholes greater than 15 feet deep shall be accomplished by man entry into the manhole (Internal). Industry standard OSHA, NIOSH, OSDH and NASSCO confined space entry policies and practices shall be followed to ensure safe entry and egress of all confined spaces. Manholes may also be inspected from the topside utilizing zoom inspection cameras capable of recording video and photos. Cameras shall provide the adequate amount of light to ensure identification of all defects and suspect sources.

Each structural component of the manhole will be inspected and assigned a condition rating. An initial rehabilitation recommendation will also be provided by the inspectors during the inspection. Photographic records will be used to supplement and substantiate manhole inspection observations and recommendations. All manhole inspections will be recorded on City field forms and input into the City's information management system.

A field sketch of the plan view of the manhole will also be completed to verify sewer line configurations. An area photo as well as a topside photo, both north-facing, will be taken of each manhole with a digital camera. All area and topside photos are taken north-facing to ensure consistency and provide a standard point of reference for future

viewing. Field crews will utilize a white board to provide a media for manhole identification of area photos. This will facilitate the visual identification of the manhole when viewing the area photo without further investigation and provide another avenue of QA/QC checking for manhole inspection photos. Digital photographs will also be taken of selected I&I defects and other non-I&I related defects such as roots, debris, or structurally deteriorated steps. Each photo shall be uniquely annotated and attached to the specific inspection record, as specified herein.

Each field crew will carry metal detectors and probing rods to assist in locating manholes. If a manhole cannot be located, the manhole will be placed on a "Can Not Locate" list with a general map of the position for location services at a later time. If a manhole is found to be buried, the approximate location of the manhole will be identified in the field. New manholes found by field crews will be assigned a temporary manhole number consisting of the last known downstream manhole number followed by a T1, T2, T3...(0184-T1). If located on public sewer mains, these manholes will be inspected and location details for the manhole will be made on field maps.

4.7.2 Visual Pipe (Lamping) Inspections

Line lamping will be performed in conjunction with the manhole inspections to collect pipe sizes, rim-to-invert measurements and to observe the sewer line's structural condition and potential for leakage. Typically, up to 10-15 feet of incoming and outgoing pipes can be viewed from within a manhole utilizing digital cameras. Visual pipe inspections conducted utilizing zoom inspection cameras can typically increase sight distance to 50-100 ft in an 8" line, depending on how straight the line is.

Prioritization of the sewer lines for follow-up cleaning and CCTV inspections will be determined from sewer lines that exhibit structural and/or maintenance issues during line lamping and line segments that exhibited smoke during smoke testing activities indicating sources of I&I.

4.7.3 Smoke Testing

Smoke testing will be conducted on all line segments located within the City to identify inflow sources from both the public and private sector, to locate manholes not identified on the City's existing map, and to obtain a lineal footage of the sewer line segments for the system inventory. Each positively identified source is photographically documented, precisely located using GPS technology and referenced to allow for efficient repair. Suspect sources are identified for subsequent dyed-water testing.

Two (2) smoke blowers (rated at 6,211 cfm) using liquid smoke will be set-up on every other manhole to expedite the procedure. The high rated smoke blowers combined with the use of liquid smoke allow for continuous and constant smoke production while the field crew canvasses the areas over and adjacent to the lines and conduct a perimeter check of all buildings in close proximity for evidence of smoke.

Smoke testing activities will include a minimum of 48 hours advance notification to all residents within the study areas. Notification will be done by placement of door hangers on homes and businesses, including instructions to fill infrequently used plumbing traps with water and a tablespoon of cooking oil to prohibit smoke from entering buildings via service lines. Telephone numbers will be provided enabling residents to contact the City for more information or with any special needs and concerns they may have.

Photographic records will be used to supplement and substantiate smoke testing observations. Line segments exhibiting smoke from public sources other than manholes, will be included in the concurrent CCTV inspection program. All smoke testing inspections will be conducted using GPS cameras capable of recording defect information or by recording information on field forms.

4.7.4 Cleaning/CCTV Inspections

All of the line segments recommended for cleaning and CCTV inspections will be based on the results from visual pipe inspections and smoke testing programs. Necessary cleaning and root cutting will be performed prior to the television inspections. This allows

passage of the camera and offers the best view of the interior of the lines for evaluating structural conditions and identifying potential I&I sources.

It is anticipated that approximately 15 percent of sewers will be recommended for cleaning and CCTV as part of the I&I Assessment. All video records shall be recorded in electronic format and supplied to the City on CD's, DVD's, or on an external hard drive.

4.8 Cost-Effectiveness Analysis

All field information will be combined with additional treatment cost to conduct a cost-effectiveness analysis (CEA). The CEA will become the basis of establishing the optimal I&I reduction and sanitary sewer overflow (SSO) control plan for the basins included in the study. The CEA will, in essence, provide the City with a program that yields the "biggest bang for the buck".

4.8.1 Establishing Source Flows and Costs

Utilizing the City's database with the populated physical information for the sanitary sewers investigated, data from all completed I&I source investigation inspection and testing activities will be used to calculate defect flow rates. A summary listing will then be completed. The listing will, for each specific I&I source, include the following:

- Source type (manhole defect, sewer line defect, etc.)
- Source category (public sector, private sector)
- Source status (confirmed, suspect)
- Number of such sources
- Source unit flow rate, based on five-year storm event
- Total five-year flow rate contributed by such sources
- Source unit repair cost
- Total repair cost for such sources
- Source cost/flow ratio (total repair cost divided by total five-year flow rate)

The final listing will be sorted in ascending order by source cost/flow ratio. Sources with low ratios are considered more cost-effective to repair than sources with higher ratios.

To balance the source flows, the I&I source summary listing will be used along with the peak infiltration and five-year inflow flow rates. Source unit flow rates will be calculated following the guidelines established in the *Existing Sewer Evaluation & Rehabilitation*, (WEF Manual of Practice FD-6).

A certain percentage of five-year I&I flow will be attributed to unidentified I&I sources. The unidentified sources would be those which investigations were unable to verify. These typically include building foundation drains, private service laterals, and other such sources for which smoke testing and inspection activities are not totally effective.

4.8.2 Capacity Analysis

The I&I data collected and the flow monitoring results will be evaluated and entered into the current hydraulic model. The model will be used to analyze 100 percent of the sanitary sewer system in targeted basins. Hydraulic models for each basin will be calibrated to storm event criteria that are established by the City and which meet the guidelines of proposed SSO policies or regulations.

The models will be used to identify additional capacity requirements, if necessary, to transport peak wet-weather flows for several levels of I&I reduction, beginning with 0 percent. The model will also determine the cost of relief sewers for each 10 percent increment of I&I reduction, based on residual I&I.

4.8.3 Treatment Analysis

Treatment cost data from City's WWTF will include both capital and operations and maintenance costs associated with normal daily and peak wet-weather flows. Unit, per gallon, rates will then be determined and applied to incremental levels of I&I

reduction beginning at the 0 percent I&I elimination level until a treatment cost curve is completed.

4.8.4 Cost-Effectiveness Analysis

The cost-effectiveness analysis compares costs associated with I&I source repair to costs associated with providing flow transportation and treatment for the extraneous flows. Combining the three cost curves, a composite cost curve can be developed based on present worth cost. The cost-effective level of I&I removal is that percentage associated with the minimum cost point on the curve.

4.9 Recommendations and Implementation Plan

The results of the studies should be provided in a clear and concise format summarizing the findings and recommendations for the field investigations and data analysis. The following information should be included in the final report:

- Executive Summary – highlighting all tasks performed, conclusions, recommendations and costs.
- Background Information – describing the previous problems, studies and rehabilitation work within the study area.
- Sewer Map – delineating subsystems, monitoring locations, sewer size, etc.
- Flow Monitoring Results – showing how dry weather and wet weather flows were determined and graphically comparing subsystem results.
- Field Data Analysis – tabulating the results of the field activities while quantifying I&I flows per source.
- Cost-effectiveness Analysis – graphically presenting the maximum amount of I&I that can be cost-effectively eliminated.
- Recommendations – listing the following recommended activities, including cost and schedule:
    - Prioritized manhole defect/rehabilitation schedule
    - Public sector inflow and infiltration reduction and elimination

- Private sector inflow and infiltration reduction and elimination
- Prioritized line rehabilitation schedule
- Routine maintenance recommendations

- Appendix B – including a complete bound copy of written inspection forms and a DVD containing scanned images of the inspection forms and digital inspection photos.

4.9.1 I&I Reduction

The I&I Reduction Plan to manage and control peak wastewater flows will consist of both public and private sector I&I elimination. Based on recommendations from the I&I Assessment Plan, I&I Reduction may be divided into the following five (5) parts including post rehabilitation flow monitoring:

- Priority 1 – Cost Effective Rehabilitation
- Priority 2 – Structural Rehabilitation
- Private I&I Abatement
- Preventative Maintenance
- Post-Rehabilitation Flow Monitoring

4.10 Priority 1 – Cost Effective Rehabilitation

Cost-effective rehabilitation is based on recommendations from the I&I Assessment plan and are those repairs that remove I&I and meet the lowest point on the CEA curve. Cost effective rehabilitation will consist of both manhole and pipeline rehabilitation.

4.10.1 Manhole Rehabilitation

Cost-effective manhole rehabilitation may consist of the following methods which are focused on the top-end of the manhole where higher I&I flows are found:

- Replace Vented Covers Below Grade
- Raise Manhole to Grade

- Replace/Rehabilitate Frame Seal
- Replace/Rehabilitate Chimney

4.10.2 Pipeline Rehabilitation

Cost-effective pipeline rehabilitation may consist of the following methods which may include immediate structural repairs if discovered during the I&I Assessment phase:

- Point Repairs
- Full Line Replacement
- Full Line Rehabilitation
- Abandon/Realign Pipeline
- Disconnecting Direct Storm Connections
- Disconnecting Indirect Storm Connections

4.11 Priority 2 – Structural Rehabilitation

Additional defects that exhibit enough structural deterioration to possibly warrant rehabilitation but may not be classified as "cost-effective" are recommended for further evaluation and possible repair. Structural rehabilitation will also consist of both manhole and pipeline rehabilitation.

4.11.1 Manhole Rehabilitation

Structural manhole rehabilitation may consist of the following methods which may include additional top-end manhole repairs:

- Replace/Rehabilitate Frame Seal
- Replace/Rehabilitate Chimney
- Rehabilitate Cone and Wall
- Rehabilitate Bench and Invert
- Rehabilitate Pipe Seals
- Replace Manhole

4.11.2 Pipeline Rehabilitation

Structural pipeline rehabilitation may consist of the following methods:

- Point Repairs
- Full Line Replacement
- Full Line Rehabilitation
- Abandon/Realign Pipeline

4.12 Private I&I Abatement

Defects on private property may be significant contributors of excessive I&I to the collection system. Cost analysis from previous studies has shown that several sources of private-sector I&I, such as uncapped cleanouts, are cost-effective to remove. In addition, some of the sources of I&I on private property may be illegal connections according to current ordinances. The following illicit connections are required to be completed by the resident upon discovery:

- Uncapped Cleanouts
- Downspouts
- Foundation Drains
- Driveway Drains
- Basement Entry Drains

Defective service laterals identified during the I&I Assessment Plan are reported to the resident and are further recommended to be repaired by the resident. These defects are not considered as illicit connections and are currently not required to be repaired.

4.13 Preventative Maintenance

The City's current line cleaning and preventative maintenance program includes cleaning all sewer lines by quarter section and a selected list of lines requiring monthly cleaning. The City's current preventative maintenance program includes cleaning approximately 150,000 feet of sewer a year. In addition, the City conducts monthly

maintenance on 30 line segments, representing approximately 10,566 feet of sewer. The *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) identified 36 line segments, representing approximately 7,856 feet of sewer, as requiring routine maintenance. These 36 line segments should be included in City's current preventative maintenance list if maintenance records indicate they have been cleaned since the completion of the SSES.

4.14 Post Rehabilitation Flow Monitoring

As part of the I&I Reduction Plan and following the rehabilitation of individual study areas, post-rehabilitation flow monitoring will be conducted to measure the success of the program. Flow monitoring will be performed as previously described in the I&I Assessment Plan in the same locations prior to the rehabilitation. Flow data will then be compared to the pre-rehabilitation flow monitoring. Results will then be evaluated to determine the success of the rehabilitation program and if future rehabilitation methods should be altered.

4.15 Schedule

The *Wastewater Master Plan* (B&V, 2001) and the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) ranked sub-systems and mini-basins based on their peak inflow rates and were further prioritized for follow-up I&I elimination. The City has completed an I&I Assessment of sub-system SUB01 and subsequently I&I Reduction within the sub-system.

The City plans to continue its ongoing commitment of improving the sanitary sewer collection system. This includes continuing the I&I Assessment in the remaining sub-systems, the rehabilitation of public sector defects, the elimination of illicit private sector defects, on-going sewer maintenance, and a post rehabilitation flow analysis to measure the success of the I&I Reduction Plan. *Table 4-1* presents the proposed schedule to complete the I&I Assessment and Reduction for the City's entire collection system by the year 2025:

Table 4-1
I&I Assessment and Reduction Plan

Basin	Pipe Footage (lf.)	Priority[1]	I&I Assessment Plan[2]					I&I Reduction Plan[3]		Cost Effective Work Completed[4]		
			Flow Monitored	CCTV Inspections	Smoke Testing	Manhole Inspections	Building Inspections	Priority 1 Cost-Effective Rehab	Priority 2 Structural Rehab	Point Repairs (each)	CIPP / Replace (lf)	Manhole Rehab (each)
SUB01-02	33,397	1	2003, 2017	2004	2003	2003	2014	2011 – 2012	2022 -2023	-	832	-
SUB01-05	61,491	2	2003, 2017	2004	2003	2003	2014	2012 – 2013	2022 -2023	-	-	-
SUB01-04	70,900	3	2003, 2017	2004	2003	2003	2014	2013 – 2014	2022 -2023	-	666	-
SUB01-01	31,593	4	2003, 2011	2004	2003	2003	2014	2014 – 2015	2022 -2023	-	396	-
SUB01-06	58,296	5	2003, 2017	2004	2003	2003	2003	2015 – 2016	2022 -2023	-	630	-
SUB01-03	69,702	6	2003, 2017	2004	2003	2003	2014	2016 – 2017	2022 -2023	-	932	-
SUB04	25,672	7	2000, 2011	2011	2011	2011	2011	2017 – 2018	2024 – 2025	-	-	-
SUB06	13,575	8	2000, 2011	2011	2011	2011	2011	2017 – 2018	2024 – 2025	-	-	-
SUB05	373,736	9	2000, 2011	2012	2012	2012	2012	2019	2024 – 2025	-	-	-
SUB02-03	40,781	10	2000, 2011	2013	2013	2013	2013	2020 – 2021	2024 – 2025	-	-	-
Totals:	**779,143**											

Note: 1. Priority based on flow monitoring results from *Sanitary Sewer Evaluation Survey Sub-System SUB0I* (Wade, November 2005) and *Wastewater Master Plan* (B&V, 2001).
2. I&I Assessment is year of completed or scheduled task.
3. I&I Reduction is year of completed or scheduled task.
4. Work Completed is units of work completed.

4.16. Recommendations

4.16.1 Introduction

This section discusses TREKK's recommended improvement plan for eliminating cost-effective I&I related defects and discusses additional flow monitoring to determine current peak wet weather flow in the collection system. As indicated in Section 7 of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005), all identified defects are not cost-effective to remove and it is virtually impossible to remove all flow from these defects. This recommended improvement plan entails removing identified defect flows from both public and private sectors up to the cost-effective level of 45 percent.

Implementation of this improvement plan will require the City to initiate a private sector I&I disconnect program. The ultimate success of this improvement plan for reducing wastewater surcharges and backups will depend largely upon the success of implementing this program. Partial implementation will not result in satisfactory reductions and transport of peak wet-weather-induced wastewater flows. Careful consideration must also be given to the desired schedule for improvements and method(s) of financing. All improvements recommended in this study will require varying degrees of involvement by the City.

4.17 Cost Effective Rehabilitation

The City has recently completed several I&I related rehabilitation projects identified in the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005). These projects included the cured-in-place lining of twelve (12) VCP line segments, representing approximately 3,000 lf of sanitary sewer, and the replacement of one (1) VCP line segment, representing 455 lf of sanitary sewer. It is recommended that the City continue with its efforts to eliminate cost effective I&I from their collection system. TREKK has re-evaluated the recommendations from the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) and has developed a prioritized "plan of attack" for eliminating cost effective I&I from the system. SUB01 was identified as being Priority 1; this plan prioritized all mini-basins in SUB01 and includes eliminating public and private sector

defects on a mini-basin by mini-basin basis. Mini-basins were prioritized based on their severity of I&I (ratio of peak inflow to peak dry weather).

The total estimated cost to perform the recommended Priority 1 improvements to Sub-System 01 is approximately $4,042,000. This cost includes improvements to the public and private sector infrastructures. Partial implementation of this improvement plan will not result in satisfactory reductions in peak wet-weather-induced wastewater flows. *Table 4-2* summarizes the recommended improvement tasks and provides a cost estimate for each task. The specific improvements to each mini-basin are discussed further in the appendices.

4.18 Flow Monitoring

The previous collection system flow monitoring was conducted as part of the *Wastewater Master Plan* (B&V, 2001). The collection system flow monitoring data is over 10 years old and may not accurately represent current flows in the system. The Average Daily Dry Weather Flow (ADDF) recorded at the WWTP during the 2000 flow monitoring period between April 11 and June 26 of 2000 was 3.940 mgd. The ADDF recorded at the WWTP between April 11 and June 26 of 2009, minus wet weather days, was 4.775 mgd. This correlates to an increase in ADDF of 21 percent over a nine year period. It should also be noted that during this same time period the City's population decreased from 35,420 (2000 census) to 35,081 (2009 census estimate). This dramatic increase in dry weather flow, with no population increase, could be an indication of the steady deterioration of the collection system. This deterioration could account for the higher ADDF due to an increase in the amount of groundwater entering the system. Current flow monitoring data should be collected and compared with the previous data to determine actual changes in the ADDF and peak wet weather flow rates.

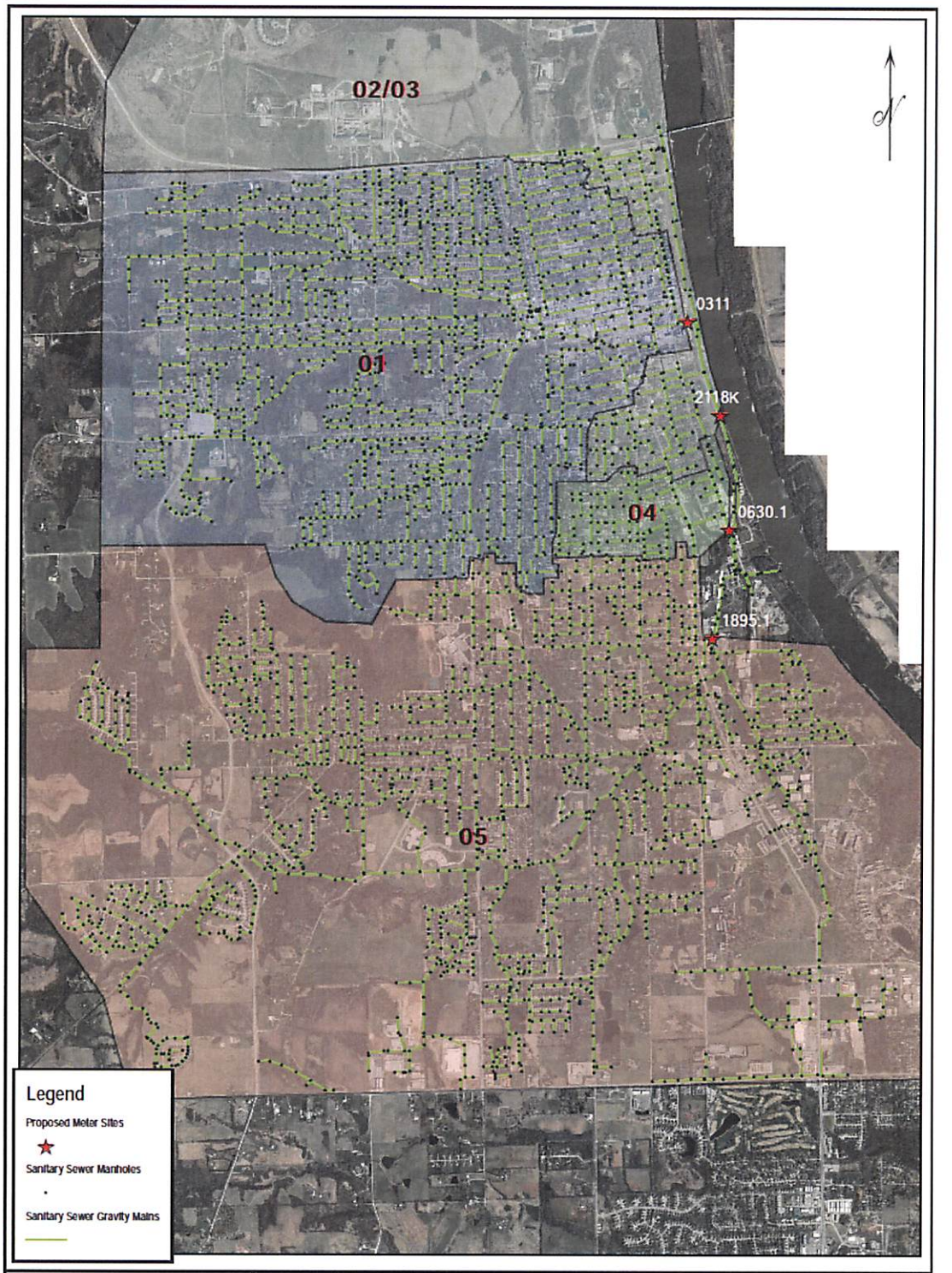
It is recommended that temporary flow monitors be installed to re-monitor flows at the outlet of each sub-system for a minimum of 60 days to determine the peak wet weather flow going to the WWTP. An extension to the monitoring period may be necessary if insufficient wet or dry weather events are recorded during the monitoring

period. It is recommended that at least five (5) flow meters be installed to isolate the collection system. Meters should be re-installed in the same locations as previously installed during the *Wastewater Master Plan* (B&V, 2001). In addition to installing flow meters, two (2) temporary rain gauges should be installed to correlate peak sewer flows to total rainfall and peak rainfall intensity. *Table 4-2* summarizes the estimated cost associated with conducting the collection system flow monitoring. *Figure 4-1* shows proposed meter locations and the general system layout.

Table 4-2
Recommended Improvement Cost Summary

Priority	Description of Improvements	Cost Estimate ($)
Study Area Improvements		
1-1	**Mini-Basin 01-02 Improvements**	
	Manhole Rehabilitation Program	26,000
	Private-Sector I&I Abatement Program	82,000
	Pipeline Rehabilitation Program	213,000
	Sub-Total:	**321,000**
1-2	**Mini-Basin 01-05 Improvements**	
	Manhole Rehabilitation Program	124,000
	Private-Sector I&I Abatement Program	30,000
	Pipeline Rehabilitation Program	281,000
	Sub-Total:	**435,000**
1-3	**Mini-Basin 01-04 Improvements**	
	Manhole Rehabilitation Program	49,000
	Private-Sector I&I Abatement Program	42,000
	Pipeline Rehabilitation Program	709,000
	Sub-Total:	**800,000**
1-4	**Mini-Basin 01-01 Improvements**	
	Manhole Rehabilitation Program	78,000
	Private-Sector I&I Abatement Program	20,000
	Pipeline Rehabilitation Program	525,000
	Sub-Total:	**623,000**

Table 4-2 Recommended Improvement Cost Summary		
Priority	**Description of Improvements**	**Cost Estimate ($)**
1-5	**Mini-Basin 01-06 Improvements**	
	Manhole Rehabilitation Program	170,000
	Private-Sector I&I Abatement Program	7,000
	Pipeline Rehabilitation Program	368,000
	Sub-Total:	**545,000**
1-6	**Mini-Basin 01-03 Improvements**	
	Manhole Rehabilitation Program	47,000
	Private-Sector I&I Abatement Program	50,000
	Pipeline Rehabilitation Program	1,221,000
	Sub-Total:	**1,318,000**
Sub-Total:		**4,042,000**
Additional Investigation Work		
1-1	**Sub-System Flow and Rainfall Monitoring**	
	Site Assessment and Install (5 meters)	2,000
	Flow Monitoring (5 meter sites, 60-days)	18,000
	Flow Data Analysis (5 meter sites)	8,000
	Rain Fall Monitoring (2 sites, 60-days)	1,000
Sub-Total:		**29,000**
Total Cost:		**4,063,000**



City of Leavenworth, Kansas I&I Assessment and Reduction Plan Trekk Project No. 10-066	**Figure 4-1** Proposed Meter Sites & General System Layout	TREKK

5.0 Implementation

5.1 Facility Improvement Recommendations

This chapter summarizes implementation recommendations for the proposed disinfection facilities and provides a phasing plan for future nutrient removal facilities at the Leavenworth Wastewater Treatment Plant (WWTP). In addition, this chapter discusses other plant improvements to consider, future staffing levels, improvements to plant hydraulics, site considerations, capital and operation and maintenance (O&M) costs, and project schedule.

5.1.1 Disinfection Facilities

Chapter 3.0 presents the complete disinfection alternatives evaluation. Based on this evaluation that considered project capital investment, O&M costs, net present worth, and non-economic factors, ultraviolet (UV) disinfection is recommended for implementation at the Leavenworth WWTP.

The testing conducted showed that the effluent transmittance was lower than anticipated. Therefore, a study was completed to determine if the addition of chemical prior to the final clarifier could result an increase in effluent transmittance. The results of the chemical addition studies indicated that a small addition of polymer added before the clarifier would increase the transmittance to 50-percent.

