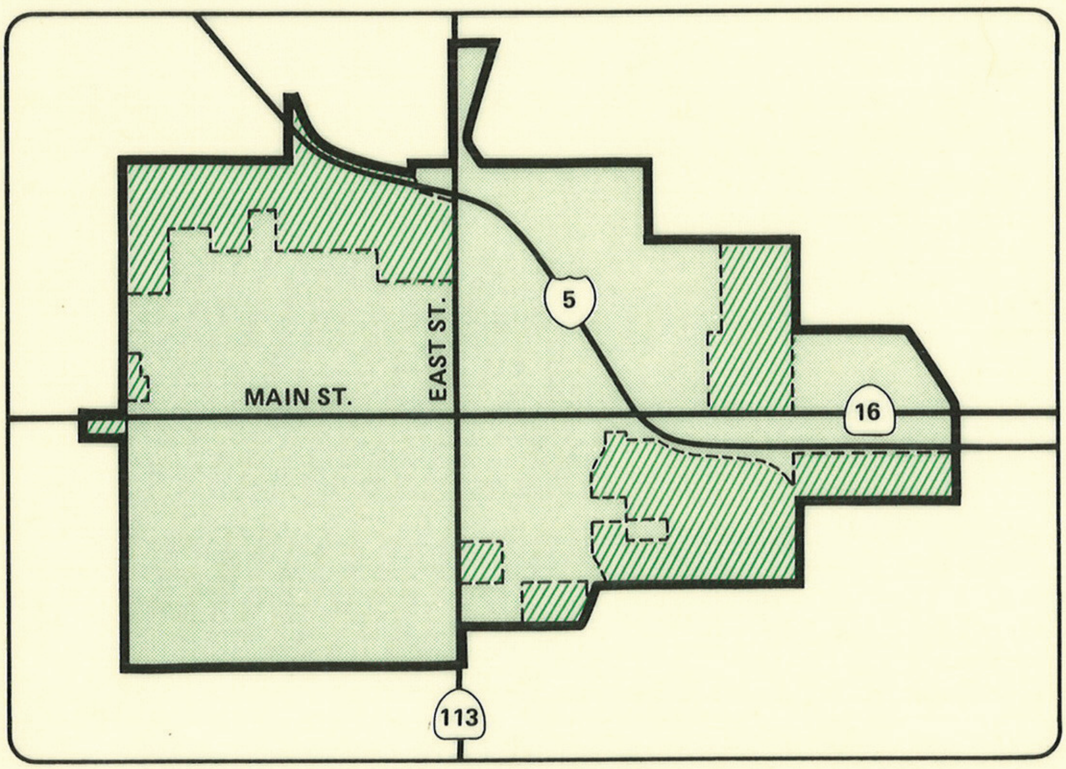
Greg M.

City of Woodland

WASTEWATER FACILITIES MASTER PLAN



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APRIL 1986

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

CH2M HILL
April 1986

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CHAPTER 1
Introduction

Chapter 1
INTRODUCTION

This report presents the Wastewater Facilities Master Plan for the City of Woodland, California. The master plan objectives are to identify limitations of the existing system and to recommend necessary improvements to meet present and future needs within the major trunk collection system, the Kentucky Avenue Lift Station, the old Beamer Street Primary Plant and the Woodland Wastewater Treatment Plant (WWTP). An additional objective of the master plan is to evaluate financial alternatives for funding necessary improvements. The master plan outlines a staged capital improvement program for implementing the recommendations.

PLANNING AREA

The City of Woodland is in central Yolo County in a predominantly agricultural area 20 miles northwest of Sacramento and 10 miles north of Davis. Cache Creek is just north of the City, and to the east is the Yolo Bypass. The planning area, as shown in Figure 1-1, coincides with the Woodland urban limit line. The existing sewer service boundary conforms generally to the urban limit line except in the area east of County Road 101. For the purposes of the master plan, the entire area within the urban limit line has been considered.

The existing wastewater collection system serves approximately 5,140 acres and a population of 33,920. Including unsewered areas within the urban limit line, the total area is 7,120 acres. Wastewater is currently directed either to the Beamer Street Primary Plant or the Woodland Wastewater Treatment Plant for treatment and disposal.

