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 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.

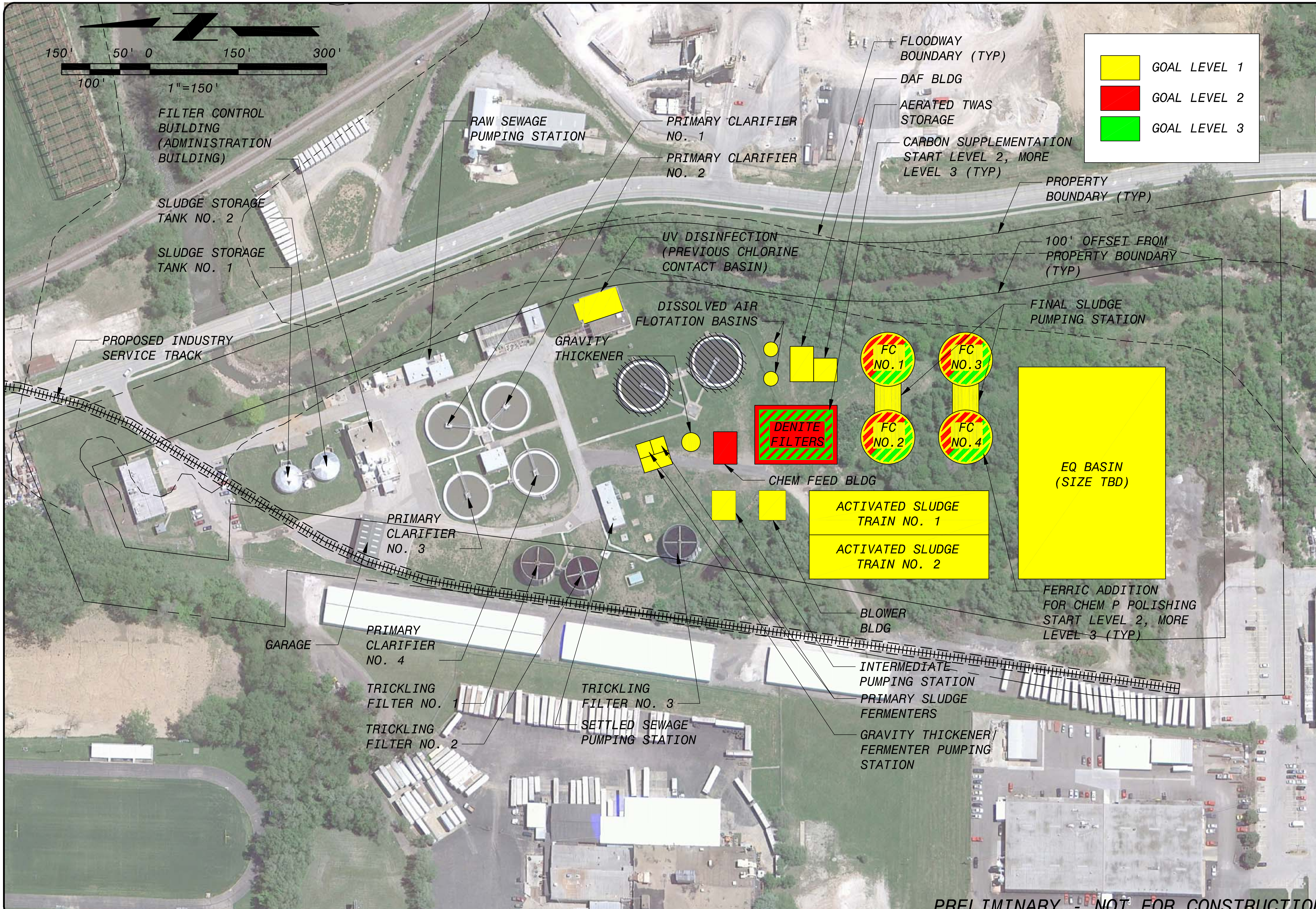
A phased site layout showing the facilities required for each goal level is included in *Figure 5-1*. The layout includes facility sizing to treat an annual average (AA) flow of 8.1 million gallons per day (mgd) which essentially maximizes the use of the existing plant property and is considered ultimate 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

DATE	REVISIONS AND RECORD OF ISSUE	NO.	BY	CK	APP

CYGNET ID: PW FLDR: 168597....\41.4100 - Drawings (Not Leavenworth Construction)
XREF1 ID: User Site Design
SAVED: CRA45417, 11/10/2010 5:32:31 PM
XREF2 ID:
DWG VER #: 1000
XREF3 ID:
PLOTTED: CRA45417, 11/18/2010 3:16:54 PM
XREF4 ID:
USER: CRA45417
SW: PW FILE: 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. Twelve (12) operators (Class III) are dedicated to the Leavenworth plant.

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 one (1) additional operator, 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.

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-yr 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.

- 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		666,000	673,000	749,000
	20-year PW of O&M		10,890,000	11,004,000	12,247,000
	TOTAL PW COST		**67,113,700**	**23,054,000**	**12,247,000**