Due to the fact that improvements for nutrient removal will likely occur within the next 10 years, as well as the fact that UV technology changes frequently (approximately every 10 years), it is recommended that the City install the UV system for 2020 flow with 50-percent transmittance. As noted above, this will require upgrades to the existing polymer system or a new polymer system to increase transmittance to 50-percent. By using this approach, the UV system should have sufficient capacity beyond the design period since nutrient removal with activated sludge will increase the transmittance to 65-percent which effectively increases the disinfection system capacity.

The National Pollutant Discharge Elimination System (NPDES) permit requires that the disinfection system be operational by December 31, 2012. In order to meet the construction schedule, it is recommended that the City consider pre-selection and possibly pre-purchasing of the UV equipment. In addition, the City may consider conducting demonstration testing to verify the fouling of the UV lamps. This study would have to be conducted in a parallel to the design effort to meet the schedule imposed by KDHE. However, it is preferable to complete testing prior to initiation of preselection and detailed design. On-line transmittance measurements should continue to be collected through the design effort. A proposed project schedule is included in the Executive Summary

Due to the fact that the recommended UV disinfection facility will be constructed in the existing chlorine contact basins that are currently not in service and isolated by a sluice gate, minimal plant disruptions are required to perform the work. The layout shown in *Figure 3-17* requires that final clarifier effluent be re-routed to the south wall of the existing chlorine contact basins and therefore, yard piping modifications will be required to implement these improvements. Clarified effluent will flow through the channels from south to north and discharge to the plant outfall pipe over the existing weirs. This concept was developed in order to maintain the existing effluent weir on the north end of the chlorine contact basin. It also allows construction to take place without disrupting existing service.

The layout shows four channels to accept UV equipment. Only two channels are required (2 banks per channel, 4 banks total) for the initial improvements, however, space for two additional channels will be allocated to accept additional banks in the future if required. The requirement for additional UV equipment will depend on the peak hourly flow rate and the transmittance. Whether the future channels are built during the initial improvements or deferred to a later date should be determined during detailed design.

The existing chlorine storage room is currently being used to store miscellaneous items. This space has been designated for an electrical room on the proposed layout. Electrical space required varies greatly between manufacturers. Depending on which

manufacturer is selected for the UV equipment, the existing electrical room (rather than the storage room) could possibly be used to house the electrical equipment and controls for the UV equipment.

It is recommended that the UV channels be covered. This can be accomplished with a pre-fabricated metal building or a traditional brick and block superstructure similar to the existing architecture at the plant. The capital cost opinion at the end of this chapter includes a brick and block building, however, this decision should be finalized during detailed design.

The UV equipment should be protected from a 100-year flood. The river elevation at the 100-year flood causes the existing weirs to become flooded. The UV manufacturer should consider the flood elevation in the design of their equipment to ensure that sensitive equipment (ballasts, etc.) are above the water level in the event of a flood. This should be coordinated with the manufacturer during detailed design.

5.1.2 Nutrient Removal Facilities

The Activated Sludge Process was identified as the process that could be implemented to accomplish the nutrient removal goals outlined in the NPDES permit. The activated sludge process is a proven, versatile technology capable of numerous system enhancements to meet the future Goal Level 1 through 3 requirements. This process is discussed in greater detail in Chapter 2.0.

Given the vagueness of the regulatory schedule, it is reasonable to consider alternative methods for meeting nutrient removal goals. Before making a commitment to a specific process, it is recommended that the condition of the existing facilities be assessed. If the trickling filter media and structures have an estimated 10 years or more life, then other processes may be economical. As structures approach the end of their useful life, it will become more economical to abandon those aging structures and build new facilities.

This basic activated sludge system design will be able to meet the Goal Level 1 effluent quality listed in the permit. However, the implementation of Goal Level 2

requirements is of particular importance to the proposed phasing considerations. With the addition of a combination second anoxic zone and re-aeration zone to the activated sludge process or a deep bed denitrification filter, the activated sludge process can be upgraded to meet Goal Levels 2 and 3. The decision of whether to use filters or the two additional zones in the biological nutrient removal basins will be required before implementation of Goal Level 1. In either case, a chemical feed building will be required for the addition of iron for phosphorus polishing as needed, and a carbon source such as methanol for additional denitrification.

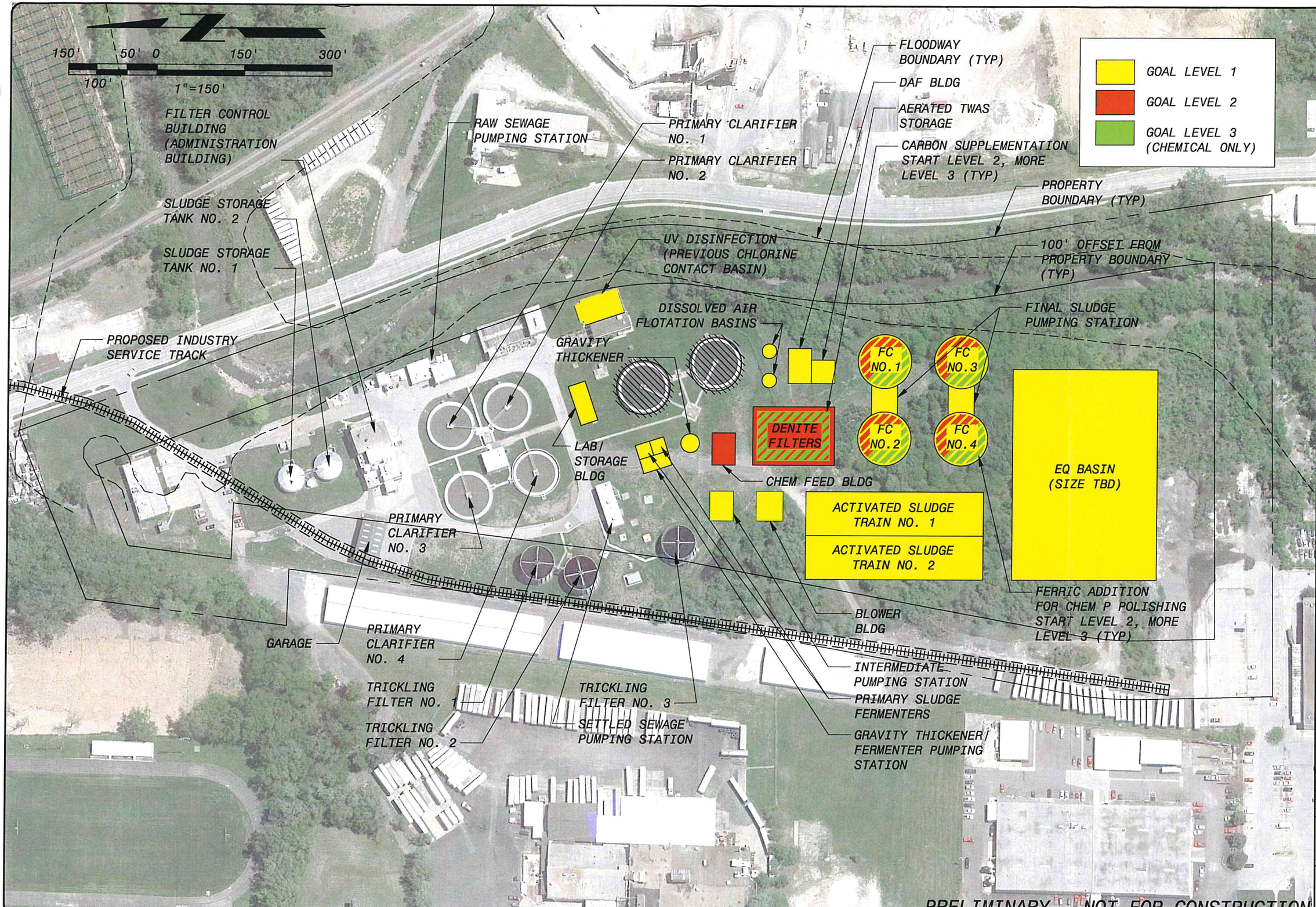
A phased site layout showing the facilities required for each goal level is included in *Figure 5-1*. The layout includes facility sizing to treat an annual average (AA) flow of 8.1 million gallons per day (mgd) which essentially maximizes the use of the existing plant property and is considered ultimate buildout of the site. The initial expansion for Goal Level 1 effluent quality is shown to bring the plant capacity to 8.1 mgd, however, an intermediate expansion to a capacity less than 8.1 mgd could be accomplished. This should be determined prior to design of the initial nutrient removal improvements.

Other site considerations are discussed in a separate section of this chapter.

5.1.3 Other Future Improvements to Consider

There are other improvements and ongoing work that should be considered that are not directly related to disinfection or nutrient removal. The following future improvements should be considered and are listed in no particular order.

- Flow Equalization
- Screening and Grit Removal Replacement/Upgrade
- Solids Processing Improvements
- Odor Control
- Flood Protection (levee or flood wall)
- Improvements to Flow Metering
- Installation of Automatic Transfer Feed Switch
- Replace shallow Primary Clarifiers (PC Nos. 1 and 2)



PRELIMINARY - NOT FOR CONSTRUCTION

NO.	DATE	REVISIONS AND RECORD OF ISSUE	BY	CK	APP

CYGNET ID: PW FLDR: 168597...\41.4100 - Drawings\XREF:
SAVED: CRAE417, 11/10/2010 5:32:31 PM XREF2 ID:
DWG VER #: 1000 XREF3 ID:
PLOTTED: CRAE417, 11/23/2010 11:23:09 AM XREF4 ID:
USER: CRAE417 SW: PW FILES: Site Plan.dwg XREF5 ID:

BLACK & VEATCH Corporation
Kansas City, Missouri

LEAVENWORTH, KANSAS
MASTER PLAN & COLLECTION SYSTEM UPDATE

PHASED SITE LAYOUT

DESIGNED:
DETAILED:
CHECKED:
APPROVED:
DATE:

PROJECT NO.
168597

FIG 5-1

SHEET OF

FB5000
B5000

- Flow Monitoring

These improvements are recommended for the following reasons: to replace worn equipment, increase capacity, improve plant performance and reliability, improve public perception, provide protection for the facilities, increase accuracy of reporting, and reduce maintenance and repair activities. Many of these improvements could be added to the future nutrient removal improvement projects.

5.2 Staffing

5.2.1 Current Staffing Level

Currently, the Leavenworth WWTP is staffed from 7:30 a.m. to 4:00 p.m. on weekdays and weekend work includes only answering calls. The plant has a rated design capacity of 5.4 mgd and utilizes trickling filters for secondary treatment. Staff consists of twelve (12) operators for the wastewater treatment plant and the collection system, an administrative clerk, a lab technician, a plant superintendent, and an assistant plant superintendent. Generally, three operators are on call every weekend.

5.2.2 Future Staffing Levels

The addition of a new secondary process (activated sludge) and the associated aeration facilities will increase the O&M needs of the facilities. These additional facilities will also increase the number of instruments on site and the need for an Instrumentation and Control (I&C) technician. As a result of these additional facilities, a minimum of one (1) additional maintenance technician, and a half-time I&C technician should be added to on-site staff with the completion of the initial nutrient removal improvements.

Future staffing needs will increase with future plant expansions. The increased nutrient removal restrictions are expected to create the need for increased I&C involvement among operations personnel. Future considerations, such as the operation of

secondary treatment trains individually or combined would also affect the staffing needed.

5.3 Plant Hydraulics

The hydraulics at the plant is highly influenced by the Missouri River level. The preliminary hydraulic modeling indicates that when the river is at the 100-year flood level, weirs at the chlorine contact basin, Special Manhole No. 2, final clarifiers, and primary clarifiers are submerged during peak hour flows. Some of these weirs are submerged at the 100-year river level regardless of the flow the plant receives. Therefore, there appears to be two issues: backwater from the river during flood stages, and hydraulic bottlenecks within the plant and outfall pipe. An existing plant hydraulic profile has been included in Chapter 1.0.

5.3.1 Proposed Hydraulic Modifications

There are some modifications that could help alleviate some of the hydraulic concerns. Modifications which may be considered with future improvements are as follows.

- Raise walls of the existing chlorine contact basin to increase freeboard.
- Modify piping between the final clarifiers and disinfection to reduce headloss.
- Add effluent pumping.
- Increase primary clarifier capacity by replacing the two shallow units.
- Increase Settled Sewage Pumping Station capacity and remove emergency bypass.
- Add equalization facilities.

5.4 Site Considerations

The proposed facilities for each nutrient removal goal level to ultimate build-out of the treatment facility are shown in *Figure 5-1*. The proposed facilities allow for future

growth and more stringent permit regulations. In addition, the layout of the proposed facilities was arranged so the existing treatment facilities can remain on-line during construction. The following paragraphs discuss how the site layout was developed and identify important site considerations.

There are several boundaries that constrain the amount of land available for construction of the proposed facilities. In accordance with KDHE's "Minimum Standards of Design for Water Pollution Control Facilities" facilities shall be located such that there is a minimum of 100 feet of separation from the property boundary. This property boundary offset is delineated on the site plan. In addition, it is good practice for facilities to remain outside of the floodway boundary to prevent obstruction of floodwaters and the modeling/ permitting efforts associated with proving a "no-rise" in the water surface elevation. The floodway boundary was obtained from recent FEMA Flood Insurance Rate Map and has been delineated on the site plan.

A future railroad spur and its minimum clearance requirements as determined by Union Pacific Railroad are shown on the site plan. The proposed rail spur, when constructed, will require a new plant entrance drive and will require the Maintenance Building to be relocated. For the most part, this rail spur will reside within the 100 foot offset from the property boundary and should have a minimal impact to the location of future nutrient removal facilities.

As mentioned in Chapter 1.0, the 100-year flood elevation is 772.00. There are a few locations within the property that are at or below this elevation. It will be important to consider the grade elevation during design to ensure that facilities are adequately protected from the 100-year flood, which is required by KDHE standards.

Another concern is the presence of buried trash on the site. This was discovered during the construction of Trickling Filter No. 3 in the Phase II plant expansion. It is believed that there is more trash in much of the land south of the existing plant. This is important because it will affect foundation design and could impact costs.

5.5 Economic Evaluation

5.5.1 Capital Costs

The conceptual facility improvements presented in this report were used to develop a preliminary opinion of probable project cost. The preliminary opinion of probable project costs includes the costs of construction, engineering, and contingencies. Construction costs include contractor's overhead and profit, electrical and instrumentation. Contingency has been included to account for project elements unknown during the conceptual phase of design. Engineering costs for design, construction administration, and resident services were projected at 20 percent.

5.5.2 O&M Costs

O&M costs were developed for each goal level. O&M costs were calculated for the Leavenworth plant only and do not include any administration or collections system costs. The following assumptions were used in developing the O&M costs for nutrient removal facilities. O&M cost development for disinfection facilities is discussed in Chapter 3.0.

- Electrical costs were based on a unit cost $0.10/kWh with major equipment average power draw considered for usage.
- Chemical costs included methanol and ferric chloride.
    - Ferric chloride costs included use for phosphorus polishing at a unit cost of $1.50/gallon.
    - Methanol costs included use for denitrification at a unit cost of $1.15/gallon.

5.5.3 Opinion of Probable Costs

Capital and O&M costs for implementing UV Disinfection are included in *Table 5-1*. Capital and O&M costs for implementing nutrient removal at the three goal levels are included in *Table 5-2*.

Table 5-1 Capital and O&M Costs for UV Disinfection			
	UV Disinfection and Generator		3,248,000
CAPITAL COSTS	GENERAL REQUIREMENTS	12%	400,000
	SITEWORK	10%	300,000
	ELECTRICAL & I&C	22%	800,000
	CONTINGENCY	25%	800,000
	CONSTRUCTION SUBTOTAL		**5,548,000**
	ENGINEERING	20%	1,100,000
	TOTAL CAPITAL COST		**6,648,000**
O&M COSTS	Annual O&M Cost		188,000
	20-year PW of O&M		3,074,000
	TOTAL PW COST		**9,722,000**

Table 5-2 Capital and O&M Cost for Various Levels of Nutrient Removal				
Phase of Treatment	**Facility**	**Goal Level 1**	**Goal Level 2**	**Goal Level 3**
Preliminary Treatment	EQ Basin	1,814,500		
Primary Treatment	Fermenter	601,000		
	Gravity Thickener/Fermenter PS	818,000		
	Gravity Thickener	251,000		
Secondary Treatment	BNR	7,663,500		
	Blower Building	1,987,000		
	Final Sludge PS	2,066,000		
	Final Clarifiers	3,992,000		
Tertiary Treatment	Intermediate Pumping Station	1,053,200		
	Filters		4,006,000	
Disinfection	Disinfection			
Solids	WAS Thickening	1,388,500		
	Aerated TWAS Storage	696,000		

Table 5-2
Capital and O&M Cost for Various Levels of Nutrient Removal

Phase of Treatment	Facility		Goal Level 1	Goal Level 2	Goal Level 3
Ancillary	Chemical Feed			944,000	
	Additional Lab/Storage Space		393,000		
COST MULTIPLIERS	SUBTOTAL		22,723,700	4,950,000	0
	GENERAL REQUIREMENTS	15%	3,400,000	700,000	0
	SITEWORK	15%	3,400,000	700,000	0
	ELECTRICAL & I&C	25%	6,500,000	1,400,000	0
	CONTINGENCY	30%	10,800,000	2,300,000	0
	CONSTRUCTION SUBTOTAL		**46,823,700**	**10,050,000**	**0**
	ENGINEERING	20%	9,400,000	2,000,000	0
	TOTAL CAPITAL COST		**56,223,700**	**12,050,000**	**0**
O&M COSTS	Annual O&M Cost		835,000	843,000	919,000
	20-year PW of O&M		13,653,000	13,784,000	15,027,000
	TOTAL PW COST		**69,876,700**	**25,834,000**	**15,027,000**

Appendix A:

Current NPDES Permit

KANSAS

Kathleen Sebelius, Governor
Roderick L. Bremby, Secretary

DEPARTMENT OF HEALTH
AND ENVIRONMENT

www.kdheks.gov

Division of Environment

June 19, 2008

City Clerk
100 N. 5th Street
Leavenworth, KS 66048

RE: Kansas Water Pollution Control
Permit No. M-MO12-IO01
City of Leavenworth

Dear Permittee:

You have fulfilled all the filing requirements for a Kansas Water Pollution Control Permit and Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES). We are pleased to forward your new permit. While it is permissible to make as many copies as needed for monitoring and reporting purposes, you need to retain the original permit for your files.

We suggest you carefully read the terms and conditions of your permit and understand these terms and conditions are enforceable under both State and Federal law.

Please notice the reporting paragraph on page 2 of your permit, where all reports are due by the 28th day of the schedule noted. Please submit reports to the Kansas Department of Health and Environment, Bureau of Water-TSS, 1000 SW Jackson St., Suite 420, Topeka, Kansas 66612-1367.

If you have any questions concerning this permit, contact Ed Dillingham at (785)296-5513.

Sincerely,

Karl Mueldener

Karl Mueldener, P.E.
Director, Bureau of Water

pc: NE - District
RG- Permit File

Kansas Permit No.: M-MO12-IO01

Federal Permit No.: KS0036366

KANSAS WATER POLLUTION CONTROL PERMIT AND
AUTHORIZATION TO DISCHARGE UNDER
THE NATIONAL POLLUTANT DISCHARGE
ELIMINATION SYSTEM

Pursuant to the Provisions of Kansas Statutes Annotated 65-164 and 65-165, the Federal Water Pollution Control Act as amended, (33 U.S.C. 1251 et seq; the "Act"),

Owner:	Leavenworth, City of
Owner's Address:	100 N. 5th Street Leavenworth, Kansas 66048
Facility Name:	Leavenworth Wastewater Treatment Plant
Facility Location:	1800 S. 2nd Street Leavenworth, Kansas 66048 SE¼, NW¼, NE¼, Section 1, Township 9S, Range 22E Leavenworth County, Kansas
Receiving Stream & Basin:	Missouri River Missouri River Basin

is authorized to discharge from the wastewater treatment facility described herein, in accordance with effluent limitations and monitoring requirements as set forth herein.

This permit is effective July 1, 2008, supersedes the previously issued water pollution control permit M-MO12-IO01, and expires December 31, 2012.

FACILITY DESCRIPTION:

1. Bar Screening
2. Aerated grit basin
3. Primary settling basin
4. Trickling filters - plastic media
5. Final settling basin
6. Chlorine contact basin (Currently Not Used)
7. Belt Filter Press for Sludge Dewatering
8. Pug Mill for Lime Addition
9. Design P.E. = 55,000
10. Design Flow = 6.88 MGD

Secretary, Kansas Department of Health and Environment

June 19, 2008
Date

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

The permittee is authorized to discharge from outfall(s) with serial number(s) as specified in this permit. The effluent limitations shall become effective on the dates specified herein. Such discharges shall be controlled, limited, and monitored by the permittee as specified. There shall be no discharge of floating solids or visible foam in other than trace amounts.

Monitoring reports shall be submitted on or before the 28th day of the following month. In the event no discharge occurs, written notification is still required.

	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
	Interim Limitations Upon Issuance	Final Limitations Per Schedule of Compliance		
ffective Date				
ıtfall Number and ffluent Parameters			Measurement Frequency	Sample Type
)1AG - Influent to Treatment Plant				
.ochemical Oxygen Demand (5-Day)-mg/l	Monitor	Monitor	Twice Weekly	24-Hour Composite
›tal Suspended Solids-mg/l	Monitor	Monitor	Twice Weekly	24-Hour Composite
›tal Phosphorus (as P)-mg/l	Monitor	Monitor	Once Monthly	Grab
Kjeldahl Nitrogen (as N)-mg/l	Monitor	Monitor	Once Monthly	Grab
›1 - Effluent after disinfection				
ochemical Oxygen Demand (5-Day)*			Twice Weekly	24-Hour Composite
Weekly Average-mg/l	45	45		
Monthly Average-mg/l	30	30		
·tal Suspended Solids*			Twice Weekly	24-Hour Composite
Weekly Average-mg/l	45	45		
Monthly Average-mg/l	30	30		
monia (as N)-mg/l	Monitor	Monitor	Twice Weekly	Grab
coli (Colonies/100 ml)			Twice Weekly	Grab
April through October				
Monthly Geometric Average	Monitor	160		
November through March				
Monthly Geometric Average	Monitor	2358		
tal Residual Chlorine**			Daily	Grab
Daily Maximum - ug/l	N/A	71		
- Standard Units	6.0-9.0	6.0-9.0	Twice Weekly	Grab
tal Phosphorus-mg/l (as P)(lbs/day)	Monitor (Calc.)	Monitor (Calc.)	Once Monthly	Grab
e (NO_3) + Nitrite (NO_2)as N-mg/l***	Monitor	Monitor	Once Monthly	Grab
.al Kjeldahl Nitrogen (as N)-mg/l ***	Monitor	Monitor	Once Monthly	Grab
tal Nitrogen (as N)-mg/l (lbs/day)*** TKN + NO_3 + NO_2)	Calculate	Calculate	Once Monthly	Calculate

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS (continued)

ffective Date utfall Number and ffluent Parameters	EFFLUENT LIMITATIONS Interim Limitations Upon Issuance	 Final Limitations Per Schedule of Compliance	MONITORING REQUIREMENTS Measurement Frequency	 Sample Type
hole Effluent Toxicity - See Supplemental Conditions E.1.				
riority Pollutant Scan - See Supplemental Conditions E.2.				
low - MGD	Monitor	Monitor	Daily	Meter

* Minimum removal of 85% required for Total Suspended Solids and Biochemical Oxygen Demand (5-Day). If inhibited Biochemical Oxygen Demand (5-Day) test is used, limits are 5 mg/l less than shown.

** (If disinfection is by chlorination) Permittee shall conduct testing for total residual chlorine according to the methods prescribed in 40 CFR Part 136. The current acceptable quantification level for total residual chlorine in wastewater is 100 micrograms/L. Test results in excess of the quantification level are violations of the permit limits.

*** Permittee shall sample for these tests on the same day and calculate the total nitrogen only when both test values are available. The Minimum Reportable Limit (MRL) for TKN is 1 mg/l and for nitrate + nitrite is 0.1 mg/l. Values less than the MRL shall be reported using the less than sign (<) with the MRL value but for purposes of calculating and reporting the total nitrogen result, less than values shall be defaulted to zero.

STANDARD CONDITIONS

In addition to the specified conditions stated herein, the permittee shall comply with the attached Standard Conditions dated August 1, 1996.

SUPPLEMENTAL CONDITIONS

Sludge disposal shall be in accordance with the 40 CFR Part 503 Sludge Regulations.

SCHEDULE OF COMPLIANCE

1. Permittee shall submit to KDHE for review an updated Wastewater Master Plan for the City by December 1, 2010.

   a. The Master Plan shall include plans and a schedule to upgrade the wastewater treatment facility (or facilities) to meet the final limits for E. coli stated herein. The schedule shall require the final limits for E. coli for the current wastewater treatment facility to be met by December 31, 2012 and any new wastewater treatment facility to be met within 3 months of startup. For the current wastewater treatment plant, the permittee shall provide completion dates for the following activities for the disinfection upgrade.

      1) Submit Plans and Specifications to KDHE for approval
      2) Advertise for Construction Bids
      3) Begin Construction
      4) Complete Construction
      5) Achieve Compliance with Permit by no later than December 31, 2012.

   b. The Master Plan shall include the study of options to meet the nutrient reduction goals as stated herein in the plant effluent for the current wastewater treatment facility and any new wastewater treatment facilities planned by the permittee.

SCHEDULE OF COMPLIANCE (continued)

1) The permittee shall conduct studies to assess the cost and feasibility for this facility to meet each of the following effluent nutrient goals as annual averages:

Goal	1	2	3
Total Nitrogen (as N) - mg/l	8.0	5.0	3.0
Total Phosphorus (as P)- mg/l	1.5	0.5	0.3

The studies shall include operational and capital costs for 1) operational changes only, if feasible, 2) biological treatment additions and 3) physical and chemical treatment additions to meet the stated goals.