The existing land uses within the City consist of residential, commercial, industrial, and agricultural development. The commercial activities, concentrated along Main and East Streets, are directed toward local residents and residents of surrounding towns and farm areas. The major industries are related to agriculture and to mobile home fabrication. Most industries are located in the northeastern section of the City, as well as along West Kentucky Avenue and East Street. Agricultural uses within the urban limit line are primarily located in the areas north of Kentucky Avenue and east of Matmor Road.

PROJECT SCOPE

This master plan was prepared to incorporate current and proposed developments consistent with the Land Use Element of the City's General Plan and to evaluate the impacts on the existing collection system and the City's WWTP. In evaluating system capacity, it is necessary to determine if infiltration/inflow (I/I) contributes to flows during wet weather. The results of the evaluation enable any potential capacity problem areas to be localized and the cause related to excessive I/I, insufficient capacity, or both. Insufficient capacity exists in pipelines where additional capacity is not available for flows from new developments, even without an allowance for I/I.

The master plan identifies the limitations of the existing collection system under maximum flow conditions, establishes treatment capacity, and recommends a plan for specific improvements. The major tasks involved in preparing this master plan were as follows:

- Collect Existing Data. Following an extensive review of existing maps, plans, as-builts, and land use planning information, a data base was developed for performing the remaining tasks. Historical flow records from the treatment plant and pump station were collected and analyzed.

- Measure Wastewater Flows. A program was developed to monitor wastewater flow at key manholes under both dry and wet conditions. Rainfall data were also collected during the flow monitoring period.

- Determine Present and Future Flows. After reviewing the Land Use Element of the City's General Plan and meeting with the planning staff, existing and future land uses were determined for each basin within the City. Unit flow allocation factors, developed for characteristic land use categories were used to project the existing and future sanitary flow contributions. These factors were input to the collection system computer model. For this master plan, buildout will be achieved by the year 2020.

- Develop Design Flows. Design flows for existing and future conditions were developed for each major trunk sewer. Base sanitary flow hydrographs for existing and future conditions were combined with I/I hydrographs to develop a design rain event for each monitor. The relationship between rainfalldependent infiltration/inflow (RDI/I) and rainfall at each monitor site was used to develop design I/I flow conditions.

- Analyze Collection System Capacity. Using a computer model, the major trunk sewers of the collection system were analyzed for available capacity and pipeline deficiencies. System deficiencies were identified for present and future (year 2020) dry weather and wet weather flow conditions.

- Analyze WWTP Capacity Requirements. Average flow conditions for 1985 and 2020 were totaled and compared with the capacity available at the WWTP. Alternatives to expand the capacity and to improve the effluent quality were evaluated.

- Develop Recommended Plan. The computer modeling identified additional facilities required to convey peak flows where existing capacity is not sufficient. After analyzing the results, a capital improvement program and a preliminary cost estimate were developed. The recommended plan has been staged to give priority to correcting the most critical areas.

- Develop Financial Alternatives. To finance the recommended plan improvements, alternatives were evaluated, these included long-term debt, pay-as-you-go, and a combination policy. The advantages and disadvantages of each approach were analyzed and a recommended program was selected.

The recommended program is for the City of Woodland to upgrade the wastewater collection system to enable it to convey flows under the future peak wet weather design conditions expected by the year 2020 without surcharge or overflow. A plan for WWTP expansion is also presented with the objective of improving effluent quality in compliance with the Regional Board requirements. This master plan should be considered preliminary and should remain flexible to incorporate possible changes in land use strategies. A significant influence on recommended pipeline sizes is I/I flows. As an example, Appendix B illustrates the effects of a comprehensive rehabilitation approach on reducing the I/I contribution.

OTHER WOODLAND MASTER PLAN REPORTS

As a result of an increasing awareness of the need to evaluate the condition and capacity of the infrastructure, the City of Woodland has recently completed two other master plan studies, one of the storm drainage system and one of the water supply system. Since usage of both of these systems may impact the wastewater collection and treatment system, these studies are briefly summarized here.

DRAFT STORM DRAINAGE MASTER PLAN, APRIL 1985

This report, prepared by Brown and Caldwell for the City of Woodland, examined the existing capacity of the storm drainage system. The study found that the storm drainage system in the central business section of town has insufficient capacity to convey runoff from a storm with a 2-year recurrence interval. The standard level of protection of most systems is for a 10-year storm. As a result of cost analysis, the report recommended upgrading the system to provide a 2-year level of service west of County Road 101 and a 10-year level of service east of this road. The construction of a new 800 cfs pump station at the Cache Creek Settling Basin and the use of a detention pond east of Road 101 were also recommended.