2) The permittee shall provide the study results to KDHE with the updated Master Plan.

c. The Master Plan may also include plans and schedules for implementing any alternative equivalent methods for nutrient (mass) reduction in lieu of meeting the nutrient reduction goals at the current wastewater treatment facility and any new facilities proposed by the permittee.

2. Plans and schedules provided in the submittals are subject to approval by KDHE and may be incorporated into this permit or other enforceable documents.

BIOMONITORING AND PRIORITY POLLUTANTS

1. Whole Effluent Toxicity:

a. Acute Whole Effluent Toxicity (WET) testing on a 24-hr composite sample shall be conducted once in calendar year 2008 and annually thereafter. The median lethal concentration, LC50, shall be equal to or greater than 89% effluent. Test results less than 89% are violations of this permit. The test procedures shall use the 48 hour static non-renewal test method in accordance with the EPA document, Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, fifth edition, October 2002 using test organisms *Pimephales promelas* (fathead minnow) and any of the following daphnid (water flea) species: *Daphnia pulex, Daphnia magna,* or *Ceriodaphnia dubia* within a dilution series containing 0%, 25%, 50%, 75%, 89%, and 100% effluent. KDHE reserves the right to increase or decrease testing frequency based upon compliance history and toxicity testing results.

b. If the WET test results indicate the LC50 is equal to or greater than 89% effluent, the effluent has passed the toxicity test and the test report shall be due with the next scheduled Discharge Monitoring Report.

c. If the WET test results indicate the LC50 is less than 89% effluent, the effluent has failed the toxicity test and the permittee shall immediately notify KDHE by telephone (785) 296-5517 and submit to KDHE a copy of the test report within five days of receipt of the information. KDHE reserves the right to require the permittee to take such actions as are reasonable to identify and remedy any identified or predicted toxic conditions in the receiving stream outside of the zone of initial dilution which is caused by the permittee's effluent.

BIOMONITORING AND PRIORITY POLLUTANTS (continued)

d. Permittee shall also test a portion of one of same effluent samples used for the WET test for the following parameters (required minimum reportable detection levels are in parenthesis):

Antimony (10 µg/L)*	Nickel (10 µg/L)*
Arsenic (10 µg/L)*	Selenium (5 µg/L)*
Beryllium (5 µg/L)*	Silver (2 µg/L)*
Cadmium (2 µg/L)*	Thallium (10 µg/L)*
Chromium (10 µg/L)*	Zinc (20 µg/L)*
Copper (10 µg/L)*	Total Hardness as CaCO3 mg/l
Lead (5 µg/L)*	Ammonia (mg/l)

Mercury (0.2 µg/L-Cold Vapor Method)

* Parameter shall be tested and reported as "total recoverable" metals.

e. The permittee shall coordinate sampling for this test with other requirements of this permit. The permittee shall use a laboratory approved by KDHE for Whole Effluent Toxicity testing.

2. Permittee shall conduct a Priority Pollutant Scan on the effluent from Outfall 001A1 for the parameters listed in Table I, Priority Pollutant Scan, as noted below. The Priority Pollutant Scan shall be conducted during the last calendar year of this permit and the results reported to KDHE with the next Discharge Monitoring Report following receipt of the results but not later than August 31, 2012. Sample type shall be 24-hour composite except for Volatiles which shall be a grab sample. See Supplemental Condition E.1.d. for minimum detection limits for certain metals in the Priority Pollutant Scan.

Table I
Priority Pollutant Scan

Metals
Total Recoverable Arsenic (ug/l)
Total Recoverable Beryllium (ug/l)
Total Recoverable Cadmium (ug/l)
Total Recoverable Chromium (ug/l)
Total Recoverable Copper (ug/l)
Total Recoverable Lead (ug/l)
Total Mercury (ug/l)
Total Recoverable Molybdenum (ug/l)
Total Recoverable Potassium (ug/l)
Total Recoverable Nickel (ug/l)
Total Recoverable Selenium (ug/l)
Total Recoverable Silver (ug/l)
Total Recoverable Thallium (ug/l)
Total Recoverable Zinc (ug/l)

Pesticides
Aldrin (mg/l)
Alpha-BHC (mg/l)
Beta-BHC (mg/l)
Gamma-BHC (mg/l)
Delta-BHC (mg/l)
Chlordane (mg/l)
4,4-DDT (mg/l)
4,4-DDD (mg/l)
4,4-DDE (mg/l)
Dieldrin (mg/l)
Alpha-endosulfan (mg/l)
Beta-endosulfan (mg/l)
Endosulfan sulfate (mg/l)
Endrin (mg/l)
Endrin aldehyde (mg/l)
Heptachlor (mg/l)
Heptachlor epoxide (mg/l)
Toxaphene (mg/l)
Malathion (mg/l)
Diazinon (mg/l)

Polychlorinated Biphenyls (mg/l)
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016

Priority Pollutant Scan (continued)

:/Neutral
.cenaphthene (mg/l)
Acenaphtylene (mg/l)
Anthracene (mg/l)
Benzidine (mg/l)
Benzo(a) anthracene (mg/l)
Benzo(a)pyrene (mg/l)
3,4-benzofluoranthene (mg/l)
Benzo (ghi) perylene (mg/l)
Benzo (b) fluoranthene (mg/l)
Bis(2-chloroethoxy)methane (mg/l)
Bis(2-chloroethyl)ether (mg/l)
Bis(2-ethylhexyl)phthalate (mg/l)
Bis(2-chloroisopropyl) ether (mg/l)
1,2-diphenylhydrazine (mg/l)
Fluoranthene (mg/l)
Fluorene (mg/l)
Nitrobenzene (mg/l)
N-nitrosodimethylamine (mg/l)
N-nitrosodi-n-propylamine (mg/l)
N-nitrosodiphenylamine (mg/l)
Phenanthrene (mg/l)
Pyrene (mg/l)
1,2,4-trichlorobenzene (mg/l)
4-bromophenyl phenyl ether (mg/l)
Butyl benzyl phthalate (mg/l)
2-chloronaphthalene (mg/l)
4-chlorophenyl phenyl ether (mg/l)
Chrysene (mg/l)
benzo(a,h) anthracene (mg/l)
1,2-dichlorobenzene (mg/l)
1,3-dichlorobenzene (mg/l)
1,4-dichlorobenzene (mg/l)
3,3-dichlorobenzidine (mg/l)
Dimethyl phthalate (mg/l)
Diethyl phthalate (mg/l)
Di-n-butyl phthalate (mg/l)
2,4-dinitrotoluene (mg/l)
2,6-dinitrotoluene (mg/l)
Di-n-octyl phthalate (mg/l)
Hexachlorobenzene (mg/l)
Hexachlorobutadiene (mg/l)
Hexachlorocyclopentadiene (mg/l)
Hexachloroethane (mg/l)
Indeno (1,2,3-cd) pyrene (mg/l)
Naphthalene (mg/l)
Isophorone (mg/l)

Priority Pollutant Scan (continued)

' Compounds
hlorophenol (mg/l)
4-dichlorophenol (mg/l)
-,4-dimethylphenol (mg/l)
2,4-dinitrophenol (mg/l)
2-nitrophenol (mg/l)
4-nitrophenol (mg/l)
Parachlorometa cresol (mg/l)
Pentachlorophenol (mg/l)
Phenol (mg/l)
4,6-dinitro-o-cresol (mg/l)
2,4,6-trichlorophenol (mg/l)

olatiles
Acrolein (mg/l)
Acrylonitrile (mg/l)
Benzene (mg/l)
Bromoform (mg/l)
Carbon Tetrachloride (mg/l)
Chlorobenzene (mg/l)
Chlorodibromomethane (mg/l)
Chloroethane (mg/l)
2-chloroethylvinyl ether (mg/l)
Chloroform (mg/l) (mg/l)
Dichlorobromomethane (mg/l)
1,1-dichloroethane (mg/l)
1,2-dichloroethane (mg/l)
1,1-dichloroethylene (mg/l)
1,2-dichloropropane (mg/l)
-dichloropropylene (mg/l)
ylbenzene (mg/l)
thyl bromide (mg/l)
ethyl chloride (mg/l)
Methylene chloride (mg/l)
1,1,2,2-tetrachloroethane (mg/l)
Tetrachloroethylene (mg/l)
Toluene (mg/l)
1,2 trans-dichloroethylene (mg/l)
1,1,1-trichloroethane (mg/l)
1,1,2-trichloroethane (mg/l)
Trichloroethylene (mg/l)
Vinyl chloride (mg/l)

scellaneous
Total Cyanide (mg/l)*
Total Phenols (mg/l)

The total cyanide analysis must include preliminary treatment of the sample to avoid NO_2^- interference. Addition of sulfamic acid to the sample before distillation can prevent such interference, see Standard Methods for the Examination of Water and Wastewater, 18th Edition, 4500-CN^- B. Preliminary Treatment of Samples.

STANDARD CONDITIONS FOR
KANSAS WATER POLLUTION CONTROL AND
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

1. Representative Sampling:

   A. Samples and measurements taken as required herein shall be representative of the nature and volume of the monitored discharge. All samples shall be taken at the location designated in this permit, and unless specified, at the outfall(s) before the effluent joins or is diluted by any other water or substance.

   B. Monitoring results shall be recorded and reported on forms acceptable to the Division and postmarked no later than the 28th day of the month following the completed reporting period. Signed and certified copies of these, prepared in accordance with KAR 28-16-59 and all other reports required herein, shall be submitted to:

      Kansas Department of Health & Environment
      Bureau of Water-Technical Services Section
      1000 SW Jackson Street, Suite 420
      Topeka, KS 66612-1367

2. Schedule of Compliance: No later than 14 calendar days following each date identified in the "Schedule of Compliance," the permittee shall submit to the above address, either a report of progress or, in the case of specific action being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirements, or, if there are no more scheduled requirements, when such noncompliance will be corrected.

3. Definitions:

   A. The "daily average" discharge means either the total discharge by weight during a calendar month divided by the number of days in the month that the facility was operating or the average concentration for the month. The daily average discharge shall be determined by the summation of all measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made, or by the summation of all concentrations determined during the calendar month divided by the number of samples collected and analyzed.

   B. The "daily maximum" discharge means the total discharge by weight or average concentration during a 24 hour period.

   C. The "monthly average", other than for fecal coliform bacteria, is the arithmetic mean of the value of effluent samples collected in a period of 30 consecutive days. The monthly average for fecal coliform bacteria is the geometric mean of the value of the effluent samples collected in a period of 30 consecutive days.

   D. The "weekly average", other than for fecal coliform bacteria, is the arithmetic mean of the value of effluent samples collected in a period of 7 consecutive days. The weekly average for fecal coliform bacteria is the geometric mean of the value of effluent samples collected in a period of 7 consecutive days.

   E. A "grab sample" is an individual sample collected in less than 15 minutes.

F. A "composite sample" is a combination of individual samples in which the volume of each individual sample is proportional to the discharge flow, the sample frequency is proportioned to the flow rate over the sample period, or the sample frequency is proportional to time.

G. The "act" means the Clean Water Act, 30 USC Section 1251 et seq.

H. The terms "Director", "Division", and "Department" refer to the Director, Division of Environment, Kansas Department of Health and Environment, respectively.

I. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

J. "Bypass" means any diversion of waste streams from any portion of a treatment facility or collection syste

4. Test Procedures: All analysis required by this permit shall conform to the requirements of 33 USC Section 1314(h), and shall be conducted in a laboratory certified by this Department. For each measurement or sample, the permittee shall record the exact place, date, and time of sampling; the date of the analyses, the analytical techniques or methods used, and the individual(s) who performed the sampling and analysis and, the results. If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved procedures, the results shall be included in the Discharge Monitoring Report form required in 1.B. above. Such increased frequencies shall also be indicated.

5. Records Retention: All records and information resulting from the monitoring activities required by this permit, including all records of analyses and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation, shall be retained for a minimum of 3 years, or longer if requested by the Division.

6. Change in Discharge: All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant not authorized by this permit or of any pollutant identified in this permit more frequen' than or at a level in excess of that authorized shall constitute a violation of this permit. Any anticipated facili, expansions, productions or flow increases, or process modifications which result in a new, different, or increased discharge of pollutants shall be reported to the Division at least one hundred eighty (180) days before such chan

7. Noncompliance Notifications: If for any reason, the permittee does not comply with, or will be unable to comply with any daily maximum or weekly average effluent limitations specified in this permit, the permittee shall provide the Department with the following information in writing within five days of becoming aware of such condition:

A. A description of the discharge and cause of noncompliance, and

B. the period of noncompliance including exact dates and times or if not corrected, the anticipated time the noncompliance is expected to continue and steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

The above information shall be provided with the submittal of the regular Discharge Monitoring Report form for violations of daily average or monthly average effluent limitations.

F. A "composite sample" is a combination of individual samples in which the volume of each individual sample is proportional to the discharge flow, the sample frequency is proportioned to the flow rate over the sample period, or the sample frequency is proportional to time.

G. The "act" means the Clean Water Act, 30 USC Section 1251 et seq.

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5. Records Retention: All records and information resulting from the monitoring activities required by this permit, including all records of analyses and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation, shall be retained for a minimum of 3 years, or longer if requested by the Division.

6. Change in Discharge: All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant not authorized by this permit or of any pollutant identified in this permit more frequen than or at a level in excess of that authorized shall constitute a violation of this permit. Any anticipated facili expansions, productions or flow increases, or process modifications which result in a new, different, or increased discharge of pollutants shall be reported to the Division at least one hundred eighty (180) days before such chan

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A. A description of the discharge and cause of noncompliance, and

B. the period of noncompliance including exact dates and times or if not corrected, the anticipated time the noncompliance is expected to continue and steps taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

The above information shall be provided with the submittal of the regular Discharge Monitoring Report form for violations of daily average or monthly average effluent limitations.

Facilities Operation: The permittee shall at all times maintain in good working order and efficiently and effectively operate all treatment, collection, control systems or facilities, to achieve compliance with the terms of this permit. Such proper operation and maintenance procedures shall also include adequate laboratory controls and appropriate quality assurance procedures. Maintenance of treatment facilities which results in degradation of effluent quality, even though not causing violations of effluent limitations shall be scheduled during noncritical water quality periods and shall be carried out in a manner approved in advance by the Division. The permittee shall take all necessary steps to minimize or prevent any adverse impact to waters of the State resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge. When necessary to maintain compliance with the permit conditions, the permittee shall halt or reduce those activities under its control which generate wastewater routed to this facility.

9. Immediate Reporting Required: Any diversion from, or bypass of facilities necessary to maintain compliance with the permit is prohibited, except: where no feasible alternatives to the bypass exist and 1) where necessary to prevent loss of human life, personal injury or severe property damage; or 2) where excessive stormwater inflow or infiltration would damage any facilities necessary to comply with this permit or 3) where the permittee notifies the Director seven days in advance of an anticipated bypass. The Director or Director's designee may approve a bypass, after considering its adverse effects, if any of the three conditions listed above are met. The permittee shall immediately notify the Division by telephone [(913) 296-5517 or the appropriate KDHE District Office] of each bypass and shall confirm the telephone notification with a letter explaining what caused this spill or bypass and what actions have been taken to prevent recurrence. Written notification shall be provided to the Director within five days of the permittee becoming aware of the bypass. The Director or Director's designee may waive the written report on a case-by-case basis.

10. Removed Substances: Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner acceptable to the Division.

11. Power Failures: The permittee shall provide an alternative power source sufficient to operate the wastewater control facilities or otherwise control pollution and all discharges upon the loss of the primary source of power to the wastewater control facilities.

12. Right of Entry: The permittee shall allow authorized representatives of the Division of Environment or the Environmental Protection Agency upon the presentation of credentials, to enter upon the permittee's premises where an effluent source is located, or in which are located any records required by this permit, and at reasonable times, to have access to and copy any records required by this permit, to inspect any monitoring equipment or monitoring method required in this permit, and to sample any influents to, discharges from or materials in the wastewater facilities.

13. Transfer of Ownership: The permittee shall notify the succeeding owner or controlling person of the existence of this permit by certified letter, a copy of which shall be forwarded to the Division. The succeeding owner shall secure a new permit. The permit is not transferable to any person except after notice and approval by the Director. The Director may require modification or revocation and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary.

14. Availability of Records: Except for data determined to be confidential under 33 USC Section 1318, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department. Effluent data shall not be considered confidential. Knowingly making any false statement on any such report or tampering with equipment to falsify data may result in the imposition of criminal penalties as provided for in 33 USC Section 1319 and KSA 65-170c.

Permit Modifications and Terminations: As provided by KAR 28-16-62, after notice and opportunity for a hearing, this permit may be modified, suspended or revoked or terminated in whole or in part during its term for cause as provided but not limited to those set forth in KAR 28-16-62 and KAR 28-16-28b through f. The permittee shall furnish to the Director, within a reasonable amount of time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The permittee shall also furnish upon request, copies of all records required to be kept by this permit.

16. Toxic Pollutants: Notwithstanding paragraph 15 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified at such effluent standards) is established under 33 USC Section 1317(a) for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition. Nothing in this permit relieves the permittee from complying with federal toxic effluent standards as promulgated pursuant to 33 USC Section 1317.

17. Civil and Criminal Liability: Except as authorized in paragraph 9 above, nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance as provided for in KSA 65-170d, KSA 65-167, and 33 USC Section 1319.

18. Oil and Hazardous Substance Liability: Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities or penalties to which the permittee is or may be subject to under 33 USC Section 1321 or KSA 65-164 et seq. The municipal permittee shall promptly notify the Division by telephone upon discovering crude oil or any petroleum derivative in its sewer system or wastewater treatment facilities.

19. Industrial Users: The municipal permittee shall require any industrial user of the treatment works to comply with 33 USC Section 1317, 1318 and any industrial user of storm sewers to comply with 33 USC Section 1308.

20. Property Rights: The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights nor a infringements of or violation of federal, state or local laws or regulations.

21. Operator Certification: The permittee shall ensure the wastewater facilities are under the supervision of an operator certified by the Department. If the permittee does not have a certified operator or loses its certified operator, appropriate steps shall be taken to obtain a certified operator as required by KAR 28-16-30 et seq.

22. Severability: The provisions of this permit are severable. If any provision of this permit or any circumstance is held invalid, the application of such provision to other circumstances and the remainder of the permit shall not be affected thereby.

23. Removal from Service: The permittee shall inform the Division at least three months before a pumping station, treatment unit, or any other part of the treatment facility permitted by this permit is to be removed from service and shall make arrangements acceptable to the Division to decommission the facility or part of the facility being removed from service such that the public health and waters of the state are protected.

24. Duty to Reapply: A permit holder wishing to continue any activity regulated by this permit after the expiration date, must apply for a new permit at least 180 days prior to expiration of the permit.

15. Permit Modifications and Terminations: As provided by KAR 28-16-62, after notice and opportunity for a hearing, this permit may be modified, suspended or revoked or terminated in whole or in part during its term for cause as provided but not limited to those set forth in KAR 28-16-62 and KAR 28-16-28b through f. The permittee shall furnish to the Director, within a reasonable amount of time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this permit. The permittee shall also furnish upon request, copies of all records required to be kept by this permit.

16. Toxic Pollutants: Notwithstanding paragraph 15 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified at such effluent standards) is established under 33 USC Section 1317(a) for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition. Nothing in this permit relieves the permittee from complying with federal toxic effluent standards as promulgated pursuant to 33 USC Section 1317.

17. Civil and Criminal Liability: Except as authorized in paragraph 9 above, nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance as provided for in KSA 65-170d, KSA 65-167, and 33 USC Section 1319.

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20. Property Rights: The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights nor any infringements of or violation of federal, state or local laws or regulations.

21. Operator Certification: The permittee shall ensure the wastewater facilities are under the supervision of an operator certified by the Department. If the permittee does not have a certified operator or loses its certified operator, appropriate steps shall be taken to obtain a certified operator as required by KAR 28-16-30 et seq.

22. Severability: The provisions of this permit are severable. If any provision of this permit or any circumstance is held invalid, the application of such provision to other circumstances and the remainder of the permit shall not be affected thereby.

23. Removal from Service: The permittee shall inform the Division at least three months before a pumping station, treatment unit, or any other part of the treatment facility permitted by this permit is to be removed from service and shall make arrangements acceptable to the Division to decommission the facility or part of the facility being removed from service such that the public health and waters of the state are protected.

24. Duty to Reapply: A permit holder wishing to continue any activity regulated by this permit after the expiration date, must apply for a new permit at least 180 days prior to expiration of the permit.

Appendix B:

Collection System Recommended Rehabilitation

Legend

- Completed Rehabilitation
- Sanitary Sewer Manholes
- Sanitary Sewer Gravity Mains
- 01-01_MH_Rehab
- 01_01_Private_Defects
- 01-01_Pipeline_Rehabillitation
- 01-01_Capacity_Improvements

Cheyenne
Pawnee
Dakota
Johnson
Kiowa
Lamphole
7th
8th
Esplanade
3rd
2nd
322 POTTAWATOMIE ST
Pottawatomie
423 POTTAWATOMIE ST
408 5TH ST
Osage
201 OSAGE ST
229 OSAGE ST
309 ESPLANADE ST
112 MIAMI ST
214 MIAMI ST
4th
Broadway
522 MIAMI ST
Miami
215 4TH ST
422 SENECA ST
602 SENECA ST
Seneca
01-01
01-06
Shawnee
01-05
Delaware
01-04
Ryan
Cherokee
413 CHEROKEE ST
525 CHEROKEE ST
Choctaw
Ottawa
Grand
Sherman
9th
Lawrence
Short
01-02
Oak
7th
N

Figure D1

Recommended Rehabilitation
Mini Basin 01-01

City of Leavenworth, Kansas
I&I Assessment and Reduction Plan
Trekk Project No. 10-066

Mini-Basin 01-02 Recommended Rehabilitation

Mini-Basin 01-02

Manhole Rehabilitation Program

Information summarized in Section 8 of the Sanitary Sewer Evaluation Study – SUB01 (Wade, 2005) recommended a total of 56 potential I/I sources, within 44 manholes, be repaired. A revised cost-effective manhole rehabilitation schedule, detailing the type of rehabilitation for each defective manhole, is included as Attachment A1. A total of $26,000 has been estimated for the Mini-Basin 01-02 recommended manhole rehabilitation program. Of this total, $6,000 has been estimated for contingencies such as engineering, administration, inspection, and potential construction overages. A general breakdown of the type and cost of rehabilitation is shown in Table A1.

This list, in addition with an overall map of the manholes and the City's technical specifications for the rehabilitation methods, will provide the City with a "ready to bid" packet. TREKK has provided this end product numerous times that have resulted in ***successful, cost-effective*** rehabilitation projects.

Table A1

Mini-Basin 01-02: Recommended Manhole Rehabilitation Summary

Type of Rehabilitation	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Replace Frame / Cover*	3	EA	600	1,800
Seal Frame Seal	34	EA	300	10,200
CIP Chimney	10	EA	575	5,750
Bench / Invert Rehab	1	EA	225	225
Resurfacing	1	LS	1,650	1,650
Sub-Total:**				**20,000**
Contingencies (30%):**				**6,000**
Total Cost:**				**26,000**

* It is recommended that vented covers and poor fitting covers be replaced with an entirely new frame and cover.

**Costs are rounded up to the nearest thousand dollars.

Private-Sector I&I Abatement Program

It is recommended that all cost-effective private sector defects be included in a private sector I&I reduction program. Studies conducted by WERF estimate that some municipalities receive up to 80% of their I&I from private property sources. Allowing these sources to remain connected simply increases the cost of relief sewers, maintenance related cost, and transportation and treatment costs. It should also be noted that, over time defects that have been abated may be re-introduced to the sewer system.

The total cost to complete the recommended private sector I&I rehabilitation is estimated at $82,000 including a 30% contingency set-aside of $19,000. A general breakdown of the costs to implement the recommended private sector rehabilitation program is outlined in *Table A2*. Details regarding the type, location, and unit cost are included as Attachment A2.

Table A2

Mini-Basin 01-02: Recommended Private Sector I&I Abatement Summary

Type of Rehabilitation	$/GPM*	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Repair Uncapped Cleanout	1.5	12	EA	25	300
Disconnect Downspout	1.8	2	EA	75	150
Disconnect Area Drain	58	3	EA	2,500	7,500
Disconnect Driveway Drain	335	5	EA	5,000	25,000
Repair Service Lateral	350	12	EA	2,500	30,000
Sub-Total*:					**63,000**
Contingencies (30%)*:					**19,000**
Total Cost*:					**82,000**

* Costs to repair versus I&I Flow Rate. Defects with a lower rate are more cost-effective to repair.

** Costs are rounded to the nearest thousand dollars.

Pipeline Rehabilitation Program

The *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) identified numerous locations in the Study Area where I&I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I&I and

other major deficiencies such as voids, broken pipe, or partially collapsed pipe. All defects were initially located by smoke testing and manhole inspection activities and identified for cleaning and CCTV inspection. A total of 12 individual line segments, representing approximately 4,035 linear feet of sanitary sewer, were identified in mini-basin 01-02 for rehabilitation. Two of these line segments have been recently addressed as part of the City's rehabilitation efforts. The total estimated cost to complete the pipeline rehabilitation program is $213,000. This cost includes a 30% contingency fee of $49,000 for engineering, inspection, legal, and general administration costs. A general breakdown of the quantity and cost to implement the recommended pipeline rehabilitation program is shown in Table A3. A complete list of all lines recommended for rehabilitation is included as Attachment A3. The location of all recommended rehabilitation in mini-basin 01-02 is shown in Figure A1. Also, shown in Figure A1 are capacity improvements identified as part of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005), however, these capacity improvements are not recommended at this time. The recommended rehabilitation and post-rehabilitation flow monitoring should be completed prior to capacity improvements.

Table A3

Mini-Basin 01-02: Recommended Pipeline Rehabilitation Program

Type of Rehabilitation	Unit	Quantity	Unit Cost	Footage	Total Cost ($)
Point Repair	EA	3	$65	30	1,950
Replacement (8" Pipe)	LF	7	$65	1,542	100,230
Replacement (12" Pipe)	LF	1	$85	310	26,350
Manhole Replacement	EA	14	$2,500		35,000
Sub-Total*:					**164,000**
Contingencies (30%)*:					**49,000**
Total Cost*:					**213,000**
*Costs are rounded to the nearest thousand dollars.					

Attachment A1
City Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-02

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Frame Seal	01-02	0099			RICHARD ALLEN		11.10	300	27.03	11.10	300	0.09
2	Frame Seal	01-02	0312			Harris Bros. Cleaners		11.10	300	27.03	22.20	600	0.17
3	Frame Seal	01-02	0313					11.10	300	27.03	33.30	900	0.26
4	Frame Seal	01-02	0319					11.10	300	27.03	44.40	1,200	0.35
5	Frame Seal	01-02	0320			Walnut and Broadway		11.10	300	27.03	55.50	1,500	0.44
6	Frame Seal	01-02	0321			Broadway and Chestnut		11.10	300	27.03	66.60	1,800	0.52
7	Frame Seal	01-02	0323					11.10	300	27.03	77.70	2,100	0.61
8	Frame Seal	01-02	0482					11.10	300	27.03	88.80	2,400	0.70
9	Frame Seal	01-02	0507					11.10	300	27.03	99.90	2,700	0.78
10	Frame Seal	01-02	0741					11.10	300	27.03	111.00	3,000	0.87
11	Frame Seal	01-02	0099A			RICKARD ALLEN		11.10	300	27.03	122.10	3,300	0.96
12	Frame Seal	01-02	0313A			E. of 6th, N. of Walnut		11.10	300	27.03	133.20	3,600	1.05
13	Frame Seal	01-02	0359B			Hospital, 7th & Marshall		11.10	300	27.03	144.30	3,900	1.13
14	Frame Seal	01-02	0365B					11.10	300	27.03	155.40	4,200	1.22
15	Replace Frame / Cover	01-02	0504			S. of Medical Arts		18.94	600	31.68	174.34	4,800	1.37
16	Replace Frame / Cover	01-02	0313B			Court House		14.30	600	41.96	188.64	5,400	1.48
17	Frame Seal	01-02	0322					2.22	300	135.14	190.86	5,700	1.50
18	Frame Seal	01-02	0330					2.22	300	135.14	193.08	6,000	1.52
19	Frame Seal	01-02	0331					2.22	300	135.14	195.30	6,300	1.53
20	Frame Seal	01-02	0359			7th and Spruce		2.22	300	135.14	197.52	6,600	1.55
21	Frame Seal	01-02	0478					2.22	300	135.14	199.74	6,900	1.57
22	Frame Seal	01-02	0495					2.22	300	135.14	201.96	7,200	1.58
23	Frame Seal	01-02	0501					2.22	300	135.14	204.18	7,500	1.60
24	Frame Seal	01-02	0503					2.22	300	135.14	206.40	7,800	1.62
25	Frame Seal	01-02	0505					2.22	300	135.14	208.62	8,100	1.64
26	Frame Seal	01-02	0506					2.22	300	135.14	210.84	8,400	1.65
27	Frame Seal	01-02	0508					2.22	300	135.14	213.06	8,700	1.67
28	Frame Seal	01-02	0739					2.22	300	135.14	215.28	9,000	1.69
29	Frame Seal	01-02	0312A					2.22	300	135.14	217.50	9,300	1.71
30	Frame Seal	01-02	0313C			Salvation Army		2.22	300	135.14	219.72	9,600	1.72
31	Frame Seal	01-02	0324B					2.22	300	135.14	221.94	9,900	1.74
32	Frame Seal	01-02	0326A					2.22	300	135.14	224.16	10,200	1.76
33	Frame Seal	01-02	0492B					2.22	300	135.14	226.38	10,500	1.78
34	Frame Seal	01-02	0495A					2.22	300	135.14	228.60	10,800	1.79
35	Frame Seal	01-02	0500A					2.22	300	135.14	230.82	11,100	1.81
36	Frame Seal	01-02	0501A			behind address		2.22	300	135.14	233.04	11,400	1.83
37	Chimney	01-02	0099A			RICKARD ALLEN		3.16	575	181.96	236.20	11,975	1.85
38	Bench	01-02	0359B			Hospital, 7th & Marshall		0.70	225	321.43	236.90	12,200	1.86
39	Replace Frame / Cover	01-02	0313B			Court House		1.66	600	361.45	238.56	12,800	1.87
40	Chimney	01-02	0312			Harris Bros. Cleaners		1.11	575	518.02	239.67	13,375	1.88
41	Chimney	01-02	0313					1.11	575	518.02	240.78	13,950	1.89
42	Chimney	01-02	0320			Walnut and Broadway		1.11	575	518.02	241.89	14,525	1.90
43	Chimney	01-02	0321			Broadway and Chestnut		1.11	575	518.02	243.00	15,100	1.91
44	Chimney	01-02	0322					1.11	575	518.02	244.11	15,675	1.92
45	Chimney	01-02	0359			7th and Spruce		1.11	575	518.02	245.22	16,250	1.92

Attachment A1
City Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-02

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
46	Chimney	01-02	0360					1.11	575	518.02	246.33	16,825	1.93
47	Chimney	01-02	0508					1.11	575	518.02	247.44	17,400	1.94
48	Chimney	01-02	0326A					1.11	575	518.02	248.55	17,975	1.95

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

Attachment A2
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Private I/I Abatement - Mini Basin 01-02

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Uncapped Cleanout	01-02	0516	01-02	0503	772 PENN. ST.	A	39.23	25	0.64	39.23	25	0.31
2	Uncapped Cleanout	01-02	0485	01-02	0484	1320 9TH. AVE.	A	33.62	25	0.74	72.85	50	0.57
3	Uncapped Cleanout	01-02	0489	01-02	0488	1422 9TH. AVE.	B	28.02	25	0.89	100.87	75	0.79
4	Uncapped Cleanout	01-02	0498A	01-02	0498	1209 COLUMBIA AVE.	A	22.42	25	1.12	123.29	100	0.97
5	Uncapped Cleanout	01-02	0487	01-02	0486	1320 9TH AVE	A	16.81	25	1.49	140.10	125	1.10
6	Downspout	01-02	0500	01-02	0499	1417 COLUMBIA AVE.	B	44.83	75	1.67	184.93	200	1.45
7	Downspout	01-02	0325A	01-02	0325	732 OLIVE	B	39.23	75	1.91	224.16	275	1.76
8	Uncapped Cleanout	01-02	0326A	01-02	0326	730 WALNUT ST.	B	11.21	25	2.23	235.37	300	1.85
9	Uncapped Cleanout	01-02	0363	01-02	0364	804 COLUMBIA AVE	A	11.21	25	2.23	246.58	325	1.94
10	Uncapped Cleanout	01-02	0499	01-02	0498A	1314 COLUMBIA AVE.	A	11.21	25	2.23	257.79	350	2.02
11	Uncapped Cleanout	01-02	0508	01-02	0507A	1315 S BWD	A	11.21	25	2.23	269.00	375	2.11
12	Uncapped Cleanout	01-02	0359A	01-02	0359	920 W 7TH ST	D	5.60	25	4.46	274.60	400	2.15
13	Uncapped Cleanout	01-02	0508	01-02	0507A	1403 S BWD	B	5.60	25	4.46	280.20	425	2.20
14	Area Drain	01-02	0485	01-02	0484	1205 9TH.AVE.	B	86.92	2,500	28.76	367.12	2,925	2.88
15	Uncapped Cleanout	01-02	0366A	01-02	0366	788 SPRUCE ST	A	0.56	25	44.64	367.68	2,950	2.89
16	Area Drain	01-02	0500	01-02	0499	1413 COLUMBIA AVE.	A	21.73	2,500	115.05	389.41	5,450	3.06
17	Area Drain	01-02	0484	01-02	0483	1024 9TH. AVE.	A	20.01	2,500	124.94	409.42	7,950	3.21
18	Service Lateral	01-02	0500A	01-02	0500	756 OHIO ST.	A	14.30	2,500	174.83	423.72	10,450	3.33
19	Driveway Drain	01-02	0501B	01-02	0501A	1500 BROADWAY	A	25.73	5,000	194.33	449.45	15,450	3.53
20	Service Lateral	01-02	0489	01-02	0488	1434 9TH. AVE.	A	8.58	2,500	291.38	458.03	17,950	3.59
21	Service Lateral	01-02	0502	01-02	0501	1508 COLUMBIA AVE.	A	8.58	2,500	291.38	466.61	20,450	3.66
22	Service Lateral	01-02	0495A	01-02	0495B	900 BROADWAY	B	8.58	2,500	291.38	475.19	22,950	3.73
23	Driveway Drain	01-02	0482	01-02	0481A	1443 CENTRAL AVE.	C	15.44	5,000	323.83	490.63	27,950	3.85
24	Driveway Drain	01-02	0497	01-02	0496	1020 COLUMBIA	C	12.87	5,000	388.50	503.50	32,950	3.95
25	Service Lateral	01-02	0322	01-02	0323	722 BROADWAY	A	5.72	2,500	437.06	509.22	35,450	4.00
26	Service Lateral	01-02	0323	01-02	0324	808 S. BROADAY	C	5.72	2,500	437.06	514.94	37,950	4.04
27	Service Lateral	01-02	0481A	01-02	0481	1423 CENTRAL AVE.	A	5.72	2,500	437.06	520.66	40,450	4.09
28	Service Lateral	01-02	0484	01-02	0483	S. OF 1029 9TH. AVE.	E	5.72	2,500	437.06	526.38	42,950	4.13
29	Service Lateral	01-02	0498	01-02	0497	780 JAMES ST	B	5.72	2,500	437.06	532.10	45,450	4.18
30	Service Lateral	01-02	0502	01-02	0501	1508 COLUMBIA AVE.	B	5.72	2,500	437.06	537.82	47,950	4.22
31	Service Lateral	01-02	0331	01-02	0324B	721 OLIVE ST.	A	5.72	2,500	437.06	543.54	50,450	4.27
32	Service Lateral	01-02	0495A	01-02	0495B	EAST OF 756 FRANK ST	A	5.72	2,500	437.06	549.26	52,950	4.31
33	Driveway Drain	01-02	0484	01-02	0483	1029 9TH AVE.	B	10.29	5,000	485.91	559.55	57,950	4.39
34	Driveway Drain	01-02	0485	01-02	0484	1117 9TH AVE	C	10.29	5,000	485.91	569.84	62,950	4.47

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

ttachment 3
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Pipeline Rehabilitation - Mini Basin 01-02

Basinup	Manhole Up	Basindn	Manhole Dn	Diameter	Length	Pipe Type	Recommendations	City Action	Replacement Diameter	Rehab Cost	Priority
01-02	314	01-01	302	12	310	VCP	Replace		12	$ 26,350.00	1
01-02	317	01-02	316	8	358	VCP	Replace		8	$ 23,270.00	1
01-02	318	01-02	317	8	194	VCP	Point Repair			$ 650.00	2
01-02	0325A	01-02	325	8	389	VCP	Replace		8	$ 25,285.00	1
~~01-02~~	~~338~~	~~01-02~~	~~313~~	~~8~~	~~377~~	~~VCP~~	~~Point Repair, CIPP~~	~~CIPP~~		~~$ 14,222.00~~	~~2~~
01-02	0338A	01-02	338	8	418	VCP	Replace		8	$ 27,170.00	1
01-02	0359A	01-02	359	8	459	VCP	Partial Replacement		8	$ 6,500.00	1
01-02	481	01-02	0480A	8	328	CIPP	Point Repair			$ 650.00	2
01-02	494	01-02	493	6	132	VCP	Replace		8	$ 8,580.00	1
~~01-02~~	~~498~~	~~01-02~~	~~497~~	~~6~~	~~455~~	~~VCP~~	~~Replace~~	~~Replace~~	~~8~~	~~$ 29,575.00~~	~~1~~
01-02	516	01-02	503	6	470	VCP	Point Repair			$ 650.00	2
01-02	0742B	01-02	0742A	8	145	VCP	Replace		8	$ 9,425.00	1

Total: $ 172,327.00
Completed: $ 43,797.00
emaining $ 12 ,530.00

01-01

01-02

01-04

01-05

N

Legend

- Completed Rehabilitation
- Sanitary Sewer Manholes
- Sanitary Sewer Gravity Mains
- 01-02_MH_Rehab
- 01_02_Private_Defects
- 01-02_Pipeline_Rehabillitation
- 01-02_Capacity_Improvements

TREKK DESIGN GROUP, LLC

Figure A1

Recommended Rehabilitation
Mini Basin 01-02

City of Leavenworth, Kansas
I&I Assessment and Reduction Plan
Trekk Project No. 10-066

Mini-Basin 01-05

Manhole Rehabilitation Program

Information summarized in Section 8 of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) recommended a total of 104 potential I/I sources, within 73 manholes, be repaired. A revised cost-effective manhole rehabilitation schedule detailing the type of rehabilitation for each manhole is included as Attachment B1. A total of $124,000 has been estimated for the Mini-Basin 01-05 recommended manhole rehabilitation program. Of this total, $29,000 has been estimated for contingencies such as engineering, administration, inspection, and potential construction overages. A general breakdown of the type and cost of rehabilitation is shown in *Table B1*.

Table B1

Mini-Basin 01-05: Recommended Manhole Rehabilitation Summary

Type of Rehabilitation	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Replace Frame / Cover	40	EA	600	24,000
Seal Frame Seal	36	EA	300	10,800
Rehab Lining	9	VF	200	1,800
CIP Chimney	14	EA	575	8,050
Bench / Invert Rehab	1	EA	225	225
Pipe Seal Rehab	12	EA	250	3,000
Resurfacing	1	LS	22,000	22,000
Sub-Total:**				**95,000**
Contingencies (30%):**				**29,000**
Total Cost:**				**124,000**

* It is recommended that vented covers and poor fitting covers be replaced with an entirely new frame and cover.

**Costs are rounded up to the nearest thousand dollars.

Private-Sector I&I Abatement Program

The total cost to complete the recommended private sector I&I rehabilitation is estimated at $30,000 including a 30% contingency set-aside of $7,000. A general breakdown of the costs to implement the recommended private sector rehabilitation program is outlined in *Table B2*. Details regarding the type, location, and unit cost are included in Attachment B2.

Table B2

Mini-Basin 01-05: Recommended Private Sector I&I Abatement Summary

Type of Rehabilitation	$/GPM*	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Repair Uncapped Cleanout	6	3	EA	25	75
Disconnect Area Drain	18	2	EA	2,500	5,000
Disconnect Driveway Drain	173	1	EA	5,000	5,000
Repair Service Lateral	267	5	EA	2,500	12,500
Sub-Total*:					**23,000**
Contingencies (30%)*:					**7,000**
Total Cost*:					**30,000**

* Costs to repair versus I&I Flow Rate. Defects with a lower rate are more cost-effective to repair.

** Costs are rounded to the nearest thousand dollars.

Pipeline Rehabilitation Program

The Sanitary Sewer Evaluation Study – SUB01 (Wade, 2005) identified numerous locations in the Study Area where I&I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I&I and other major deficiencies such as voids, broken pipe, or partially collapsed pipe. All defects were initially located by smoke testing and manhole inspection activities and identified for cleaning and CCTV inspection. A total of 18 individual line segments, representing approximately 4,226 linear feet of sanitary sewer, were identified in mini-basin 01-05 for rehabilitation. The total estimated cost to complete the pipeline rehabilitation program is $281,000. This cost includes a 30% contingency fee of $65,000

for engineering, inspection, legal, and general administration costs. A general breakdown of the quantity and cost to implement the recommended pipeline rehabilitation program is shown in Table B3. A complete list of all lines recommended for rehabilitation is included as Attachment B3. The location of all recommended rehabilitation in mini-basin 01-05 is shown in Figure B1. Also, shown in Figure B1 are capacity improvements identified as part of the Sanitary Sewer Evaluation Study – SUB01 (Wade, 2005), however, these capacity improvements are not recommended at this time. The recommended rehabilitation and post-rehabilitation flow monitoring should be completed prior to capacity improvements.

Table B-3

Mini-Basin 01-05: Recommended Pipeline Rehabilitation Program

Type of Rehabilitation	Unit	Quantity	Unit Cost	Footage	Total Cost ($)
Point Repair	EA	14	$65	140	9,100
Replacement (8" Pipe)	LF	9	$65	2,087	136,000
Replacement (10" Pipe)	LF	1	$75	319	24,000
Manhole Replacement	EA	19	$2,500		47,500
Sub-Total*:					**216,000**
Contingencies (30%)*:					**65,000**
Total Cost*:					**281,000**
*Costs are rounded to the nearest thousand dollars.					

Attachment B1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-05

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Vented Cover	01-05	1238			Creek Bed		40.18	600	14.93	40.18	600	0.315
2	Frame Seal	01-05	0252			BETW DEL & CHEROKEE		6.66	300	45.05	46.84	900	0.368
3	Frame Seal	01-05	0284					6.66	300	45.05	53.50	1,200	0.420
4	Frame Seal	01-05	0285					6.66	300	45.05	60.16	1,500	0.472
5	Frame Seal	01-05	0289					6.66	300	45.05	66.82	1,800	0.524
6	Frame Seal	01-05	0290					6.66	300	45.05	73.48	2,100	0.577
7	Frame Seal	01-05	0295					6.66	300	45.05	80.14	2,400	0.629
8	Frame Seal	01-05	0737			S. of 15th & Shawnee		6.66	300	45.05	86.80	2,700	0.681
9	Frame Seal	01-05	0836					6.66	300	45.05	93.46	3,000	0.733
10	Frame Seal	01-05	0837					6.66	300	45.05	100.12	3,300	0.786
11	Frame Seal	01-05	1225					6.66	300	45.05	106.78	3,600	0.838
12	Frame Seal	01-05	1239					6.66	300	45.05	113.44	3,900	0.890
13	Frame Seal	01-05	1296			14th & Shawnee		6.66	300	45.05	120.10	4,200	0.942
14	Frame Seal	01-05	1391					6.66	300	45.05	126.76	4,500	0.995
15	Frame Seal	01-05	1554			Woods		6.66	300	45.05	133.42	4,800	1.047
16	Frame Seal	01-05	2103			TREE LINE BY DRAINAGE		6.66	300	45.05	140.08	5,100	1.099
17	Frame Seal	01-05	2230			IN FRONT YARD OF		6.66	300	45.05	146.74	5,400	1.152
18	Frame Seal	01-05	2293			backyard		6.66	300	45.05	153.40	5,700	1.204
19	Frame Seal	01-05	0238A					6.66	300	45.05	160.06	6,000	1.256
20	Frame Seal	01-05	0288A					6.66	300	45.05	166.72	6,300	1.308
21	Vented Cover	01-05	1237			creek bed		7.78	600	77.12	174.50	6,900	1.369
22	Vented Cover	01-05	1236			creek bed behind house		6.35	600	94.49	180.85	7,500	1.419
23	Vented Cover	01-05	0238			12th & Shawnee		5.68	600	105.63	186.53	8,100	1.464
24	Vented Cover	01-05	0243					5.68	600	105.63	192.21	8,700	1.508
25	Vented Cover	01-05	0284					5.68	600	105.63	197.89	9,300	1.553
26	Vented Cover	01-05	0832			Cherokee & Leavenworth		5.68	600	105.63	203.57	9,900	1.598
27	Vented Cover	01-05	1089					5.68	600	105.63	209.25	10,500	1.642
28	Vented Cover	01-05	1105					5.68	600	105.63	214.93	11,100	1.687
29	Vented Cover	01-05	1241					5.68	600	105.63	220.61	11,700	1.731
30	Vented Cover	01-05	1294					5.68	600	105.63	226.29	12,300	1.776
31	Vented Cover	01-05	1296			14th & Shawnee		5.68	600	105.63	231.97	12,900	1.820
32	Vented Cover	01-05	1556			17th & Sherman		5.68	600	105.63	237.65	13,500	1.865
33	Vented Cover	01-05	1190B			N. of tje & Shawnee		5.68	600	105.63	243.33	14,100	1.910
34	Vented Cover	01-05	0738			Behind house in alley		4.02	600	149.25	247.35	14,700	1.941
35	Chimney	01-05	0289					1.90	300	157.89	249.25	15,000	1.956
36	Chimney	01-05	0290					1.90	300	157.89	251.15	15,300	1.971
37	Chimney	01-05	0295					1.90	300	157.89	253.05	15,600	1.986
38	Chimney	01-05	0834					1.90	300	157.89	254.95	15,900	2.001
39	Vented Cover	01-05	1190A			N. of 10th & Shawnee		3.43	600	174.93	258.38	16,500	2.028
40	Chimney	01-05	0285					1.63	300	184.05	260.01	16,800	2.040
41	Chimney	01-05	2230			IN FRONT YARD OF		1.63	300	184.05	261.64	17,100	2.053
42	Chimney	01-05	0238A					1.63	300	184.05	263.27	17,400	2.066
43	Frame Seal	01-05	0286					1.33	300	225.56	264.60	17,700	2.076

Attachment B1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-05

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
44	Frame Seal	01-05	1280					1.33	300	225.56	265.93	18,000	2.087
45	Frame Seal	01-05	1557			PARKING LOT FOOD F		1.33	300	225.56	267.26	18,300	2.097
46	Frame Seal	01-05	1558			BESIDE FOOD FOR LESS		1.33	300	225.56	268.59	18,600	2.108
47	Frame Seal	01-05	1567			BH APTS IN PARKING		1.33	300	225.56	269.92	18,900	2.118
48	Frame Seal	01-05	1568			N OF APT BUILDINGS		1.33	300	225.56	271.25	19,200	2.129
49	Frame Seal	01-05	1763					1.33	300	225.56	272.58	19,500	2.139
50	Frame Seal	01-05	1764					1.33	300	225.56	273.91	19,800	2.149
51	Frame Seal	01-05	1769					1.33	300	225.56	275.24	20,100	2.160
52	Frame Seal	01-05	1770					1.33	300	225.56	276.57	20,400	2.170
53	Frame Seal	01-05	1802					1.33	300	225.56	277.90	20,700	2.181
54	Frame Seal	01-05	1940			INTERS HIGH & 21ST		1.33	300	225.56	279.23	21,000	2.191
55	Frame Seal	01-05	2078					1.33	300	225.56	280.56	21,300	2.202
56	Frame Seal	01-05	2295					1.33	300	225.56	281.89	21,600	2.212
57	Frame Seal	01-05	2361					1.33	300	225.56	283.22	21,900	2.223
58	Frame Seal	01-05	0237A					1.33	300	225.56	284.55	22,200	2.233
59	Frame Seal	01-05	0289A					1.33	300	225.56	285.88	22,500	2.243
60	Pipe Seal	01-05	1208				1	0.80	250	312.50	286.68	22,750	2.250
61	Pipe Seal	01-05	1208				2	0.80	250	312.50	287.48	23,000	2.256
62	Pipe Seal	01-05	1215			behind house	1	0.80	250	312.50	288.28	23,250	2.262
63	Pipe Seal	01-05	1215			behind house	2	0.80	250	312.50	289.08	23,500	2.269
64	Pipe Seal	01-05	1215			behind house	3	0.80	250	312.50	289.88	23,750	2.275
65	Pipe Seal	01-05	1234			N SIDE OF SPRUCE	1	0.80	250	312.50	290.68	24,000	2.281
66	Pipe Seal	01-05	1238			Creek Bed	1	0.80	250	312.50	291.48	24,250	2.287
67	Pipe Seal	01-05	1238			Creek Bed	2	0.80	250	312.50	292.28	24,500	2.294
68	Pipe Seal	01-05	1654			Creek Bed	1	0.80	250	312.50	293.08	24,750	2.300
69	Pipe Seal	01-05	1654			Creek Bed	2	0.80	250	312.50	293.88	25,000	2.306
70	Pipe Seal	01-05	1654			Creek Bed	3	0.80	250	312.50	294.68	25,250	2.312
71	Pipe Seal	01-05	1940			INTERS HIGH & 21ST	2	0.80	250	312.50	295.48	25,500	2.319
72	Vented Cover	01-05	0290					1.72	600	348.84	297.20	26,100	2.332
73	Vented Cover	01-05	0285					1.42	600	422.54	298.62	26,700	2.343
74	Vented Cover	01-05	0289					1.42	600	422.54	300.04	27,300	2.355
75	Vented Cover	01-05	0737			S. of 15th & Shawnee		1.42	600	422.54	301.46	27,900	2.366
76	Vented Cover	01-05	0831					1.42	600	422.54	302.88	28,500	2.377
77	Vented Cover	01-05	0834					1.42	600	422.54	304.30	29,100	2.388
78	Vented Cover	01-05	0835					1.42	600	422.54	305.72	29,700	2.399
79	Vented Cover	01-05	0836					1.42	600	422.54	307.14	30,300	2.410
80	Vented Cover	01-05	0837					1.42	600	422.54	308.56	30,900	2.421
81	Vented Cover	01-05	1209					1.42	600	422.54	309.98	31,500	2.433
82	Vented Cover	01-05	1295					1.42	600	422.54	311.40	32,100	2.444
83	Vented Cover	01-05	1297					1.42	600	422.54	312.82	32,700	2.455
84	Vented Cover	01-05	1298					1.42	600	422.54	314.24	33,300	2.466
85	Vented Cover	01-05	1299					1.42	600	422.54	315.66	33,900	2.477
86	Vented Cover	01-05	1769					1.42	600	422.54	317.08	34,500	2.488