WATER SUPPLY SYSTEM MASTER PLAN, SEPTEMBER 1985

This report, prepared by Dewante and Stowell for the City of Woodland, analyzed the current water usage in the City, the existing production capacity, and expected future water usage and capacity requirements based on land use. The study recommended a reliable peak well pumping capacity of 32 mgd to meet existing demands and a future peak well pumping capacity of 51 mgd to meet ultimate (year 2020) demand.

ABBREVIATIONS AND DEFINITIONS

In order to conserve space, the following abbreviations have been used within the report. Selected definitions are also provided for reference.

ADWF	Average Dry Weather Flow
Basin	A distinct drainage area within the City dictated by gravity flow
BOD	Biochemical Oxygen Demand, an indicator of oxygen demanding microorganisms present in wastewater
City	City of Woodland
DAF	Dissolved Air Flotation
design conditions	Selected conditions for system design, determined by corresponding peak sanitary flow, peak GWI, and peak RDI/I.

dry weather flow	Wastewater flow monitored in the winter season without rain (includes GWI).
du	dwelling unit
ENR	Engineering News-Record, San Francisco, Construction Cost Index
existing	Flow or land use associated with the year 1985.
fps	feet per second
ft	feet
future	Flow or land use associated with the year 2020.
gal	gallons
gpcd	gallons per capita per day
gpd	gallons per day
gpad	gallons per acre per day
GWI	Groundwater Infiltration
hp	horsepower
hrs	hours
I/I	Infiltration/Inflow, The wastewater component caused by groundwater infiltration (GWI) and rainfall-dependent infiltration/inflow.
in	inches
Isohetal pattern	A pattern connecting points of equal rainfall
kWh	kilowatt hours
lf	linear feet
major sewer	Major collector pipelines used to represent the collection system in SAM.

mgal	million gallons
mgd	million gallons per day
mg/l	milligrams per liter
min	minutes
O&M	Operation and Maintenance
overflow	A condition occurring in sewers when flows beyond sewer capacity are imposed upon the system, causing the hydraulic grade line to rise above the street surface and resulting in sewage flowing into the receiving water.
PDWF	Peak Dry Weather Flow
peaking factor	A factor used for collection system analysis to project the average daily sanitary flow to the peak daily sanitary flow.
PWWF	Peak Wet Weather Flow
RDI	Rainfall-Dependent Infiltration. Rainfall runoff, that enters a sewer system and service connections during, after, and as a result of a rainfall event from the ground, through (but not limited to) defective pipes, pipe joints, connections, and manholes.
RDI/I	Rainfall-Dependent Infiltration/ Inflow. Rainfall runoff from both infiltration and inflow sources that enters the collection system during and shortly after a rain event. RDI/I consists of Storm Water Inflow (SWI) and Rain Dependent Infiltration (RDI).
Regional Board	California Regional Water Quality Control Board
rpm	revolutions per minute
sanitary flow	Wastewater flow generated by individual users (does not include I/I).

SAM	System Analysis Model. SAM represents the City's collection system for various flow conditions.
surcharge	A condition occurring in sewers when flows beyond the capacity of the sewers are imposed upon the system causing the hydraulic grade line to rise above the sewer crown.
SWI	Storm Water Inflow
SWRCB	California State Water Resources Control Board
sq ft	square feet
trunk sewer	major sewer
wastewater flow	Total flow within the collection system, including I/I.
wet weather flow	Monitored winter season flow during rainfall (includes GWI and RDI/I).
WWTP	Wastewater Treatment Plant
yr	year