Attachment B1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-05

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
87	Vented Cover	01-05	1791					1.42	600	422.54	318.50	35,100	2.499
88	Vented Cover	01-05	2161					1.42	600	422.54	319.92	35,700	2.511
89	Vented Cover	01-05	0288A					1.42	600	422.54	321.34	36,300	2.522
90	Vented Cover	01-05	0289A					1.42	600	422.54	322.76	36,900	2.533
91	Chimney	01-05	0281			ON 10TH STREET		0.67	300	447.76	323.43	37,200	2.538
92	Chimney	01-05	0286					0.67	300	447.76	324.10	37,500	2.543
93	Chimney	01-05	1226					0.67	300	447.76	324.77	37,800	2.549
94	Chimney	01-05	1282					0.67	300	447.76	325.44	38,100	2.554
95	Chimney	01-05	2818			ON 10TH IN STREET		0.67	300	447.76	326.11	38,400	2.559
96	Chimney	01-05	0281B					0.67	300	447.76	326.78	38,700	2.564
97	Chimney	01-05	0289A					0.67	300	447.76	327.45	39,000	2.570
98	Bench	01-05	1938					0.50	225	450.00	327.95	39,225	2.574
99	Cover To Rim	01-05	0286					1.00	600	600.00	328.95	39,825	2.581
100	Cover To Rim	01-05	0289					1.00	600	600.00	329.95	40,425	2.589
101	Cover To Rim	01-05	1239					1.00	600	600.00	330.95	41,025	2.597
102	Cover To Rim	01-05	1567			BH APTS IN PARKING		1.00	600	600.00	331.95	41,625	2.605
103	Cover To Rim	01-05	1769					1.00	600	600.00	332.95	42,225	2.613
104	Corbel	01-05	1238			Creek Bed		1.00	1,780	1,780.00	333.95	44,005	2.621

Total Estimated I/I for 5yr, 90-minute Storm Event: 12,743 gpm

Attachment B2
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Private I/I Abatement - Mini Basin 01-05

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Uncapped Cleanout	01-05	2296	01-05	2295	1350 A & B	A	6.28	25	3.98	6.28	25	0.049
2	Uncapped Cleanout	01-05	0287	01-05	2101	1117 CHEROKEE ST	A	3.92	25	6.38	10.20	50	0.080
3	Uncapped Cleanout	01-05	0285A	01-05	0244	206 S 11TH ST	A	3.14	25	7.96	13.34	75	0.105
4	Area Drain	01-05	1211	01-05	1210	107	S	136.09	2,500	18.37	149.43	2,575	1.173
5	Area Drain	01-05	1211	01-05	1210	107	T	136.09	2,500	18.37	285.52	5,075	2.241
6	Service Lateral	01-05	1240	01-05	1239	1407 HIGH ST	A	24.02	2,500	104.08	309.54	7,575	2.429
7	Driveway Drain	01-05	0241	01-05	0242	1312 DELAWARE ST	A	28.82	5,000	173.49	338.36	12,575	2.655
8	Service Lateral	01-05	0252	01-05	0251	914 CHEROKEE ST	B	6.40	2,500	390.63	344.76	15,075	2.705
9	Service Lateral	01-05	1295	01-05	1296	1404 SHAWNEE ST		5.49	2,500	455.37	350.25	17,575	2.749
10	Service Lateral	01-05	1787	01-05	1786	1420 OLIVE ST	A	5.49	2,500	455.37	355.74	20,075	2.792
11	Service Lateral	01-05	0836	01-05	0834	1717 CHEROKEE ST	A	5.49	2,500	455.37	361.23	22,575	2.835

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

ttachment B3
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Pipeline Rehabilitation - Mini Basin 01-05

Basinup	Manhole Up	Basindn	Manhole Dn	Diameter	Length	Pipe Type	Recommendations	City Action	Replacement Diameter	Rehab Cost	Priority
01-05	0239	01-05	0242	8	266	VCP	Replace		8	$ 17,290.00	1
01-05	0240	01-05	0241	8	201	VCP	Replace		8	$ 13,065.00	1
01-05	0249	01-05	0245	7	173	VCP	Replace		8	$ 11,245.00	1
01-05	0250	01-05	2049	7	134	VCP	Replace		8	$ 8,710.00	1
01-05	0292	01-05	0291	6	346	VCP	Replace		8	$ 22,490.00	1
01-05	0293	01-05	0293A	8	136	VCP	Replace		8	$ 8,840.00	1
01-05	1089	01-05	0838	8	198	VCP	Point Repair			$ 650.00	2
01-05	1153	01-05	1152	8	296	VCP	Point Repair (2)			$ 1,300.00	2
01-05	1155	01-05	1154	8	351	VCP	Replace		8	$ 22,815.00	1
01-05	1227	01-05	1226	12	314	VCP	Point Repair (2)			$ 1,300.00	1
01-05	1229A	01-05	1229	10	319	VCP	Replace		10	$ 23,925.00	1
01-05	1265	01-05	1264	8	160	VCP	Point Repair (2)			$ 1,300.00	2
01-05	1298	01-05	1297	8	228	VCP	Point Repair (2)			$ 1,300.00	2
01-05	1314	01-05	1313	8	279	VCP	Point Repair (2)			$ 1,300.00	2
01-05	1562	01-05	1561	8	144	VCP	Replace		8	$ 9,360.00	1
01-05	1563	01-05	1562	8	210	VCP	Point Repair (2)			$ 1,300.00	2
01-05	1768	01-05	1767	8	336	VCP	Replace		8	$ 21,840.00	1
01-05	1769	01-05	1763	8	135	VCP	Point Repair			$ 650.00	2

Total: $ 1 , 0.00
Completed: $ -
emaining $ 1 , 0.00

01-01

01-04

01-05

01-06

Seneca

Miami

Michael

Terry

Allen

Western

Sheldon

14th

Shawnee

Delaware

1312 DELAWARE ST

1404 SHAWNEE ST

13th

11th

12th

9th

206 11TH ST

285A

914 CHEROKEE ST

Topeka

Cherokee

1717 CHEROKEE ST

16th

17th

15th

Choctaw

20th

21st

1942 Choctaw

2079.1 Choctaw

High

Marjorie

Olive

4182 (aban)

4181 (aban)

Kenton

Randolph

22nd

Edgewood

Woodridge

Sherman

1111 CHEROKEE ST

1203 CHEROKEE ST

1350 SHERMAN AVE

Young

Terrace

Sanders

Walnut

Chestnut

Sherman

Casey

1407 HIGH ST

1420 OLIVE ST

Spruce

Newman

Klemp

Madison

Jackson

Franklin

Grand

Stockton

Ironmoulders

Quincy

Washington

Western

Patterson

Kansas

Lecompton

Westwood

Ohio

0382 LH/FT

387.1 lamphole

Legend

- Completed Rehabilitation
- Sanitary Sewer Manholes
- Sanitary Sewer Gravity Mains
- 01-05 MH Rehab
- 01_05 Private Defects
- 01-05 Pipeline Rehabillitation
- 01-05 Capacity Improvements

TREKK DESIGN GROUP, LLC

Figure B1

Recommended Rehabilitation
Mini Basin 01-05

City of Leavenworth, Kansas
I&I Assessment and Reduction Plan
Trekk Project No. 10-066

Mini-Basin 01-04

Manhole Rehabilitation Program

Information summarized in Section 8 of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) recommended a total of 75 potential I/I sources, within 69 manholes, be repaired. A revised cost-effective manhole rehabilitation schedule detailing the type of rehabilitation for each manhole is included as Attachment C1. A total of $49,000 has been estimated for the Mini-Basin 01-04 recommended manhole rehabilitation program. Of this total, $11,000 has been estimated for contingencies such as engineering, administration, inspection, and potential construction overages. A general breakdown of the type and cost of rehabilitation is shown in *Table C1*.

Table C1

Mini-Basin 01-04: Recommended Manhole Rehabilitation Summary

Type of Rehabilitation	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Replace Frame / Cover	17	EA	600	10,200
Seal Frame Seal	54	EA	300	16,200
CIP Chimney	3	EA	575	1,725
Pipe Seal Rehab	1	EA	250	250
Resurfacing	1	LS	9,350	9,350
Sub-Total:**				**38,000**
Contingencies (30%):**				**11,000**
Total Cost:**				**49,000**

* It is recommended that vented covers and poor fitting covers be replaced with an entirely new frame and cover.

**Costs are rounded up to the nearest thousand dollars.

Private-Sector I&I Abatement Program

The total cost to complete the recommended private sector I&I rehabilitation is estimated at $42,000 including a 30% contingency set-aside of $10,000. **A general breakdown of**

the costs to implement the recommended private sector rehabilitation program is outlined in *Table 3*. Details regarding the type, location, and unit cost are included in Attachment C2.

Table C2

Mini-Basin 01-04: Recommended Private Sector I&I Abatement Summary

Type of Rehabilitation	$/GPM*	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Repair Uncapped Cleanout	3	27	EA	25	675
Disconnect Downspout	4	9	EA	75	675
Disconnect Driveway Drain	135	1	EA	5,000	5,000
Disconnect Area Drain	287	3	EA	2,500	7,500
Repair Service Lateral	310	7	EA	2,500	17,500
Sub-Total:**					**32,000**
Contingencies (30%):**					**10,000**
Total Cost:**					**42,000**

* Costs to repair versus I&I Flow Rate. Defects with a lower rate are more cost-effective to repair.

**Costs are rounded to the nearest thousand dollars.

Pipeline Rehabilitation Program

The *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) identified numerous locations in the Study Area where I&I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I&I and other major deficiencies such as voids, broken pipe, or partially collapsed pipe. All defects were initially located by smoke testing and manhole inspection activities and identified for cleaning and CCTV inspection. A total of 39 individual line segments, representing approximately 9,767 linear feet of sanitary sewer, were identified in mini-basin 01-04 for rehabilitation. Four of these line segments have been recently addressed as part of the City's rehabilitation efforts. **The total estimated cost to complete the pipeline rehabilitation program is $709,000.** This cost includes a 30% contingency fee of $164,000 for engineering, inspection, legal, and general administration costs. A general breakdown of the quantity and cost to implement the recommended pipeline rehabilitation program is shown in Table C3. A complete list of all lines recommended

for rehabilitation is included as Attachment C3. The location of all recommended rehabilitation in mini-basin 01-04 is shown in Figure C1.

Table C3

Mini-Basin 01-04: Recommended Pipeline Rehabilitation Program

Type of Rehabilitation	Unit	Quantity	Unit Cost	Footage	Total Cost ($)
Point Repair	EA	16	$65	160	10,400
Replacement (8" Pipe)	LF	20	$65	5,947	386,600
CIPP (8" Pipe)	LF	4	$50	703	35,200
CIPP (10" Pipe)	LF	1	$71	135	9,600
CCTV	LF	2	$1.25	616	800
Manhole Replacement	EA	41	$2,500		102,500
Sub-Total*:					**545,000**
Contingencies (30%)*:					**164,000**
Total Cost*:					**709,000**
*Costs are rounded to the nearest thousand dollars.					

Attachment C1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-04

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Vented Cover	01-04	0450					41.17	600	14.57	41.17	600	0.323
2	Vented Cover	01-04	0444					40.91	600	14.67	82.08	1,200	0.644
3	Vented Cover	01-04	0453					20.59	600	29.14	102.67	1,800	0.806
4	Frame Seal	01-04	0436			ON IRON MOLDERS AT		7.99	300	37.55	110.66	2,100	0.868
5	Frame Seal	01-04	0864					7.99	300	37.55	118.65	2,400	0.931
6	Frame Seal	01-04	0436E			BEHIND HOUSE		7.99	300	37.55	126.64	2,700	0.994
7	Vented Cover	01-04	0472					10.29	600	58.31	136.93	3,300	1.075
8	Vented Cover	01-04	0299					8.23	600	72.90	145.16	3,900	1.139
9	Vented Cover	01-04	0448			ACROSS STREET IN		6.82	600	87.98	151.98	4,500	1.193
10	Vented Cover	01-04	0868					6.82	600	87.98	158.80	5,100	1.246
11	Frame Seal	01-04	0276					1.60	300	187.50	160.40	5,400	1.259
12	Frame Seal	01-04	0280					1.60	300	187.50	162.00	5,700	1.271
13	Frame Seal	01-04	0371					1.60	300	187.50	163.60	6,000	1.284
14	Frame Seal	01-04	0378					1.60	300	187.50	165.20	6,300	1.296
15	Frame Seal	01-04	0382			BEHIND PORTABLE		1.60	300	187.50	166.80	6,600	1.309
16	Frame Seal	01-04	0394			ON OLIVE AT NEWMAN		1.60	300	187.50	168.40	6,900	1.322
17	Frame Seal	01-04	0397			BEHIND HOUSE, AT		1.60	300	187.50	170.00	7,200	1.334
18	Frame Seal	01-04	0398			JUST WEST OF 10TH ST.		1.60	300	187.50	171.60	7,500	1.347
19	Frame Seal	01-04	0399					1.60	300	187.50	173.20	7,800	1.359
20	Frame Seal	01-04	0403					1.60	300	187.50	174.80	8,100	1.372
21	Frame Seal	01-04	0408					1.60	300	187.50	176.40	8,400	1.384
22	Frame Seal	01-04	0419			IN ALLEY BEHIND		1.60	300	187.50	178.00	8,700	1.397
23	Frame Seal	01-04	0424					1.60	300	187.50	179.60	9,000	1.409
24	Frame Seal	01-04	0426					1.60	300	187.50	181.20	9,300	1.422
25	Frame Seal	01-04	0431					1.60	300	187.50	182.80	9,600	1.435
26	Frame Seal	01-04	0444					1.60	300	187.50	184.40	9,900	1.447
27	Frame Seal	01-04	0453					1.60	300	187.50	186.00	10,200	1.460
28	Frame Seal	01-04	0457					1.60	300	187.50	187.60	10,500	1.472
29	Frame Seal	01-04	0459					1.60	300	187.50	189.20	10,800	1.485
30	Frame Seal	01-04	0462					1.60	300	187.50	190.80	11,100	1.497
31	Frame Seal	01-04	0466					1.60	300	187.50	192.40	11,400	1.510
32	Frame Seal	01-04	0471					1.60	300	187.50	194.00	11,700	1.522
33	Frame Seal	01-04	0472					1.60	300	187.50	195.60	12,000	1.535
34	Frame Seal	01-04	0475					1.60	300	187.50	197.20	12,300	1.548
35	Frame Seal	01-04	0477					1.60	300	187.50	198.80	12,600	1.560
36	Frame Seal	01-04	0849					1.60	300	187.50	200.40	12,900	1.573
37	Frame Seal	01-04	0867					1.60	300	187.50	202.00	13,200	1.585
38	Frame Seal	01-04	1079					1.60	300	187.50	203.60	13,500	1.598
39	Frame Seal	01-04	1086					1.60	300	187.50	205.20	13,800	1.610
40	Frame Seal	01-04	1088					1.60	300	187.50	206.80	14,100	1.623
41	Frame Seal	01-04	1245					1.60	300	187.50	208.40	14,400	1.635
42	Frame Seal	01-04	1248					1.60	300	187.50	210.00	14,700	1.648
43	Frame Seal	01-04	1316					1.60	300	187.50	211.60	15,000	1.661

Attachment C1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-04

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
44	Frame Seal	01-04	1354					1.60	300	187.50	213.20	15,300	1.673
45	Frame Seal	01-04	1356					1.60	300	187.50	214.80	15,600	1.686
46	Frame Seal	01-04	1672			IN FRONT YARD		1.60	300	187.50	216.40	15,900	1.698
47	Frame Seal	01-04	1808					1.60	300	187.50	218.00	16,200	1.711
48	Frame Seal	01-04	1809					1.60	300	187.50	219.60	16,500	1.723
49	Frame Seal	01-04	2068					1.60	300	187.50	221.20	16,800	1.736
50	Frame Seal	01-04	2069					1.60	300	187.50	222.80	17,100	1.748
51	Frame Seal	01-04	2070					1.60	300	187.50	224.40	17,400	1.761
52	Frame Seal	01-04	2171					1.60	300	187.50	226.00	17,700	1.774
53	Frame Seal	01-04	3124					1.60	300	187.50	227.60	18,000	1.786
54	Frame Seal	01-04	3125					1.60	300	187.50	229.20	18,300	1.799
55	Frame Seal	01-04	0424A					1.60	300	187.50	230.80	18,600	1.811
56	Frame Seal	01-04	0436A			BEHIND ADDRESS AT		1.60	300	187.50	232.40	18,900	1.824
57	Frame Seal	01-04	0436K					1.60	300	187.50	234.00	19,200	1.836
58	Frame Seal	01-04	0449C					1.60	300	187.50	235.60	19,500	1.849
59	Frame Seal	01-04	0462D					1.60	300	187.50	237.20	19,800	1.861
60	Frame Seal	01-04	1341A					1.60	300	187.50	238.80	20,100	1.874
61	Frame Seal	01-04	1396A					1.60	300	187.50	240.40	20,400	1.887
62	Pipe Seal	01-04	0436E			BEHIND HOUSE	3	0.98	250	255.10	241.38	20,650	1.894
63	Vented Cover	01-04	0406					2.16	600	277.78	243.54	21,250	1.911
64	Vented Cover	01-04	0407					2.16	600	277.78	245.70	21,850	1.928
65	Vented Cover	01-04	0408					2.16	600	277.78	247.86	22,450	1.945
66	Vented Cover	01-04	0413					2.16	600	277.78	250.02	23,050	1.962
67	Vented Cover	01-04	0454					2.16	600	277.78	252.18	23,650	1.979
68	Vented Cover	01-04	0863					2.16	600	277.78	254.34	24,250	1.996
69	Vented Cover	01-04	0865					2.16	600	277.78	256.50	24,850	2.013
70	Vented Cover	01-04	0405A					2.16	600	277.78	258.66	25,450	2.030
71	Vented Cover	01-04	0858					2.06	600	291.26	260.72	26,050	2.046
72	Chimney	01-04	0396			BEHIND ADDRESS		0.80	300	375.00	261.52	26,350	2.052
73	Chimney	01-04	0431					0.80	300	375.00	262.32	26,650	2.059
74	Chimney	01-04	0420A			IN STREET AT ALLEY		0.80	300	375.00	263.12	26,950	2.065
75	Vented Cover	01-04	0409					0.82	600	731.71	263.94	27,550	2.071

Total Estimated I/I for 5yr, 90-minute Storm Event: 12,743 gpm

Attachment C2
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Private I/I Abatement - Mini Basin 01-04

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Uncapped Cleanout	01-04	0450	01-04	0443	1140 QUINCY ST	A	32.28	25	0.77	32.28	25	0.253
2	Uncapped Cleanout	01-04	0849	01-04	0848	823 SHAWNEE ST	A	24.21	25	1.03	56.49	50	0.443
3	Uncapped Cleanout	01-04	0297	01-04	0299	404 LAWRENCE AVE	B	20.17	25	1.24	76.66	75	0.602
4	Uncapped Cleanout	01-04	0465	01-04	0464	1600 S 10TH	A	16.14	25	1.55	92.80	100	0.728
5	Uncapped Cleanout	01-04	0859A	01-04	0859	1416 SPRUCE ST	A	16.14	25	1.55	108.94	125	0.855
6	Downspout	01-04	0433	01-04	0434	1304 GRANDE ST	A	40.35	75	1.86	149.29	200	1.172
7	Uncapped Cleanout	01-04	0415	01-04	0414	1327 SPRUCE ST	A	12.10	25	2.07	161.39	225	1.266
8	Uncapped Cleanout	01-04	0442	01-04	0439	1131 IRON COULDERS	C	12.10	25	2.07	173.49	250	1.361
9	Uncapped Cleanout	01-04	0859A	01-04	0859	1412 SPRUCE ST	B	12.10	25	2.07	185.59	275	1.456
10	Downspout	01-04	0297	01-04	0299	821 CHEROKEE ST	A	32.28	75	2.32	217.87	350	1.710
11	Uncapped Cleanout	01-04	0277	01-04	0276	850 SHERMAN ST	A	8.07	25	3.10	225.94	375	1.773
12	Uncapped Cleanout	01-04	0442	01-04	0439	1138 IRON MOULDERS	A	8.07	25	3.10	234.01	400	1.836
13	Uncapped Cleanout	01-04	0442	01-04	0439	1131 IRON MOULDERS	B	8.07	25	3.10	242.08	425	1.900
14	Uncapped Cleanout	01-04	0456	01-04	0454	1317 QUINCY ST.	B	8.07	25	3.10	250.15	450	1.963
15	Uncapped Cleanout	01-04	1085	01-04	1084	1503 OHIO ST	B	8.07	25	3.10	258.22	475	2.026
16	Downspout	01-04	0404A	01-04	0404	837 SPRUCE ST	A	20.17	75	3.72	278.39	550	2.185
17	Downspout	01-04	0464	01-04	0462A	1510 S 10TH	A	20.17	75	3.72	298.56	625	2.343
18	Uncapped Cleanout	01-04	0277	01-04	0276	872 SHERMAN ST	D	6.05	25	4.13	304.61	650	2.390
19	Uncapped Cleanout	01-04	0396	01-04	0397	1116 SPRUCE ST	B	6.05	25	4.13	310.66	675	2.438
20	Uncapped Cleanout	01-04	1809	01-04	1808	1207 WESTERN	A	6.05	25	4.13	316.71	700	2.485
21	Uncapped Cleanout	01-04	0368	01-04	0368A	714 LAWRENCE AVE	A	6.05	25	4.13	322.76	725	2.533
22	Downspout	01-04	0858	01-04	0415A	1413 SPRUCE ST	A	12.10	75	6.20	334.86	800	2.628
23	Downspout	01-04	0858	01-04	0415A	1413 SPRUCE ST	B	12.10	75	6.20	346.96	875	2.723
24	Uncapped Cleanout	01-04	0385A	01-04	0385	1201 HIGH ST	A	4.03	25	6.20	350.99	900	2.754
25	Uncapped Cleanout	01-04	0383	01-04	0394	1143 OLIVE ST	A	4.03	25	6.20	355.02	925	2.786
26	Uncapped Cleanout	01-04	0461	01-04	0462	1055 OHIO ST	A	4.03	25	6.20	359.05	950	2.818
27	Uncapped Cleanout	01-04	0466A	01-04	0469	1000 OHIO ST	A	4.03	25	6.20	363.08	975	2.849
28	Uncapped Cleanout	01-04	0849	01-04	0848	823 SHAWNEE ST	B	4.03	25	6.20	367.11	1,000	2.881
29	Uncapped Cleanout	01-04	1882	01-04	1881	1616 KLEMP ST	A	4.03	25	6.20	371.14	1,025	2.913
30	Downspout	01-04	0392	01-04	0393	1215 OLIVE ST	A	8.07	75	9.29	379.21	1,100	2.976
31	Uncapped Cleanout	01-04	0377	01-04	0376	920 WALNUT ST	A	2.02	25	12.38	381.23	1,125	2.992
32	Uncapped Cleanout	01-04	2082	01-04	0416	1420 KENTON ST	A	2.02	25	12.38	383.25	1,150	3.008
33	Uncapped Cleanout	01-04	1099	01-04	1100	1504 KLEMP ST	A	2.02	25	12.38	385.27	1,175	3.023
34	Uncapped Cleanout	01-04	0860	01-04	0859A	1417 OLIVE ST	A	2.02	25	12.38	387.29	1,200	3.039
35	Downspout	01-04	0408A	01-04	0408	1166 KENTON ST	B	4.03	75	18.61	391.32	1,275	3.071
36	Downspout	01-04	0408A	01-04	0408	1166 KENTON ST	C	4.03	75	18.61	395.35	1,350	3.102
37	Driveway Drain	01-04	0387	01-04	0385	1229 HIGH ST	A	37.05	5,000	134.95	432.40	6,350	3.393
38	Service Lateral	01-04	0456	01-04	0454	1108 WASHINGTON ST.	A	15.10	2,500	165.56	447.50	8,850	3.512
39	Area Drain	01-04	0466	01-04	0466A	1012 OHIO ST	A	14.41	2,500	173.49	461.91	11,350	3.625
40	Service Lateral	01-04	0867	01-04	0866A	1102 MADISON	B	11.32	2,500	220.85	473.23	13,850	3.714
41	Service Lateral	01-04	0393	01-04	0395	1200 SPRUCE ST	B	6.18	2,500	404.53	479.41	16,350	3.762
42	Service Lateral	01-04	0408	01-04	0407	1123 SPRUCE ST	A	6.18	2,500	404.53	485.59	18,850	3.811
43	Service Lateral	01-04	0474	01-04	0473	1401 LAWERENCE ST	A	6.18	2,500	404.53	491.77	21,350	3.859
44	Service Lateral	01-04	0406	01-04	0405A	VACANT LOT	A	6.18	2,500	404.53	497.95	23,850	3.908
45	Area Drain	01-04	1085	01-04	1084	1503 OHIO ST	A	5.87	2,500	425.89	503.82	26,350	3.954

Attachment C2
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Private I/I Abatement - Mini Basin 01-04

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
46	Area Drain	01-04	1356	01-04	1355	1808 WESTWOOD ST	A	5.87	2,500	425.89	509.69	28,850	4.000
47	Service Lateral	01-04	0280	01-04	0279	926 SHERMAN ST	A	5.15	2,500	485.44	514.84	31,350	4.040

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

ttachment C3
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Pipeline Rehabilitation - Mini Basin 01-04

Basinup	Manhole Up	Basindn	Manhole Dn	Diameter	Length	Pipe Type	Recommendations	City Action	Replacement Diameter	Rehab Cost	Priority
~~01-04~~	~~0278~~	~~01-04~~	~~0277~~	~~8~~	~~133~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 6,650.00~~	~~2~~
01-04	0279	01-04	0278	8	467	VCP	Replace		8	$ 30,355.00	1
01-04	0296	01-04	0.297	8	438	VCP	Replace		8	$ 28,470.00	1
01-04	0381	01-04	0380A	8	210	VCP	Replace		8	$ 13,650.00	1
~~01-04~~	~~0385~~	~~01-04~~	~~0392~~	~~6~~	~~195~~	~~VCP~~	~~Replace~~	~~CIPP~~	~~8~~	~~$ 9,750.00~~	~~2~~
01-04	0392	01-04	0393	6	145	VCP	Point Repair			$ 650.00	2
01-04	0393	01-04	0395	8	312	VCP	Replace		8	$ 20,280.00	1
~~01-04~~	~~0410~~	~~01-04~~	~~0409~~	~~8~~	~~143~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 7,150.00~~	~~2~~
01-04	0411	01-04	0410	8	330	VCP	Replace		8	$ 21,450.00	1
01-04	0411A	01-04	0411	8	168	VCP	Point Repair, CIPP			$ 9,050.00	2
01-04	0412	01-04	0411A	8	168	VCP	Replace		8	$ 10,920.00	1
01-04	0415	01-04	0414	8	225	VCP	CIPP			$ 11,250.00	2
01-04	0415A	01-04	0415	8	50	VCP	Replace		8	$ 3,250.00	1
01-04	0416A	01-04	0416	8	148	VCP	CIPP			$ 7,400.00	2
~~01-04~~	~~0421~~	~~01-04~~	~~0422~~	~~8~~	~~195~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 9,750.00~~	~~1~~
01-04	0423	01-04	0426A	8	622	VCP	Replace		8	$ 40,430.00	1
01-04	0430A	01-04	0430	8	180	VCP	Replace		8	$ 11,700.00	1
01-04	0434	01-04	0437	8	163	VCP	Replace		8	$ 10,595.00	1
01-04	0436F	01-04	0436E	10	135	VCP	CIPP			$ 9,585.00	2
01-04	0437	01-04	0436	8	162	VCP	CIPP			$ 8,100.00	1
01-04	0438	01-04	0440	8	150	VCP	Replace		8	$ 9,750.00	1
01-04	0447	01-04	0446	8	300	VCP	Replace		8	$ 19,500.00	1
01-04	0460	01-04	1101	6	512	VCP	Replace		8	$ 33,280.00	1
01-04	0465	01-04	0464	8	431	VCP	Point Repair, CCTV			$ 1,188.75	2
01-04	0466	01-04	0466A	8	185	VCP	Point Repair (2), CCTV			$ 1,531.25	2
01-04	0468	01-04	0429	8	661	VCP	Replace		8	$ 42,965.00	1
01-04	0472	01-04	0473	8	302	VCP	Point Repair (2)			$ 1,300.00	2
01-04	0473	01-04	0470	8	228	VCP	Point Repair (2)			$ 1,300.00	2
01-04	0475	01-04	0474	8	295	VCP	Point Repair (2)			$ 1,300.00	2
01-04	0860	01-04	0859A	8	237	VCP	Replace		8	$ 15,405.00	1
01-04	0866A	01-04	0866B	8	132	VCP	Replace		8	$ 8,580.00	1
01-04	0866B	01-04	0866	8	196	VCP	Replace		8	$ 12,740.00	1
01-04	0867	01-04	0866A	8	147	VCP	Point Repair (2)			$ 1,300.00	2
01-04	1246A	01-04	1246	8	130	VCP	Point Repair			$ 650.00	2
01-04	1353	01-04	1352	8	404	VCP	Replace		8	$ 26,260.00	1
01-04	1667	01-04	1666	8	170	VCP	Point Repair			$ 650.00	2
01-04	1670A	01-04	1670	8	283	VCP	Point Repair			$ 650.00	2
01-04	1810	01-04	0476	8	210	VCP	Replace		8	$ 13,650.00	1
01-04	1882	01-04	1881	8	205	VCP	Replace		8	$ 13,325.00	1

Total: $ 475,7 0.00
Completed: $ 33,300.00
emaining $ 442,4 0.00

Figure C1

Recommended Rehabilitation
Mini Basin 01-04

City of Leavenworth, Kansas
I&I Assessment and Reduction Plan
Trekk Project No. 10-066

TREKK DESIGN GROUP LLC

01-01
01-02
01-04
01-05
01-06

Seneca
Terry
Allen
Shawnee
Delaware
Cherokee
Choctaw
Short
Oak
Walnut
Chestnut
Olive
Sherman
Topeka
Leavenworth
Young
Ryan
Lawrence
Railroad
Columbia
Frank
Congress
Marshall
Charles
Quincy
Central
James
Middle
Scott
Prospect
Ohio
Kansas
Western
Patterson
Jackson
Newman
Klemp
Kingman
Grand
Madison
Stonleigh
Westwood
Forest
Michigan
Pennsylvania
Garland
Lawrence
Halderman
South
Ironmolders
Randolph
Kenton
Stockton
Spruce
Casey
Sanders
Terrace
Edgewood
Canterbury
Ridge
Lecompton

823 SHAWNEE ST
920 WALNUT ST
714 LAWRENCE AVE
404 LAWRENCE AVE
1401 LAWRENCE AVE
1304 GRAND AVE
1317 QUINCY ST
1140 QUINCY ST
1102 MADISON ST
1503 OHIO ST
1504 KLEMP ST
1510 10TH AVE
1600 10TH AVE
1616 KLEMP ST
1808 WESTWOOD DR
1055 OHIO ST
1229 HIGH ST
1201 HIGH ST
1200 SPRUCE ST
1116 SPRUCE ST
1123 SPRUCE ST
1327 SPRUCE ST
00000 SPRUCE ST

Legend

- Completed Rehabilitation
- Sanitary Sewer Manholes
- Sanitary Sewer Gravity Mains
- 01-04 MH Rehab
- 01_04 Private Defects
- 01-04 Pipeline Rehabillitation

Mini-Basin 01-01 Recommended Rehabilitation

Mini-Basin 01-01

Manhole Rehabilitation Program

Information summarized in Section 8 of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) recommended a total of 73 potential I/I sources, within 44 manholes, be repaired. A revised cost-effective manhole rehabilitation schedule detailing the type of rehabilitation for each manhole is included as Attachment D1. **A total of $78,000 has been estimated for the Mini-Basin 01-01 recommended manhole rehabilitation program**. Of this total, $18,000 has been estimated for contingencies such as engineering, administration, inspection, and potential construction overages. A general breakdown of the type and cost of rehabilitation is shown in Table D1.

Table D1

Mini-Basin 01-01: Recommended Manhole Rehabilitation Summary

Type of Rehabilitation	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Replace Frame / Cover	24	EA	600	14,400
Seal Frame Seal	20	EA	300	6,000
Rehab Lining	98	VF	200	19,600
CIP Chimney	3	EA	575	1,725
Bench Invert Rehab	3	EA	225	675
Pipe Seal Rehab	14	EA	250	3,500
Resurfacing	1	LS	14,400	14,400
Sub-Total:**				**60,000**
Contingencies (30%):**				**18,000**
Total Cost:**				**78,000**

* It is recommended that vented covers and poor fitting covers be replaced with an entirely new frame and cover.

**Costs are rounded up to the nearest thousand dollars.

Private-Sector I&I Abatement Program

The total cost to complete the recommended private sector I&I rehabilitation is estimated at $20,000 including a 30% contingency set-aside of $5,000. A general breakdown of the costs to implement the recommended private sector rehabilitation program is outlined in Table D2. Details regarding the type, location, and unit cost are included in Attachment D2.

Table D2

Mini-Basin 01-01: Recommended Private Sector I&I Abatement Summary

Type of Rehabilitation	$/GPM*	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Repair Uncapped Cleanout	2	6	EA	25	150
Disconnect Downspout	7	4	EA	75	300
Disconnect Area Drain	61	2	EA	2,500	5,000
Repair Service Lateral	293	4	EA	2,500	10,000
Sub-Total:**					**15,000**
Contingencies (30%):**					**5,000**
Total Cost:**					**20,000**

* Costs to repair versus I&I Flow Rate. Defects with a lower rate are more cost-effective to repair.

**Costs are rounded to the nearest thousand dollars.

Pipeline Rehabilitation Program

The *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) identified numerous locations in the Study Area where I&I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I&I and other major deficiencies such as voids, broken pipe, or partially collapsed pipe. All defects were initially located by smoke testing and manhole inspection activities and identified for cleaning and CCTV inspection. A total of 24 individual line segments, representing approximately 6,654 linear feet of sanitary sewer, were identified in mini-basin 01-01 for rehabilitation. One of these line segments has been recently addressed as part of the City's rehabilitation efforts. **The total estimated cost to complete the pipeline rehabilitation program is $525,000**. This cost includes a 30% contingency fee

of $121,000 for engineering, inspection, legal, and general administration costs. A general breakdown of the quantity and cost to implement the recommended pipeline rehabilitation program is shown in Table D3. A complete list of all lines recommended for rehabilitation is included as Attachment D3. The location of all recommended rehabilitation in mini-basin 01-04 is shown in Figure D1. Also, shown in Figure D1 are capacity improvements identified as part of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005), however, these capacity improvements are not recommended at this time. The recommended rehabilitation and post-rehabilitation flow monitoring should be completed prior to capacity improvements.

Table D3

Mini-Basin 01-01: Recommended Pipeline Rehabilitation Program

Type of Rehabilitation	Unit	Quantity	Unit Cost	Footage	Total Cost ($)
Point Repair	EA	7	$65	70	4,600
Replacement (8" Pipe)	LF	14	$65	4,546	295,500
Replacement (10" Pipe)	LF	3	$75	327	24,500
CIPP (8" Pipe)	LF	1	$50	146	7,300
Manhole Replacement	EA	29	$2,500		72,500
Sub-Total*:					**404,000**
Contingencies (30%)*:					**121,000**
Total Cost*:					**525,000**
*Costs are rounded to the nearest thousand dollars.					

Attachment D1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-01

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Vented Cover	01-01	0303			S. OF ADDRESS		29.55	600	20.30	29.55	600	0.232
2	Vented Cover	01-01	0304					14.87	600	40.35	44.42	1,200	0.349
3	Frame Seal	01-01	0099			RICHARD ALLEN		5.77	300	51.99	50.19	1,500	0.394
4	Frame Seal	01-01	0109			S. OF JOHNSON DR.		5.77	300	51.99	55.96	1,800	0.439
5	Frame Seal	01-01	0191					5.77	300	51.99	61.73	2,100	0.484
6	Frame Seal	01-01	0267					5.77	300	51.99	67.50	2,400	0.530
7	Frame Seal	01-01	0269			BEAUTY & BARBER		5.77	300	51.99	73.27	2,700	0.575
8	Frame Seal	01-01	0306			RIVER CITY FLOORING		5.77	300	51.99	79.04	3,000	0.620
9	Frame Seal	01-01	0099A			RICHARD ALLEN		5.77	300	51.99	84.81	3,300	0.666
10	Frame Seal	01-01	0269D			S. OF ADDRESS		5.77	300	51.99	90.58	3,600	0.711
11	Frame Seal	01-01	0269E			INTER. OF 4TH &		5.77	300	51.99	96.35	3,900	0.756
12	Frame Seal	01-01	0305B			INTER. OF 4TH &		5.77	300	51.99	102.12	4,200	0.801
13	Bench	01-01	0220			S. OF ADDRESS		2.55	225	88.24	104.67	4,425	0.821
14	Bench	01-01	0269D			S. OF ADDRESS		2.22	225	101.35	106.89	4,650	0.839
15	Corbel	01-01	0191					2.78	300	107.91	109.67	4,950	0.861
16	Pipe Seal	01-01	0225			GRASS MEDIAN, W	3	2.22	250	112.61	111.89	5,200	0.878
17	Pipe Seal	01-01	0306B			ADVANTAGE PRINTING	1	2.22	250	112.61	114.11	5,450	0.895
18	Vented Cover	01-01	0227			CITY HALL		4.92	600	121.95	119.03	6,050	0.934
19	Vented Cover	01-01	0267					4.92	600	121.95	123.95	6,650	0.973
20	Vented Cover	01-01	0272					4.92	600	121.95	128.87	7,250	1.011
21	Vented Cover	01-01	0269A			S. & W. OF ADDRESS		4.92	600	121.95	133.79	7,850	1.050
22	Vented Cover	01-01	0269B			S. OF ADDRESS		4.92	600	121.95	138.71	8,450	1.089
23	Bench	01-01	0191					1.61	225	139.75	140.32	8,675	1.101
24	Vented Cover	01-01	0154			S. OF KICKAPOO & 4TH		2.97	600	202.02	143.29	9,275	1.124
25	Vented Cover	01-01	0219C			N. OF ADDRESS		2.97	600	202.02	146.26	9,875	1.148
26	Pipe Seal	01-01	0109			S. OF JOHNSON DR.	1	1.11	250	225.23	147.37	10,125	1.156
27	Pipe Seal	01-01	0109			S. OF JOHNSON DR.	4	1.11	250	225.23	148.48	10,375	1.165
28	Pipe Seal	01-01	0154			S. OF KICKAPOO & 4TH	2	1.11	250	225.23	149.59	10,625	1.174
29	Pipe Seal	01-01	0154			S. OF KICKAPOO & 4TH	4	1.11	250	225.23	150.70	10,875	1.183
30	Pipe Seal	01-01	0191				1	1.11	250	225.23	151.81	11,125	1.191
31	Pipe Seal	01-01	0227			CITY HALL	1	1.11	250	225.23	152.92	11,375	1.200
32	Pipe Seal	01-01	0273				1	1.11	250	225.23	154.03	11,625	1.209
33	Pipe Seal	01-01	0273				2	1.11	250	225.23	155.14	11,875	1.217
34	Pipe Seal	01-01	0273				3	1.11	250	225.23	156.25	12,125	1.226
35	Pipe Seal	01-01	0304				2	1.11	250	225.23	157.36	12,375	1.235
36	Pipe Seal	01-01	0304				4	1.11	250	225.23	158.47	12,625	1.244
37	Pipe Seal	01-01	1165			S. OF 3RD & CHOCTAN	3	1.11	250	225.23	159.58	12,875	1.252
38	Frame Seal	01-01	0220			S. OF ADDRESS		1.15	300	260.87	160.73	13,175	1.261
39	Frame Seal	01-01	0225			GRASS MEDIAN, W		1.15	300	260.87	161.88	13,475	1.270
40	Frame Seal	01-01	0302					1.15	300	260.87	163.03	13,775	1.279
41	Frame Seal	01-01	0304					1.15	300	260.87	164.18	14,075	1.288
42	Frame Seal	01-01	1169					1.15	300	260.87	165.33	14,375	1.297
43	Frame Seal	01-01	1188			PAUL ARPIN. NEXT TO		1.15	300	260.87	166.48	14,675	1.306
44	Frame Seal	01-01	1190			S. OF 10TH & MIAMI		1.15	300	260.87	167.63	14,975	1.315
45	Frame Seal	01-01	1361			S.E. CORNER		1.15	300	260.87	168.78	15,275	1.324

Attachment D1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-01

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
46	Frame Seal	01-01	1811					1.15	300	260.87	169.93	15,575	1.334
47	Frame Seal	01-01	0272A					1.15	300	260.87	171.08	15,875	1.343
48	Corbel	01-01	0220			S. OF ADDRESS		1.11	300	270.27	172.19	16,175	1.351
49	Corbel	01-01	0267					1.11	300	270.27	173.30	16,475	1.360
50	Corbel	01-01	0304					1.11	300	270.27	174.41	16,775	1.369
51	Corbel	01-01	1173			By Silos		1.11	300	270.27	175.52	17,075	1.377
52	Corbel	01-01	1361			S.E. CORNER		1.11	300	270.27	176.63	17,375	1.386
53	Wall	01-01	0154			S. OF KICKAPOO & 4TH		2.55	800	313.73	179.18	18,175	1.406
54	Wall	01-01	1165			S. OF 3RD & CHOCTAN		2.55	800	313.73	181.73	18,975	1.426
55	Chimney	01-01	0191					1.65	575	348.48	183.38	19,550	1.439
56	Chimney	01-01	0267					1.65	575	348.48	185.03	20,125	1.452
57	Chimney	01-01	0099A			RICHARD ALLEN		1.65	575	348.48	186.68	20,700	1.465
58	Corbel	01-01	0225			GRASS MEDIAN, W		0.67	300	447.76	187.35	21,000	1.470
59	Vented Cover	01-01	0153			S. OF HOUSE		1.23	600	487.80	188.58	21,600	1.480
60	Vented Cover	01-01	0191					1.23	600	487.80	189.81	22,200	1.490
61	Vented Cover	01-01	0310			SIDEWALK, FRONT OF		1.23	600	487.80	191.04	22,800	1.499
62	Vented Cover	01-01	1182			20' W. OF BROADWAY		1.23	600	487.80	192.27	23,400	1.509
63	Vented Cover	01-01	1183			N. OF ADDRESS		1.23	600	487.80	193.50	24,000	1.518
64	Vented Cover	01-01	1361			S.E. CORNER		1.23	600	487.80	194.73	24,600	1.528
65	Vented Cover	01-01	1860			2ND & DELAWARE		1.23	600	487.80	195.96	25,200	1.538
66	Vented Cover	01-01	1861			N. OF ADDRESS,		1.23	600	487.80	197.19	25,800	1.547
67	Vented Cover	01-01	1884			N. OF ADDRESS		1.23	600	487.80	198.42	26,400	1.557
68	Vented Cover	01-01	0194A			W. OF ADDRESS		1.23	600	487.80	199.65	27,000	1.567
69	Vented Cover	01-01	0225A			S. OF ADDRESS		1.23	600	487.80	200.88	27,600	1.576
70	Vented Cover	01-01	0269C			S. OF ADDRESS		1.23	600	487.80	202.11	28,200	1.586
71	Vented Cover	01-01	0310A			S. OF ADDRESS		1.23	600	487.80	203.34	28,800	1.596
72	Vented Cover	01-01	0310C			S.E. OF ADDRESS		1.23	600	487.80	204.57	29,400	1.605
73	Cover To Rim	01-01	0269			BEAUTY & BARBER		0.87	600	689.66	205.44	30,000	1.612

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

Attachment D2
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Private I/I Abatement - Mini Basin 01-01

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Uncapped Cleanout	01-01	0194B	01-01	0194A	309 ESPLANDE ST	A	31.38	25	0.80	31.38	25	0.246
2	Uncapped Cleanout	01-01	0162	01-01	0163	322 POTTOWATOMIE ST	B	9.41	25	2.66	40.79	50	0.320
3	Uncapped Cleanout	01-01	0189	01-01	0190A	408 5TH ST	A	9.41	25	2.66	50.20	75	0.394
4	Downspout	01-01	0303	01-01	0304	525 CHEROKEE	A	21.97	75	3.41	72.17	150	0.566
5	Uncapped Cleanout	01-01	0193	01-01	0194	201 OSAGE	A	4.71	25	5.31	76.88	175	0.603
6	Uncapped Cleanout	01-01	0195	01-01	0194	229 OSAGE	B	4.71	25	5.31	81.59	200	0.640
7	Uncapped Cleanout	01-01	0258	01-01	0259	516 DELAWARE ST	A	3.14	25	7.96	84.73	225	0.665
8	Downspout	01-01	0198A	01-01	0198	522 MIAMI ST	A	6.28	75	11.94	91.01	300	0.714
9	Downspout	01-01	0198A	01-01	0198	522 MIAMI ST	B	6.28	75	11.94	97.29	375	0.763
10	Downspout	01-01	0218B	01-01	0218A	BUTLER MUFFLER	A	6.28	75	11.94	103.57	450	0.813
11	Area Drain	01-01	0218	01-01	0218B	602 SENECA ST	A	76.05	2,500	32.87	179.62	2,950	1.410
12	Service Lateral	01-01	0304	01-01	0305A	413 CHEROKEE	A	13.72	2,500	182.22	193.34	5,450	1.517
13	Service Lateral	01-01	0190A	01-01	0190	473 POTTOWATOMIE ST	A	8.01	2,500	312.11	201.35	7,950	1.580
14	Service Lateral	01-01	0218A	01-01	0219A	215 N 4TH ST	A	6.86	2,500	364.43	208.21	10,450	1.634
15	Area Drain	01-01	0195	01-01	0194	214 MIAMI ST	A	6.08	2,500	411.18	214.29	12,950	1.682
16	Service Lateral	01-01	0194A	01-01	0194	112 MIAMI ST	A	5.49	2,500	455.37	219.78	15,450	1.725

Total Estimated I/I for 5yr, 90-minute Storm Event: 12,743 gpm

ttachment D3
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Pipeline Rehabilitation - Mini Basin 01-01

Basinup	Manhole Up	Basindn	Manhole Dn	Diameter	Length	Pipe Type	Recommendations	City Action	Replacement Diameter	Rehab Cost	Priority
~~01-01~~	~~108~~	~~01-01~~	~~109~~	~~8~~	~~396~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 19,800~~	~~1~~
01-01	164	01-01	163	8	408	VCP	Replace		8	$ 26,520	1
01-01	189	01-01	0190A	8	328	VCP	Replace		8	$ 21,320	1
01-01	190	01-01	0197B	8	154	VCP	Replace		8	$ 10,010	1
01-01	0190A	01-01	190	7	332	VCP	Replace		8	$ 21,580	1
01-01	192	01-01	193	8	405	VCP	Replace		8	$ 26,325	1
01-01	0193A	01-01	193	8	169	VCP	Point Repair (3)			$ 1,950	2
01-01	0193C	01-01	0193A	8	146	VCP	CIPP			$ 7,300	2
01-01	194	01-01	222	8	347	VCP	Replace		8	$ 22,555	1
01-01	195	01-01	194	6	408	VCP	Replace		8	$ 26,520	1
01-01	197	01-01	0219DTEE	10	10	VCP	Replace		10	$ 750	1
01-01	0197B	01-01	197	8	174	VCP	Replace		8	$ 11,310	1
01-01	198	01-01	0197A	8	444	VCP	Replace		8	$ 28,860	1
01-01	0198A	01-01	198	8	381	VCP	Replace		8	$ 24,765	1
01-01	218	01-01	0218B	8	458	VCP	Replace		8	$ 29,770	1
01-01	0218A	01-01	0219A	8	235	VCP	Replace		8	$ 15,275	1
01-01	0219D	01-01	219	10	177	VCP	Replace		10	$ 13,275	1
01-01	0219DTEE	01-01	0219D	10	140	VCP	Replace		10	$ 10,500	1
01-01	222	01-01	224	8	327	VCP	Replace		8	$ 21,255	1
01-01	0222A	01-01	222	8	173	VCP	Point Repair			$ 650	2
01-01	259	01-01	260	8	145	VCP	Replace		8	$ 9,425	1
01-01	1171	01-01	1170	24	125	VCP	Point Repair			$ 650	2
01-01	1190	01-01	1189	24	596	VCP	Point Repair			$ 650	2
01-01	1361	01-01	306	8	176	VCP	Point Repair			$ 650	2

Total: $ 351, 5.00
Completed: $ 19, 00.00
emaining $ 331, 5.00

Mini-Basin 01-06

Manhole Rehabilitation Program

Information summarized in Section 8 of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) recommended a total of 232 potential I/I sources, within 137 manholes, be repaired. A revised cost-effective manhole rehabilitation schedule detailing the type of rehabilitation for each manhole is included as Attachment E1. **A total of $99,000 has been estimated for the Mini-Basin 01-06 recommended manhole rehabilitation program**. Of this total, $23,000 has been estimated for contingencies such as engineering, administration, inspection, and potential construction overages. A general breakdown of the type and cost of rehabilitation is shown in Table E1.

Table E1

Mini-Basin 01-06: Recommended Manhole Rehabilitation Summary

Type of Rehabilitation	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Replace Frame / Cover*	52	EA	600	31,200
Seal Frame Seal	101	EA	300	30,300
Rehab Lining	42	VF	200	8,400
CIP Chimney	42	EA	575	24,150
Bench / Invert Rehab	6	EA	225	1,350
Pipe Seal Rehab	27	EA	250	6,750
Resurfacing	1	LS	28,600	28,600
Sub-Total:**				**131,000**
Contingencies (30%):**				**39,000**
Total Cost:**				**170,000**

*It is recommended that vented covers and poor fitting covers be replaced with an entirely new frame and cover.

**Costs are rounded up to the nearest thousand dollars.

Private-Sector I&I Abatement Program

The total cost to complete the recommended private sector I&I rehabilitation is estimated at $7,000 including a 30% contingency set-aside of $2,000. A general breakdown of the costs to implement the recommended private sector rehabilitation program is outlined in Table E2. Details regarding the type, location, and unit cost are included in Attachment E2.

Table E2

Mini-Basin 01-06: Recommended Private Sector I&I Abatement Summary

Type of Rehabilitation	$/GPM*	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Repair Uncapped Cleanout	3	10	EA	25	250
Disconnect Driveway Drain	202	1	EA	5,000	5,000
Sub-Total:**					**5,000**
Contingencies (30%):**					**2,000**
Total Cost:**					**7,000**

* Costs to repair versus I&I Flow Rate. Defects with a lower rate are more cost-effective to repair.

**Costs are rounded to the nearest thousand dollars.

Pipeline Rehabilitation Program

The *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) identified numerous locations in the Study Area where I&I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I&I and other major deficiencies such as voids, broken pipe, or partially collapsed pipe. All defects were initially located by smoke testing and manhole inspection activities and identified for cleaning and CCTV inspection. A total of 30 individual line segments, representing approximately 7,552 linear feet of sanitary sewer, were identified in mini-basin 01-06 for rehabilitation. Two of these line segments have been recently addressed as part of the City's rehabilitation efforts. **The total estimated cost to complete the pipeline rehabilitation program is $368,000.** This cost includes a 30% contingency fee of $85,000 for engineering, inspection, legal, and general administration costs. A general breakdown of the quantity and cost to implement the recommended pipeline

rehabilitation program is shown in Table E3. A complete list of all lines recommended for rehabilitation is included as Attachment E3. The location of all recommended rehabilitation in mini-basin 01-06 is shown in Figure E1. Also, shown in Figure E1 are capacity improvements identified as part of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005), however, these capacity improvements are not recommended at this time. The recommended rehabilitation and post-rehabilitation flow monitoring should be completed prior to capacity improvements.

Table E3

Mini-Basin 01-06: Recommended Pipeline Rehabilitation Program

Type of Rehabilitation	Unit	Quantity	Unit Cost	Footage	Total Cost ($)
Point Repair	EA	19	$65	190	12,400
Replacement (8" Pipe)	LF	11	$65	2,300	149,500
Replacement (12" Pipe)	LF	4	$85	632	53,700
CIPP (8" Pipe)	LF	1	$36	337	12,100
CCTV	LF	1	$1.25	318	400
Manhole Replacement	EA	22	$2,500		55,000
Sub-Total*:					**283,000**
Contingencies (30%)*:					**85,000**
Total Cost*:					**368,000**
*Costs are rounded to the nearest thousand dollars.					