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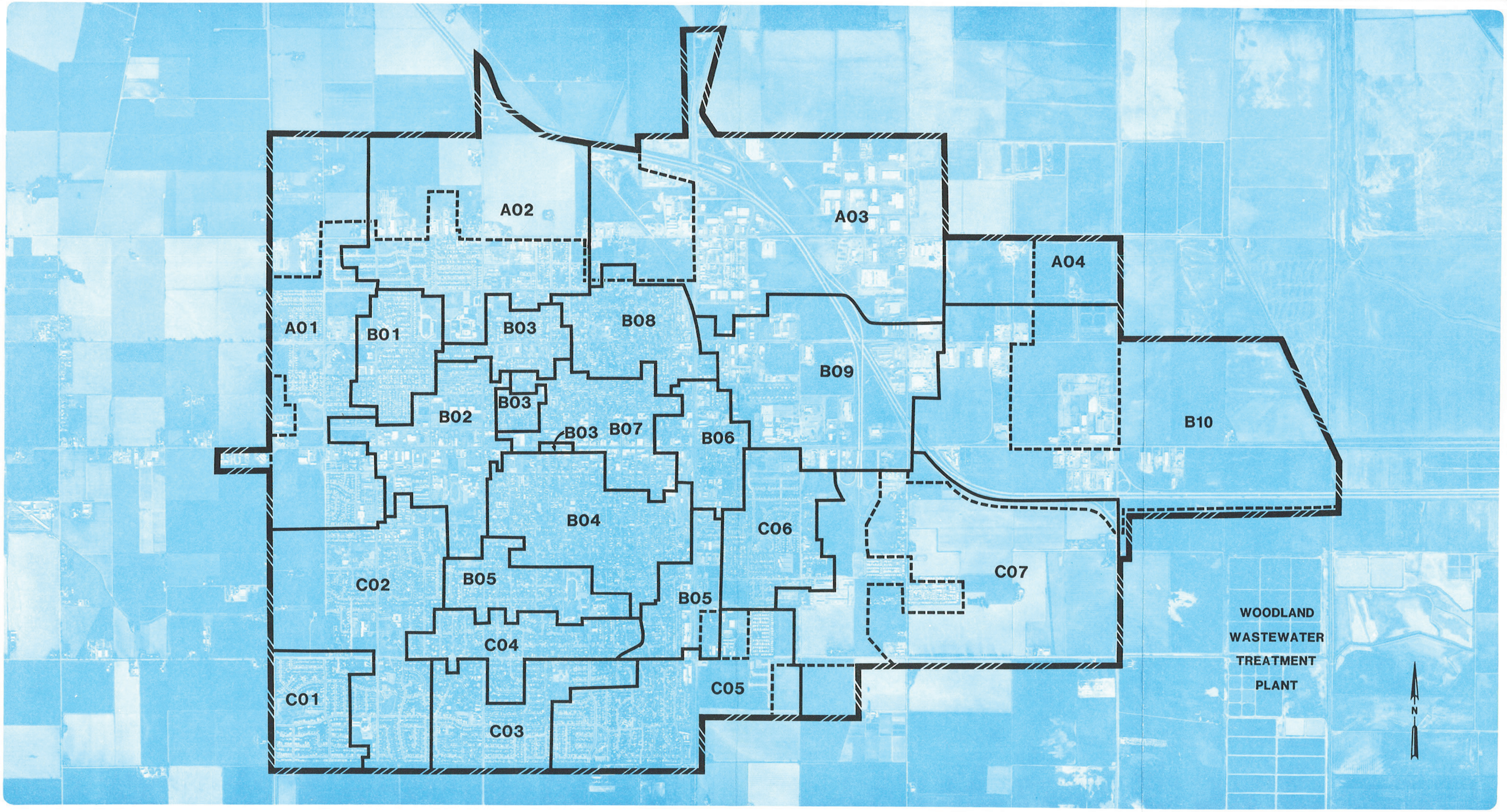

LEGEND :

URBAN LIMIT LINE

CITY BOUNDARY

BASIN BOUNDARY

A01 BASIN IDENTIFICATION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1" = 1200'

PLANNING AREA LOCATION

FIGURE 1-1

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

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CHAPTER 2
Summary and Recommendations

Chapter 2
SUMMARY AND RECOMMENDATIONS

The purpose of this master plan for the City of Woodland is to incorporate current land use information and future development policies, consistent with the Land Use Element of City's General Plan, into an analysis of the wastewater facilities. The results of a computerized model have been used to determine specific pipelines within the major trunk collection system with insufficient capacity under peak flow conditions. Existing and projected flow information and effluent discharge requirements have been used to evaluate the wastewater treatment and disposal system. This chapter presents the results of this evaluation and recommendations for the City to begin a program for wastewater facilities improvement.

EXISTING WASTEWATER FACILITIES

The existing collection system, serving approximately 5,140 acres, includes approximately 110 miles of pipeline with diameters ranging from 6 to 36 inches. The City is divided into three major systems which collect and transport wastewater to the Woodland Wastewater Treatment Plant. System A serves approximately 1,390 acres, System B serves approximately 2,080 acres, and System C serves the remaining 1,670 acres.