Attachment E1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-06

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Frame Seal	01-06	0692			12th and Osage		7.99	300	37.55	7.99	300	0.063
2	Frame Seal	01-06	0724					7.99	300	37.55	15.98	600	0.125
3	Frame Seal	01-06	0818					7.99	300	37.55	23.97	900	0.188
4	Frame Seal	01-06	0820					7.99	300	37.55	31.96	1,200	0.251
5	Frame Seal	01-06	0821					7.99	300	37.55	39.95	1,500	0.314
6	Frame Seal	01-06	0823					7.99	300	37.55	47.94	1,800	0.376
7	Frame Seal	01-06	0827					7.99	300	37.55	55.93	2,100	0.439
8	Frame Seal	01-06	0829			STREET		7.99	300	37.55	63.92	2,400	0.502
9	Frame Seal	01-06	1000					7.99	300	37.55	71.91	2,700	0.564
10	Frame Seal	01-06	1060			INTERS		7.99	300	37.55	79.90	3,000	0.627
11	Frame Seal	01-06	1115					7.99	300	37.55	87.89	3,300	0.690
12	Frame Seal	01-06	1125					7.99	300	37.55	95.88	3,600	0.752
13	Frame Seal	01-06	1137					7.99	300	37.55	103.87	3,900	0.815
14	Frame Seal	01-06	1516					7.99	300	37.55	111.86	4,200	0.878
15	Frame Seal	01-06	1647					7.99	300	37.55	119.85	4,500	0.941
16	Frame Seal	01-06	1648					7.99	300	37.55	127.84	4,800	1.003
17	Frame Seal	01-06	1650					7.99	300	37.55	135.83	5,100	1.066
18	Frame Seal	01-06	1776					7.99	300	37.55	143.82	5,400	1.129
19	Frame Seal	01-06	1030A			W ON 20TH ST		7.99	300	37.55	151.81	5,700	1.191
20	Frame Seal	01-06	1976			BEHIND CAR WASH		6.66	300	45.05	158.47	6,000	1.244
21	Vented Cover	01-06	1512					8.23	600	72.90	166.70	6,600	1.308
22	Vented Cover	01-06	1635			IN STREET		8.23	600	72.90	174.93	7,200	1.373
23	Vented Cover	01-06	0996					6.82	600	87.98	181.75	7,800	1.426
24	Vented Cover	01-06	0997			INTERS OSAGE&18TH ST		4.12	600	145.63	185.87	8,400	1.459
25	Vented Cover	01-06	1134			INTERSECTION 20TH &		4.12	600	145.63	189.99	9,000	1.491
26	Vented Cover	01-06	1140					4.12	600	145.63	194.11	9,600	1.523
27	Vented Cover	01-06	1143					4.12	600	145.63	198.23	10,200	1.556
28	Vented Cover	01-06	1145			BEHIND PARKING		4.12	600	145.63	202.35	10,800	1.588
29	Vented Cover	01-06	1148			E OF APT COMPLEX		4.12	600	145.63	206.47	11,400	1.620
30	Vented Cover	01-06	1650					4.12	600	145.63	210.59	12,000	1.653
31	Vented Cover	01-06	1704					4.12	600	145.63	214.71	12,600	1.685
32	Vented Cover	01-06	2016					4.12	600	145.63	218.83	13,200	1.717
33	Frame Seal	01-06	0694			Beside railroad easement		1.60	300	187.50	220.43	13,500	1.730
34	Frame Seal	01-06	0695			N. of Osage, next to R.R		1.60	300	187.50	222.03	13,800	1.742
35	Frame Seal	01-06	0696			N OF ADDRESS W SIDE		1.60	300	187.50	223.63	14,100	1.755
36	Frame Seal	01-06	0698			B-YARD ADDR NEXT TO		1.60	300	187.50	225.23	14,400	1.767
37	Frame Seal	01-06	0725					1.60	300	187.50	226.83	14,700	1.780
38	Frame Seal	01-06	0728					1.60	300	187.50	228.43	15,000	1.793
39	Frame Seal	01-06	0729					1.60	300	187.50	230.03	15,300	1.805
40	Frame Seal	01-06	0731			INTSEC SHELDON&HOPE		1.60	300	187.50	231.63	15,600	1.818
41	Frame Seal	01-06	0732			IN STREET		1.60	300	187.50	233.23	15,900	1.830
42	Frame Seal	01-06	0733			IN STREET		1.60	300	187.50	234.83	16,200	1.843
43	Frame Seal	01-06	0734					1.60	300	187.50	236.43	16,500	1.855

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Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
44	Frame Seal	01-06	0735			DEAD END OF HOPE		1.60	300	187.50	238.03	16,800	1.868
45	Frame Seal	01-06	0815					1.60	300	187.50	239.63	17,100	1.880
46	Frame Seal	01-06	0816					1.60	300	187.50	241.23	17,400	1.893
47	Frame Seal	01-06	0817					1.60	300	187.50	242.83	17,700	1.906
48	Frame Seal	01-06	0824					1.60	300	187.50	244.43	18,000	1.918
49	Frame Seal	01-06	0855					1.60	300	187.50	246.03	18,300	1.931
50	Frame Seal	01-06	0856			IN DITCH LINE		1.60	300	187.50	247.63	18,600	1.943
51	Frame Seal	01-06	0996					1.60	300	187.50	249.23	18,900	1.956
52	Frame Seal	01-06	0997			INTERS OSAGE&18TH ST		1.60	300	187.50	250.83	19,200	1.968
53	Frame Seal	01-06	1053					1.60	300	187.50	252.43	19,500	1.981
54	Frame Seal	01-06	1054			INTERSECTION OTTAWA		1.60	300	187.50	254.03	19,800	1.993
55	Frame Seal	01-06	1055					1.60	300	187.50	255.63	20,100	2.006
56	Frame Seal	01-06	1056					1.60	300	187.50	257.23	20,400	2.019
57	Frame Seal	01-06	1057			INTERS OTTAWA&19TH		1.60	300	187.50	258.83	20,700	2.031
58	Frame Seal	01-06	1058					1.60	300	187.50	260.43	21,000	2.044
59	Frame Seal	01-06	1059			INTERS 20TH & OTTAWA		1.60	300	187.50	262.03	21,300	2.056
60	Frame Seal	01-06	1061					1.60	300	187.50	263.63	21,600	2.069
61	Frame Seal	01-06	1062					1.60	300	187.50	265.23	21,900	2.081
62	Frame Seal	01-06	1090					1.60	300	187.50	266.83	22,200	2.094
63	Frame Seal	01-06	1106			INTERSECTION 20TH &		1.60	300	187.50	268.43	22,500	2.106
64	Frame Seal	01-06	1107					1.60	300	187.50	270.03	22,800	2.119
65	Frame Seal	01-06	1108			INTERSECTION		1.60	300	187.50	271.63	23,100	2.132
66	Frame Seal	01-06	1109					1.60	300	187.50	273.23	23,400	2.144
67	Frame Seal	01-06	1113					1.60	300	187.50	274.83	23,700	2.157
68	Frame Seal	01-06	1122			BEHIND 1902 MIAMI		1.60	300	187.50	276.43	24,000	2.169
69	Frame Seal	01-06	1124					1.60	300	187.50	278.03	24,300	2.182
70	Frame Seal	01-06	1128					1.60	300	187.50	279.63	24,600	2.194
71	Frame Seal	01-06	1129					1.60	300	187.50	281.23	24,900	2.207
72	Frame Seal	01-06	1130			INTERS 20TH		1.60	300	187.50	282.83	25,200	2.219
73	Frame Seal	01-06	1131					1.60	300	187.50	284.43	25,500	2.232
74	Frame Seal	01-06	1132			INTERSECTION 20TH &		1.60	300	187.50	286.03	25,800	2.245
75	Frame Seal	01-06	1133			INTERSECTION		1.60	300	187.50	287.63	26,100	2.257
76	Frame Seal	01-06	1134			INTERSECTION 20TH &		1.60	300	187.50	289.23	26,400	2.270
77	Frame Seal	01-06	1135					1.60	300	187.50	290.83	26,700	2.282
78	Frame Seal	01-06	1136			INTERS 20TH &		1.60	300	187.50	292.43	27,000	2.295
79	Frame Seal	01-06	1138					1.60	300	187.50	294.03	27,300	2.307
80	Frame Seal	01-06	1140					1.60	300	187.50	295.63	27,600	2.320
81	Frame Seal	01-06	1143					1.60	300	187.50	297.23	27,900	2.332
82	Frame Seal	01-06	1144			EASTSIDE OF PARKING		1.60	300	187.50	298.83	28,200	2.345
83	Frame Seal	01-06	1145			BEHIND PARKING		1.60	300	187.50	300.43	28,500	2.358
84	Frame Seal	01-06	1145			BEHIND CARPORT 2023		1.60	300	187.50	302.03	28,800	2.370
85	Frame Seal	01-06	1147			DRIVEWAY 2006 MIAMI		1.60	300	187.50	303.63	29,100	2.383
86	Frame Seal	01-06	1148			E OF APT COMPLEX		1.60	300	187.50	305.23	29,400	2.395

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Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
87	Frame Seal	01-06	1149			ACROSS ST PARKING		1.60	300	187.50	306.83	29,700	2.408
88	Frame Seal	01-06	1160			IN STREET		1.60	300	187.50	308.43	30,000	2.420
89	Frame Seal	01-06	1191			Next to creek		1.60	300	187.50	310.03	30,300	2.433
90	Frame Seal	01-06	1192					1.60	300	187.50	311.63	30,600	2.445
91	Frame Seal	01-06	1293			IN STREET		1.60	300	187.50	313.23	30,900	2.458
92	Frame Seal	01-06	1309					1.60	300	187.50	314.83	31,200	2.471
93	Frame Seal	01-06	1310					1.60	300	187.50	316.43	31,500	2.483
94	Frame Seal	01-06	1311					1.60	300	187.50	318.03	31,800	2.496
95	Frame Seal	01-06	1312					1.60	300	187.50	319.63	32,100	2.508
96	Frame Seal	01-06	1469			IN STREET		1.60	300	187.50	321.23	32,400	2.521
97	Frame Seal	01-06	1470			IN STREET		1.60	300	187.50	322.83	32,700	2.533
98	Frame Seal	01-06	1472			IN STREET		1.60	300	187.50	324.43	33,000	2.546
99	Frame Seal	01-06	1477			IN STREET		1.60	300	187.50	326.03	33,300	2.559
100	Frame Seal	01-06	1478			IN STREET		1.60	300	187.50	327.63	33,600	2.571
101	Frame Seal	01-06	1512					1.60	300	187.50	329.23	33,900	2.584
102	Frame Seal	01-06	1514					1.60	300	187.50	330.83	34,200	2.596
103	Frame Seal	01-06	1515					1.60	300	187.50	332.43	34,500	2.609
104	Frame Seal	01-06	1649			DRIVEWAY		1.60	300	187.50	334.03	34,800	2.621
105	Frame Seal	01-06	1699					1.60	300	187.50	335.63	35,100	2.634
106	Frame Seal	01-06	1700					1.60	300	187.50	337.23	35,400	2.646
107	Frame Seal	01-06	1709			IN STREET		1.60	300	187.50	338.83	35,700	2.659
108	Frame Seal	01-06	1781			INSIDE WALK		1.60	300	187.50	340.43	36,000	2.672
109	Frame Seal	01-06	1942					1.60	300	187.50	342.03	36,300	2.684
110	Frame Seal	01-06	1943					1.60	300	187.50	343.63	36,600	2.697
111	Frame Seal	01-06	2016					1.60	300	187.50	345.23	36,900	2.709
112	Frame Seal	01-06	0814A			Brewer Elementary		1.60	300	187.50	346.83	37,200	2.722
113	Frame Seal	01-06	1132A					1.60	300	187.50	348.43	37,500	2.734
114	Vented Cover	01-06	1053					3.09	600	194.17	351.52	38,100	2.759
115	Vented Cover	01-06	1054			INTERSECTION OTTAWA		3.09	600	194.17	354.61	38,700	2.783
116	Vented Cover	01-06	1056					3.09	600	194.17	357.70	39,300	2.807
117	Vented Cover	01-06	1057			INTERS OTTAWA&19TH		3.09	600	194.17	360.79	39,900	2.831
118	Vented Cover	01-06	1058					3.09	600	194.17	363.88	40,500	2.856
119	Vented Cover	01-06	1059			INTERS 20TH & OTTAWA		3.09	600	194.17	366.97	41,100	2.880
120	Vented Cover	01-06	1061					3.09	600	194.17	370.06	41,700	2.904
121	Vented Cover	01-06	1062					3.09	600	194.17	373.15	42,300	2.928
122	Vented Cover	01-06	1106			INTERSECTION 20TH &		3.09	600	194.17	376.24	42,900	2.953
123	Vented Cover	01-06	1107					3.09	600	194.17	379.33	43,500	2.977
124	Vented Cover	01-06	1108			INTERSECTION		3.09	600	194.17	382.42	44,100	3.001
125	Vented Cover	01-06	1124					3.09	600	194.17	385.51	44,700	3.025
126	Vented Cover	01-06	1125					3.09	600	194.17	388.60	45,300	3.050
127	Vented Cover	01-06	1128					3.09	600	194.17	391.69	45,900	3.074
128	Vented Cover	01-06	1130			INTERS 20TH		3.09	600	194.17	394.78	46,500	3.098
129	Vented Cover	01-06	1131					3.09	600	194.17	397.87	47,100	3.122

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Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
130	Vented Cover	01-06	1132			INTERSECTION 20TH &		3.09	600	194.17	400.96	47,700	3.147
131	Vented Cover	01-06	1133			INTERSECTION		3.09	600	194.17	404.05	48,300	3.171
132	Vented Cover	01-06	1135					3.09	600	194.17	407.14	48,900	3.195
133	Vented Cover	01-06	1136			INTERS 20TH &		3.09	600	194.17	410.23	49,500	3.219
134	Vented Cover	01-06	1138					3.09	600	194.17	413.32	50,100	3.244
135	Vented Cover	01-06	1142					3.09	600	194.17	416.41	50,700	3.268
136	Vented Cover	01-06	1147			DRIVEWAY 2006 MIAMI		3.09	600	194.17	419.50	51,300	3.292
137	Vented Cover	01-06	1149			ACROSS ST PARKING		3.09	600	194.17	422.59	51,900	3.316
138	Vented Cover	01-06	1309					3.09	600	194.17	425.68	52,500	3.341
139	Vented Cover	01-06	1310					3.09	600	194.17	428.77	53,100	3.365
140	Vented Cover	01-06	1311					3.09	600	194.17	431.86	53,700	3.389
141	Vented Cover	01-06	1514					3.09	600	194.17	434.95	54,300	3.413
142	Vented Cover	01-06	1648					3.09	600	194.17	438.04	54,900	3.437
143	Vented Cover	01-06	1649			DRIVEWAY		3.09	600	194.17	441.13	55,500	3.462
144	Vented Cover	01-06	1941					3.09	600	194.17	444.22	56,100	3.486
145	Vented Cover	01-06	1943					3.09	600	194.17	447.31	56,700	3.510
146	Vented Cover	01-06	1944			N OF MAMA MIN'S		3.09	600	194.17	450.40	57,300	3.534
147	Vented Cover	01-06	1030A			W ON 20TH ST		3.09	600	194.17	453.49	57,900	3.559
148	Vented Cover	01-06	1132A					3.09	600	194.17	456.58	58,500	3.583
149	Chimney	01-06	0823					2.28	575	252.19	458.86	59,075	3.601
150	Chimney	01-06	1060			INTERS		2.28	575	252.19	461.14	59,650	3.619
151	Chimney	01-06	1124					2.28	575	252.19	463.42	60,225	3.637
152	Chimney	01-06	1134			INTERSECTION 20TH &		2.28	575	252.19	465.70	60,800	3.655
153	Chimney	01-06	1137					2.28	575	252.19	467.98	61,375	3.672
154	Chimney	01-06	1312					2.28	575	252.19	470.26	61,950	3.690
155	Chimney	01-06	1648					2.28	575	252.19	472.54	62,525	3.708
156	Bench	01-06	1134			INTERSECTION 20TH &		0.87	225	258.62	473.41	62,750	3.715
157	Vented Cover	01-06	0823					2.06	600	291.26	475.47	63,350	3.731
158	Vented Cover	01-06	1647					2.06	600	291.26	477.53	63,950	3.747
159	Chimney	01-06	0824					1.96	575	293.37	479.49	64,525	3.763
160	Chimney	01-06	1977A			NORTH IN WOODS		1.96	575	293.37	481.45	65,100	3.778
161	Bench	01-06	1128					0.71	225	316.90	482.16	65,325	3.784
162	Vented Cover	01-06	0821					1.70	600	352.94	483.86	65,925	3.797
163	Bench	01-06	1138					0.62	225	362.90	484.48	66,150	3.802
164	Corbel	01-06	1125					0.78	300	384.62	485.26	66,450	3.808
165	Corbel	01-06	1147			DRIVEWAY 2006 MIAMI		0.78	300	384.62	486.04	66,750	3.814
166	Bench	01-06	1941					0.58	225	387.93	486.62	66,975	3.819
167	Bench	01-06	1106			INTERSECTION 20TH &		0.57	225	394.74	487.19	67,200	3.823
168	Pipe Seal	01-06	0702			TREELINE EDGE OF	1	0.62	250	403.23	487.81	67,450	3.828
169	Pipe Seal	01-06	0702			TREELINE EDGE OF	2	0.62	250	403.23	488.43	67,700	3.833
170	Pipe Seal	01-06	1053				2	0.62	250	403.23	489.05	67,950	3.838
171	Pipe Seal	01-06	1054			INTERSECTION OTTAWA	2	0.62	250	403.23	489.67	68,200	3.843
172	Pipe Seal	01-06	1054			INTERSECTION OTTAWA	3	0.62	250	403.23	490.29	68,450	3.848

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Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
173	Pipe Seal	01-06	1106			INTERSECTION 20TH &	1	0.62	250	403.23	490.91	68,700	3.852
174	Pipe Seal	01-06	1106			INTERSECTION 20TH &	3	0.62	250	403.23	491.53	68,950	3.857
175	Pipe Seal	01-06	1122			BEHIND 1902 MIAMI	2	0.62	250	403.23	492.15	69,200	3.862
176	Pipe Seal	01-06	1128				1	0.62	250	403.23	492.77	69,450	3.867
177	Pipe Seal	01-06	1128				2	0.62	250	403.23	493.39	69,700	3.872
178	Pipe Seal	01-06	1131				1	0.62	250	403.23	494.01	69,950	3.877
179	Pipe Seal	01-06	1131				2	0.62	250	403.23	494.63	70,200	3.882
180	Pipe Seal	01-06	1134			INTERSECTION 20TH &	1	0.62	250	403.23	495.25	70,450	3.886
181	Pipe Seal	01-06	1134			INTERSECTION 20TH &	3	0.62	250	403.23	495.87	70,700	3.891
182	Pipe Seal	01-06	1135				1	0.62	250	403.23	496.49	70,950	3.896
183	Pipe Seal	01-06	1135				2	0.62	250	403.23	497.11	71,200	3.901
184	Pipe Seal	01-06	1137				2	0.62	250	403.23	497.73	71,450	3.906
185	Pipe Seal	01-06	1141				2	0.62	250	403.23	498.35	71,700	3.911
186	Pipe Seal	01-06	1147			DRIVEWAY 2006 MIAMI	1	0.62	250	403.23	498.97	71,950	3.916
187	Pipe Seal	01-06	1309				2	0.62	250	403.23	499.59	72,200	3.921
188	Pipe Seal	01-06	1512				3	0.62	250	403.23	500.21	72,450	3.925
189	Pipe Seal	01-06	1513				1	0.62	250	403.23	500.83	72,700	3.930
190	Pipe Seal	01-06	1514				1	0.62	250	403.23	501.45	72,950	3.935
191	Pipe Seal	01-06	1514				3	0.62	250	403.23	502.07	73,200	3.940
192	Pipe Seal	01-06	1701				3	0.62	250	403.23	502.69	73,450	3.945
193	Pipe Seal	01-06	1712			IN STREET	3	0.62	250	403.23	503.31	73,700	3.950
194	Pipe Seal	01-06	1941				1	0.62	250	403.23	503.93	73,950	3.955
195	Bench	01-06	1135					0.50	225	450.00	504.43	74,175	3.958
196	Corbel	01-06	1516					0.62	300	483.87	505.05	74,475	3.963
197	Corbel	01-06	1772					0.62	300	483.87	505.67	74,775	3.968
198	Vented Cover	01-06	0818					1.03	600	582.52	506.70	75,375	3.976
199	Vented Cover	01-06	0820					1.03	600	582.52	507.73	75,975	3.984
200	Chimney	01-06	0692			12th and Osage		0.80	575	718.75	508.53	76,550	3.991
201	Chimney	01-06	0725					0.80	575	718.75	509.33	77,125	3.997
202	Chimney	01-06	0726					0.80	575	718.75	510.13	77,700	4.003
203	Chimney	01-06	0731			INTSEC SHELDON&HOPE		0.80	575	718.75	510.93	78,275	4.009
204	Chimney	01-06	0734					0.80	575	718.75	511.73	78,850	4.016
205	Chimney	01-06	0815					0.80	575	718.75	512.53	79,425	4.022
206	Chimney	01-06	0817					0.80	575	718.75	513.33	80,000	4.028
207	Chimney	01-06	0829			STREET		0.80	575	718.75	514.13	80,575	4.035
208	Chimney	01-06	0997			INTERS OSAGE&18TH ST		0.80	575	718.75	514.93	81,150	4.041
209	Chimney	01-06	1056					0.80	575	718.75	515.73	81,725	4.047
210	Chimney	01-06	1057			INTERS OTTAWA&19TH		0.80	575	718.75	516.53	82,300	4.053
211	Chimney	01-06	1058					0.80	575	718.75	517.33	82,875	4.060
212	Chimney	01-06	1059			INTERS 20TH & OTTAWA		0.80	575	718.75	518.13	83,450	4.066
213	Chimney	01-06	1090					0.80	575	718.75	518.93	84,025	4.072
214	Chimney	01-06	1106			INTERSECTION 20TH &		0.80	575	718.75	519.73	84,600	4.079
215	Chimney	01-06	1109					0.80	575	718.75	520.53	85,175	4.085

Attachment E1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-06

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
216	Chimney	01-06	1113					0.80	575	718.75	521.33	85,750	4.091
217	Chimney	01-06	1128					0.80	575	718.75	522.13	86,325	4.097
218	Chimney	01-06	1129					0.80	575	718.75	522.93	86,900	4.104
219	Chimney	01-06	1130			INTERS 20TH		0.80	575	718.75	523.73	87,475	4.110
220	Chimney	01-06	1140					0.80	575	718.75	524.53	88,050	4.116
221	Chimney	01-06	1141					0.80	575	718.75	525.33	88,625	4.122
222	Chimney	01-06	1145			BEHIND PARKING		0.80	575	718.75	526.13	89,200	4.129
223	Chimney	01-06	1147			DRIVEWAY 2006 MIAMI		0.80	575	718.75	526.93	89,775	4.135
224	Chimney	01-06	1148			E OF APT COMPLEX		0.80	575	718.75	527.73	90,350	4.141
225	Chimney	01-06	1310					0.80	575	718.75	528.53	90,925	4.148
226	Chimney	01-06	1311					0.80	575	718.75	529.33	91,500	4.154
227	Chimney	01-06	1469			IN STREET		0.80	575	718.75	530.13	92,075	4.160
228	Chimney	01-06	1470			IN STREET		0.80	575	718.75	530.93	92,650	4.166
229	Chimney	01-06	1514					0.80	575	718.75	531.73	93,225	4.173
230	Chimney	01-06	1544			IN STREET		0.80	575	718.75	532.53	93,800	4.179
231	Chimney	01-06	0814A			Brewer Elementary		0.80	575	718.75	533.33	94,375	4.185
232	Chimney	01-06	1030A			W ON 20TH ST		0.80	575	718.75	534.13	94,950	4.192

Total Estimated I/I for 5yr, 90-minute Storm Event: 12,743 gpm

Attachment E2
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Private I/I Abatement - Mini Basin 01-06

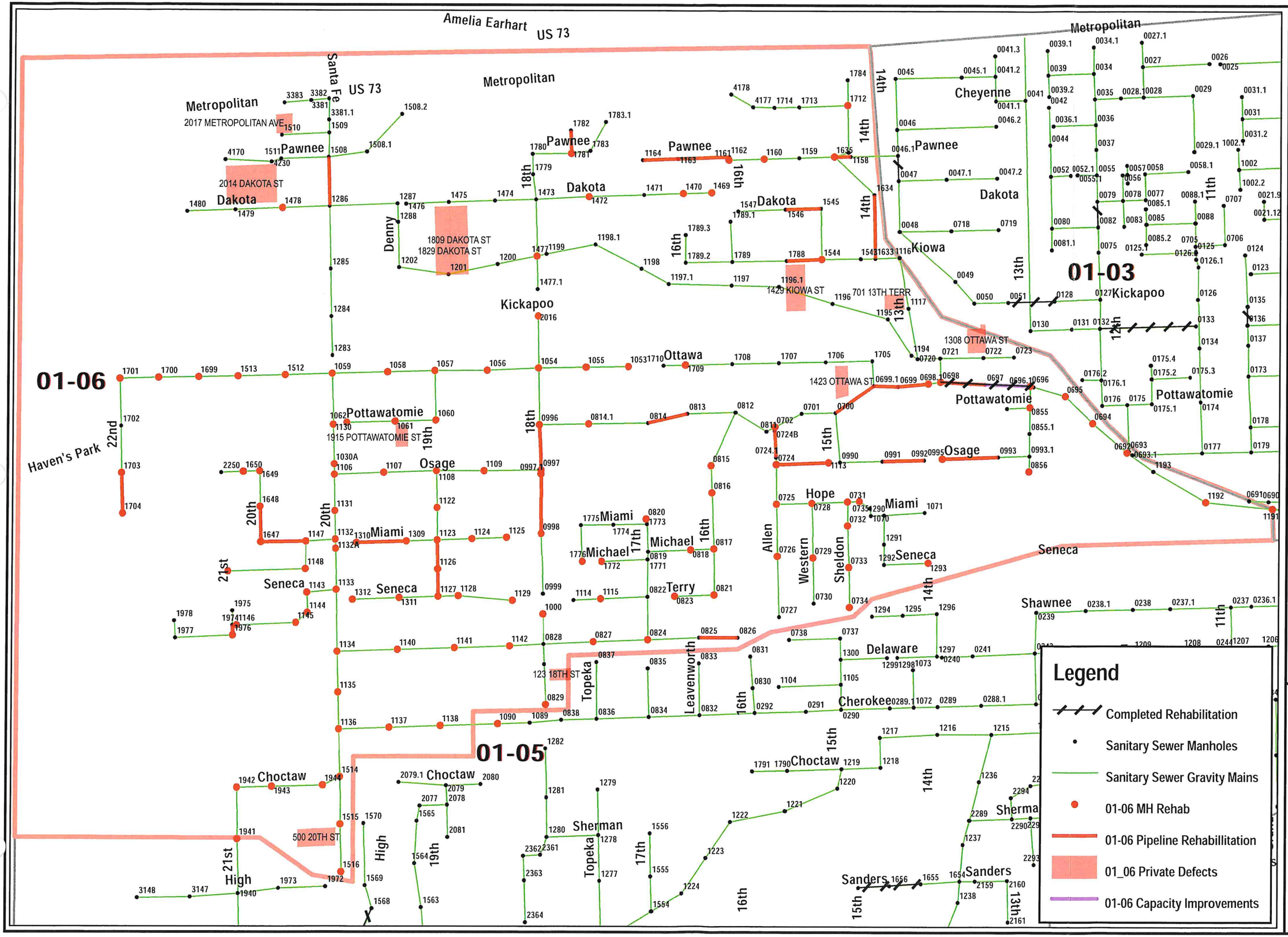
Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Uncapped Cleanout	01-06	1516	01-06	1515	500 S. 20TH ST.	A	33.62	25	0.74	33.62	25	0.264
2	Uncapped Cleanout	01-06	0829	01-06	0828	123 18TH ST	A	13.45	25	1.86	47.07	50	0.369
3	Uncapped Cleanout	01-06	0722	01-06	0721	1308 OTTAWA ST	A	10.09	25	2.48	57.16	75	0.449
4	Uncapped Cleanout	01-06	1510	01-06	1509	2017 METROPOLATIAN	A	6.72	25	3.72	63.88	100	0.501
5	Uncapped Cleanout	01-06	1706	01-06	1705	1423 OTTAWA ST	B	3.36	25	7.44	67.24	125	0.528
6	Uncapped Cleanout	01-06	1475	01-06	1474	1809 DAKOTA ST	A	1.68	25	14.88	68.92	150	0.541
7	Uncapped Cleanout	01-06	1116	01-06	1117	701 13TH TERR	A	0.84	25	29.76	69.76	175	0.547
8	Uncapped Cleanout	01-06	1196A	01-06	1196	1427 KIOWA ST	A	0.84	25	29.76	70.60	200	0.554
9	Uncapped Cleanout	01-06	1476	01-06	1475	1829 DAKOTA ST	A	0.84	25	29.76	71.44	225	0.561
10	Uncapped Cleanout	01-06	1479	01-06	1478	2014 DAKOTA ST	A	0.84	25	29.76	72.28	250	0.567
11	Driveway Drain	01-06	1061	01-06	1060	1915 POTTAWATONIE	A	24.70	5,000	202.43	96.98	5,250	0.761

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

ttachment E3
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Pipeline Rehabilitation - Mini Basin 01-06

Basinup	Manhole Up	Basindn	Manhole Dn	Diameter	Length	Pipe Type	Recommendations	City Action	Replacement Diameter	Rehab Cost	Priority
~~01-06~~	~~0697~~	~~01-06~~	~~0696~~	~~18~~	~~350~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 23,100.00~~	~~2~~
~~01-06~~	~~0698~~	~~01-06~~	~~0697~~	~~18~~	~~280~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 18,480.00~~	~~2~~
01-06	0699	01-06	0698A	12	193	VCP	Replace		12	$ 16,405.00	1
01-06	0699A	01-06	0699	12	156	VCP	Replace		12	$ 13,260.00	1
01-06	0700	01-06	0699A	12	299	VCP/PVC	Partial Replacement, Point Repair		12	$ 2,890.00	2
01-06	0724A	01-06	0724B	8	175	VCP	Partial Replacement, Point Repair		8	$ 2,470.00	2
01-06	0814	01-06	0813	12	259	VCP	Replace		12	$ 22,015.00	1
01-06	0826	01-06	0825	8	248	VCP	Point Repair			$ 650.00	2
01-06	0992	01-06	0991	8	271	VCP	Point Repair			$ 650.00	2
01-06	0995	01-06	0993	8	357	VCP	Replace		8	$ 23,205.00	1
01-06	0997	01-06	0996	10	361	VCP	Point Repair			$ 650.00	2
01-06	0998	01-06	0997A	8	380	VCP	Replace		8	$ 24,700.00	1
01-06	1113	01-06	0724	8	337	VCP	CIPP			$ 12,132.00	2
01-06	1126	01-06	1123	8	185	VCP	Replace		8	$ 12,025.00	1
01-06	1127	01-06	1126	8	165	VCP	Replace		8	$ 10,725.00	1
01-06	1162	01-06	1161	8	18	VCP	Replace		8	$ 1,170.00	1
01-06	1163	01-06	1162	8	311	VCP	Replace		8	$ 20,215.00	1
01-06	1164	01-06	1163	8	251	VCP	Replace		8	$ 16,315.00	1
01-06	1310	01-06	1309	8	318	VCP	Point Repair, CCTV			$ 1,047.50	2
01-06	1508	01-06	1286	8	313	VCP	Replace		8	$ 20,345.00	1
01-06	1546	01-06	1545	8	229	VCP	Point Repair			$ 650.00	2
01-06	1634	01-06	1633	8	415	VCP	Point Repair (2)			$ 1,300.00	2
01-06	1635	01-06	1634	8	341	VCP	Point Repair (2)			$ 1,300.00	2
01-06	1647	01-06	1147	8	290	VCP	Point Repair (2)			$ 1,300.00	2
01-06	1648	01-06	1647	8	225	VCP	Point Repair (2)			$ 1,300.00	2
01-06	1704	01-06	1703	8	257	VCP	Replace		8	$ 16,705.00	1
01-06	1782	01-06	1781	8	200	VCP	Point Repair			$ 650.00	2
01-06	1788	01-06	1544	8	233	VCP	Point Repair (2)			$ 1,300.00	2
01-06	1974	01-06	1146	8	35	VCP	Replace		8	$ 2,275.00	1
01-06	1975A	01-06	1974	8	100	VCP	Point Repair			$ 650.00	2

Total: $ 2 9, 79.50
Completed: $ 41,5 0.00
emaining $ 22 ,299.50



TREKK DESIGN GROUP LLC

Figure E1

Recommended Rehabilitation
Mini Basin 01-06

City of Leavenworth, Kansas
I&I Assessment and Reduction Plan
Trekk Project No. 10-066

Mini-Basin 01-03

Manhole Rehabilitation Program

Information summarized in Section 8 of the *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) recommended a total of 72 potential I/I sources, within 63 manholes, be repaired. A revised cost-effective manhole rehabilitation schedule detailing the type of rehabilitation for each manhole is included as Attachment F1. **A total of $47,000 has been estimated for the Mini-Basin 01-03 recommended manhole rehabilitation program**. Of this total, $11,000 has been estimated for contingencies such as engineering, administration, inspection, and potential construction overages. A general breakdown of the type and cost of rehabilitation is shown in Table F1.

Table F1

Mini-Basin 01-03: Recommended Manhole Rehabilitation Summary

Type of Rehabilitation	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Replace Frame / Cover	13	EA	600	7,800
Seal Frame Seal	57	EA	300	17,100
CIP Chimney	2	EA	575	1,150
Resurfacing	1	LS	9,900	9,900
Sub-Total:**				**36,000**
Contingencies (30%):**				**11,000**
Total Cost:**				**47,000**

*It is recommended that vented covers and poor fitting covers be replaced with an entirely new frame and cover.

**Costs are rounded up to the nearest thousand dollars.

Private-Sector I&I Abatement Program

The total cost to complete the recommended private sector I&I rehabilitation is estimated at $50,000 including a 30% contingency set-aside of $11,000. A general breakdown of the costs to implement the recommended private sector rehabilitation

program is outlined in Table F2. Details regarding the type, location, and unit cost are included in Attachment F2.

Table F2

Mini-Basin 01-03: Recommended Private Sector I&I Abatement Summary

Type of Rehabilitation	$/GPM*	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Disconnect Downspout	5	10	EA	75	750
Repair Uncapped Cleanout	5	22	EA	25	550
Disconnect Area Drain	116	4	EA	2,500	10,000
Disconnect Driveway	331	3	EA	5,000	15,000
Repair Service Lateral	382	5	EA	2,500	12,500
Sub-Total:**					**39,000**
Contingencies (30%):**					**11,000**
Total Cost:**					**50,000**

*Costs to repair versus I&I Flow Rate. Defects with a lower rate are more cost-effective to repair.

**Costs are rounded to the nearest thousand dollars.

Pipeline Rehabilitation Program

The *Sanitary Sewer Evaluation Study – SUB01* (Wade, 2005) identified numerous locations in the Study Area where I&I was entering the collection system through defects in the pipelines. These defects include open/exposed pipe joints with active I&I and other major deficiencies such as voids, broken pipe, or partially collapsed pipe. All defects were initially located by smoke testing and manhole inspection activities and identified for cleaning and CCTV inspection. A total of 60 individual line segments, representing approximately 14,003 linear feet of sanitary sewer, were identified in mini-basin 01-03 for rehabilitation. Six of these line segments have been recently addressed as part of the City's rehabilitation efforts. **The total estimated cost to complete the pipeline rehabilitation program is $1,221,000**. This cost includes a 30% contingency fee of $282,000 for engineering, inspection, legal, and general administration costs. A general breakdown of the quantity and cost to implement the recommended pipeline rehabilitation program is shown in Table F3. A complete list of all lines recommended

for rehabilitation is included as Attachment F3. The location of all recommended rehabilitation in mini-basin 01-03 is shown in Figure F1.

Table F3

Mini-Basin 01-03: Recommended Pipeline Rehabilitation Program

Type of Rehabilitation	Unit	Quantity	Unit Cost	Footage	Total Cost ($)
Point Repair	EA	15	$65	150	9,800
Replacement (8" Pipe)	LF	28	$65	7,160	465,400
Replacement (10" Pipe)	LF	5	$75	1,229	92,200
Replacement (15" Pipe)	LF	7	$100	1,959	195,900
CIPP (8" Pipe)	LF	1	$50	307	15,400
CCTV	LF	1	$1.25	146	200
Manhole Replacement	EA	64	$2,500		160,000
Sub-Total*:					**939,000**
Contingencies (30%)*:					**282,000**
Total Cost*:					**1,221,000**
*Costs are rounded to the nearest thousand dollars.					

Attachment F1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-03

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
1	Frame Seal	01-03	0010			Armed Forces Bank		1.07	300	280.37	5,191.40	358,475	40.739
2	Frame Seal	01-03	0015			driveway		1.07	300	280.37	5,194.61	359,375	40.764
3	Frame Seal	01-03	0023					1.07	300	280.37	5,196.75	359,975	40.781
4	Frame Seal	01-03	0031					1.07	300	280.37	5,201.03	361,175	40.815
5	Frame Seal	01-03	0035					1.07	300	280.37	5,202.10	361,475	40.823
6	Frame Seal	01-03	0041					1.07	300	280.37	5,204.24	362,075	40.840
7	Frame Seal	01-03	0045			PAVED ALLEY		1.07	300	280.37	5,206.38	362,675	40.857
8	Frame Seal	01-03	0047					1.07	300	280.37	5,208.52	363,275	40.874
9	Frame Seal	01-03	0050			FRONT YARD OF		1.07	300	280.37	5,210.66	363,875	40.890
10	Frame Seal	01-03	0055					1.07	300	280.37	5,212.80	364,475	40.907
11	Frame Seal	01-03	0064					1.07	300	280.37	5,214.94	365,075	40.924
12	Frame Seal	01-03	0083					1.07	300	280.37	5,218.15	365,975	40.949
13	Frame Seal	01-03	0085					1.07	300	280.37	5,219.22	366,275	40.958
14	Frame Seal	01-03	0092					1.07	300	280.37	5,220.29	366,575	40.966
15	Frame Seal	01-03	0112					1.07	300	280.37	5,221.36	366,875	40.974
16	Frame Seal	01-03	0123			behind address		1.07	300	280.37	5,225.64	368,075	41.008
17	Frame Seal	01-03	0124					1.07	300	280.37	5,226.71	368,375	41.016
18	Frame Seal	01-03	0138			paved alley		1.07	300	280.37	5,227.78	368,675	41.025
19	Chimney	01-03	0140					1.52	575	197.37	4,862.00	281,325	38.154
20	Frame Seal	01-03	0141					1.07	300	280.37	5,228.85	368,975	41.033
21	Vented Cover	01-03	0141					13.72	600	27.33	1,900.93	18,200	14.917
22	Frame Seal	01-03	0142					1.07	300	280.37	5,229.92	369,275	41.042
23	Frame Seal	01-03	0143					1.07	300	280.37	5,230.99	369,575	41.050
24	Frame Seal	01-03	0147					1.07	300	280.37	5,233.13	370,175	41.067
25	Frame Seal	01-03	0168					1.07	300	280.37	5,236.34	371,075	41.092
26	Frame Seal	01-03	0179					1.07	300	280.37	5,238.48	371,675	41.109
27	Frame Seal	01-03	0186					1.07	300	280.37	5,240.62	372,275	41.125
28	Vented Cover	01-03	0200					1.14	600	328.95	5,404.83	421,425	42.414
29	Frame Seal	01-03	0203					1.07	300	280.37	5,241.69	372,575	41.134
30	Vented Cover	01-03	0207			Foster Cabinet Shop		13.72	600	27.33	1,914.65	18,575	15.025
31	Frame Seal	01-03	0209					1.07	300	280.37	5,245.97	373,775	41.167
32	Frame Seal	01-03	0231			Korea House		1.07	300	280.37	5,249.18	374,675	41.193
33	Vented Cover	01-03	0233					10.98	600	34.15	2,106.89	24,550	16.534
34	Chimney	01-03	0234			N.E OF ADDRESS		1.52	575	197.37	4,863.52	281,625	38.166
35	Frame Seal	01-03	0234			N.E OF ADDRESS		5.33	300	56.29	3,052.02	64,275	23.951
36	Vented Cover	01-03	0234			N.E OF ADDRESS		5.49	600	68.31	3,165.75	71,625	24.843
37	Frame Seal	01-03	0256					1.07	300	280.37	5,250.25	374,975	41.201
38	Frame Seal	01-03	0687					1.07	300	280.37	5,251.32	375,275	41.209
39	Frame Seal	01-03	0705					1.07	300	280.37	5,255.60	376,475	41.243
40	Frame Seal	01-03	0719			PAVED ALLEY BH		1.07	300	280.37	5,256.67	376,775	41.251
41	Frame Seal	01-03	1002					1.07	300	280.37	5,257.74	377,075	41.260
42	Frame Seal	01-03	0010A					1.07	300	280.37	5,192.47	358,775	40.748
43	Vented Cover	01-03	0010A					16.47	600	22.77	1,669.34	11,975	13.100

Attachment F1
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Manhole Rehabilitation - Mini Basin 01-03

Repair Order	Source Item	Basin	Manhole	Basin	Manhole	Location	Def I/I ElimNo.	I/I Elim (GPM)	Cost ($)	$/GPM	CUM I/I(GPM)	CUM ($)	I/I Elim(%)
44	Frame Seal	01-03	0011A					1.07	300	280.37	5,193.54	359,075	40.756
45	Frame Seal	01-03	0023A					1.07	300	280.37	5,197.82	360,275	40.790
46	Cover To Rim	01-03	0034A			IN ALLEY BEHIND		0.80	600	468.75	5,681.47	533,125	44.585
47	Frame Seal	01-03	0034A			IN ALLEY BEHIND		5.33	300	56.29	3,009.38	61,875	23.616
48	Frame Seal	01-03	0041B			PAVED ALLEY		1.07	300	280.37	5,205.31	362,375	40.848
49	Vented Cover	01-03	0045A			PAVED ALLEY		9.64	600	38.90	2,613.62	42,800	20.510
50	Frame Seal	01-03	0046B					1.07	300	280.37	5,207.45	362,975	40.865
51	Frame Seal	01-03	0047A					1.07	300	280.37	5,209.59	363,575	40.882
52	Cover To Rim	01-03	0052A			BACKYARD OF ADDRESS		0.80	600	468.75	5,682.27	533,500	44.591
53	Frame Seal	01-03	0052A			BACKYARD OF ADDRESS		5.33	300	56.29	3,014.71	62,175	23.658
54	Frame Seal	01-03	0055A					5.33	300	56.29	3,020.04	62,475	23.700
55	Frame Seal	01-03	0112A			E. of 6th		1.07	300	280.37	5,222.43	367,175	40.983
56	Frame Seal	01-03	0112B			E. of 7th		1.07	300	280.37	5,223.50	367,475	40.991
57	Cover To Rim	01-03	0125A			FRONT YARD OF		0.80	600	468.75	5,683.07	533,875	44.598
58	Frame Seal	01-03	0125A			FRONT YARD OF		5.33	300	56.29	3,030.70	63,075	23.783
59	Vented Cover	01-03	0141A					1.14	600	328.95	5,403.69	421,050	42.405
60	Cover To Rim	01-03	0150C			in driveway		0.80	600	468.75	5,683.87	534,250	44.604
61	Frame Seal	01-03	0150C			in driveway		5.33	300	56.29	3,041.36	63,675	23.867
62	Frame Seal	01-03	0150F			Front yard		1.07	300	280.37	5,234.20	370,475	41.075
63	Frame Seal	01-03	0175B					1.07	300	280.37	5,237.41	371,375	41.100
64	Frame Seal	01-03	0205B			Front yard		1.07	300	280.37	5,243.83	373,175	41.151
65	Frame Seal	01-03	0207A					1.07	300	280.37	5,244.90	373,475	41.159
66	Vented Cover	01-03	0207A					19.21	600	19.52	1,624.07	11,025	12.745
67	Frame Seal	01-03	0209A					1.07	300	280.37	5,247.04	374,075	41.176
68	Frame Seal	01-03	0209B					1.07	300	280.37	5,248.11	374,375	41.184
69	Frame Seal	01-03	0687A					1.07	300	280.37	5,252.39	375,575	41.218
70	Frame Seal	01-03	0687B					1.07	300	280.37	5,253.46	375,875	41.226
71	Frame Seal	01-03	0688A					1.07	300	280.37	5,254.53	376,175	41.235
72	Frame Seal	01-03	1002B					5.33	300	56.29	3,062.68	64,875	24.034

Total Estimated I&I for 5yr, 90-minute Storm Event: 12,743 gpm

ttachment 3
City of Leavenworth, Kansas
I/I Assessment and Reduction Plan
Recommended Pipeline Rehabilitation - Mini Basin 01-03

Basinup	Manhole Up	Basindn	Manhole Dn	Diameter	Length	Pipe Type	Recommendations	City Action	Replacement Diameter	Rehab Cost	Priority
01-03	0009A	01-03	9	6	311	VCP	Replace		8	$ 20,215	1
01-03	0010AZ	01-03	0010A	6	150	VCP	Point Repair			$ 650	2
01-03	0017A	01-03	19	6	128	VCP	Replace		8	$ 8,320	1
01-03	0021C	01-03	0090A	8	322	VCP	Replace		8	$ 20,930	1
01-03	0021D	01-03	0021C	6	312	VCP	Replace		8	$ 20,280	1
01-03	0021F	01-03	0090A	8	470	VCP	Replace		8	$ 30,550	1
01-03	0021G	01-03	0021F	8	162	VCP	Replace		8	$ 10,530	1
01-03	0023A	01-03	23	6	146	VCP	Point Repair, CCTV			$ 833	2
01-03	26	01-03	27	8	430	VCP	Replace		8	$ 27,950	1
01-03	27	01-03	28	8	192	VCP	Replace		8	$ 12,480	1
01-03	28	01-03	0028A	10	131	VCP	Replace		10	$ 9,825	1
01-03	29	01-03	28	6	330	VCP	Replace		8	$ 21,450	1
01-03	31	01-03	24	8	307	VCP	CIPP			$ 15,350	1
01-03	0031B	01-03	31	8	140	VCP	Point Repair			$ 650	1
01-03	34	01-03	35	10	164	VCP	Point Repair			$ 650	1
01-03	36	01-03	37	10	156	VCP	Replace		10	$ 11,700	1
01-03	0036A	01-03	36	6	257	VCP	Replace		8	$ 16,705	1
01-03	0039B	01-03	39	8	100	VCP	Replace		8	$ 6,500	1
01-03	42	01-03	44	8	240	VCP	Point Repair			$ 650	1
~~01-03~~	~~0046A~~	~~01-03~~	~~47~~	~~10~~	~~164~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 8,856~~	~~1~~
01-03	0046C	01-03	46	7	293	VCP	Replace		8	$ 19,045	1
01-03	48	01-03	49	10	476	VCP	Replace		10	$ 35,700	1
01-03	0049	01-03	0050	10	186	VCP	Point Repair			$ 650	2
~~01-03~~	~~0051~~	~~01-03~~	~~0128~~	~~10~~	~~300~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 16,200~~	~~1~~
01-03	0052	01-03	0080	8	324	VCP	Replace		8	$ 21,060	1
01-03	0058	01-03	0077	8	166	VCP	Replace		8	$ 10,790	1
01-03	0058A	01-03	0058	6	267	VCP	Replace		8	$ 17,355	1
01-03	0059	01-03	0021H	8	162	VCP	Replace		8	$ 10,530	1
01-03	0061	01-03	0060	8	165	VCP	Replace		8	$ 10,725	1
01-03	0077	01-03	0078	8	145	VCP	Replace		8	$ 9,425	1
01-03	0078	01-03	0079	10	163	VCP	Replace		10	$ 12,225	1
~~01-03~~	~~0079~~	~~01-03~~	~~0082~~	~~10~~	~~164~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 8,856~~	~~1~~
01-03	0083	01-03	0078	10	164	VCP	Point Repair			$ 650	2
01-03	0085A	01-03	0085	8	100	VCP	Point Repair			$ 650	2
01-03	0085B	01-03	0085	8	130	VCP	Point Repair (2)			$ 1,300	2
01-03	0090A	01-03	0119	8	340	VCP	Replace		8	$ 22,100	1
01-03	0117	01-03	0145	8	221	VCP	Replace		8	$ 14,365	1
01-03	0118	01-03	0117	8	160	VCP	Point Repair (2)			$ 1,300	2
01-03	0119	01-03	0118	8	170	VCP	Replace		8	$ 11,050	1
01-03	0126A	01-03	0126	6	236	VCP	Replace		8	$ 15,340	1
01-03	0128	01-03	0127	10	303	VCP	Replace		10	$ 22,725	1
01-03	0130	01-03	0131	15	266	VCP	Replace		15	$ 26,600	1
01-03	0131	01-03	0132	15	185	VCP	Replace		15	$ 18,500	1
~~01-03~~	~~0135~~	~~01-03~~	~~0136~~	~~8~~	~~118~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 5,900~~	~~1~~
01-03	0150B	01-03	0150A	6	60	VCP	Replace		8	$ 3,900	1
01-03	0150G	01-03	0150D	6	129	VCP	Replace		8	$ 8,385	1
01-03	0152C	01-03	0151	8	199	VCP	Replace		8	$ 12,935	1
01-03	0171	01-03	0170	8	372	VCP	Replace		8	$ 24,180	1
~~01-03~~	~~0180~~	~~01-03~~	~~0181~~	~~8~~	~~280~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 14,500~~	~~1~~
01-03	0181	01-03	0182	15	136	VCP	Replace		15	$ 13,600	1
01-03	0205	01-03	0205A	15	571	VCP	Replace		15	$ 57,100	1
01-03	0210	01-03	0210A	15	135	VCP	Replace		15	$ 13,500	1
01-03	0210A	01-03	0214	15	502	VCP	Replace		15	$ 50,200	1
01-03	0214	01-03	0214A	15	164	VCP	Replace		15	$ 16,400	1
01-03	0257	01-03	0256A	8	586	VCP	Replace		8	$ 38,090	1
01-03	0691	01-03	0205B	8	125	VCP	Point Repair			$ 650	1
01-03	0691	01-03	0690	8	130	VCP	Point Repair			$ 650	2
01-03	0718	01-03	0048	6	310	VCP	Replace		8	$ 20,150	1
01-03	0719	01-03	0718	8	300	VCP	Point Repair			$ 650	2
~~01-03~~	~~1092~~	~~01-03~~	~~1091~~	~~8~~	~~178~~	~~VCP~~	~~CIPP~~	~~CIPP~~		~~$ 8,900~~	~~2~~

Total:	$	41,904.50
Completed:	$	3,212.00
emaining	$	77 , 92.50

Figure F1

Recommended Rehabilitation
Mini Basin 01-03

City of Leavenworth, Kansas
I&I Assessment and Reduction Plan
Trekk Project No. 10-066

TREKK DESIGN GROUP, LLC

Legend

- Completed Rehabilitation
- 01-03 MH Rehab
- 01-03 Pipeline Rehabillitation
- 01_03 Private Defects
- Sanitary Sewer Manholes
- Sanitary Sewer Gravity Mains

01-03
01-01
01-04
01-06