The existing wastewater treatment and disposal facilities include the Beamer Street Primary Plant, the Wastewater Treatment Plant, and the Sewage Farm. The Beamer Street Primary Plant is the original City treatment plant; it now consists of a grit chamber and the Kentucky Avenue Lift Station which transport flows originating in the northern portion of Woodland to either on-site evaporation ponds or the Wastewater Treatment Plant. The Woodland Wastewater Treatment Plant consists of approximately 282 acres of waste stabilization and chlorination ponds, flow measurement, screening, and pumping facilities. Wastewater effluent disposal is either by evaporation, land disposal to the Sewage Farm or the industrial site, or directly to the Tule Canal during November through February.

DESIGN FLOW ANALYSIS

During the period of December 1984 through February 1985, 18 flow monitors and three rain gauges were installed at key locations throughout the City. Monitored dry weather flow data were used to develop base sanitary flow and peaking factors, and to quantify groundwater infiltration. Data collected during storm periods were compared with the dry weather data to determine rainfall-dependent infiltration.

The flow monitoring results and the land use evaluation were used to develop flows for input to the computer model. The necessary data for this study included dry and wet weather flows for both existing and future conditions. Infiltration/inflow was projected to peak conditions expected for a storm event with a 2-, 5- and 10-year return period.

COLLECTION SYSTEM ANALYSIS

A comprehensive analysis was performed on the major sewer lines using the System Analysis Model (SAM), a computer model developed by CH2M HILL. For existing (1985) and projected (year 2020) flow conditions, SAM determined the pipeline sections where existing capacity had been exceeded. SAM then calculated required improvements to transport peak flows through the system without surcharge. The model results were studied in detail to determine alternative solutions and select the most cost-effective plan.

TREATMENT AND DISPOSAL CAPACITY ANALYSIS

Using the flow information developed during the collection system analysis, the Wastewater Treatment Plant was evaluated for effluent quality improvement and necessary capacity expansion. The current treatment capacity is approximately 2.9 mgd based on organic loading. However, the existing facilities cannot meet the effluent discharge requirement for suspended solids because of algae growth in the ponds. To meet the Regional Board's effluent discharge requirements, several alternatives were screened; five alternatives were evaluated in detail. The first three alternatives would expand the existing treatment ponds and either alter the type of disposal from storage with winter disposal, to land disposal with winter discharge, or complete land disposal. The final two alternatives are activated sludge treatment and oxidation ditch treatment.

CAPITAL IMPROVEMENT PROGRAM

A capital improvement program was developed for the City to alleviate capacity deficiencies within the collection system and the treatment and disposal system. The program was sized for expected peak flow conditions, which included future peak sanitary flows for the year 2020, and design I/I flows developed for the 2-year design storm.

The recommended collection system improvements include 6,700 lf of parallel overflow pipe and 15,700 lf of new or replacement pipe. The recommended collection system improvements are presented in Table 9-1 and Figure 9-1.

The recommended treatment and disposal improvements are modifications to the existing pond system, mechanical surface aeration, pump station installation, disinfection, effluent polishing by dissolved air flotation, and facilities for land disposal. The system capacity would be increased to an average flow of approximately 10.6 mgd. The specific program for the treatment and disposal system improvements is presented in Table 9-2.

The recommended program was divided into three stages based on the relative degree of restricted capacity and expected growth. Stage I projects, developed for the most severe capacity problems, should be completed by 1988. Stage II and Stage III projects should be completed by 1995 and 2010, respectively. The estimated total costs for each stage are shown in Table 2-1.

FINANCIAL ANALYSIS

A detailed financial analysis was performed with three objectives in mind: (1) to determine a recommended funding method, (2) to allocate project costs to users based on benefits received, and (3) to estimate impacts on user charges and system development fees.

In accomplishing these objectives, the recommended facilities were separated into four categories:

- Collection system upgrade facilities
- Collection system expansion facilities
- Treatment and disposal upgrade facilities
- Treatment and disposal expansion facilities

Costs for upgrading the existing system were allocated to existing users, or those connected to the system. All expansion costs (for additional capacity) were allocated to the new users for whom this additional capacity was constructed.

The recommended financing method is a combination of revenue bonds and increases in user charges and system development fees. The impacts on the different types of users are summarized in Table 2-2. The immediate (1986) rate implications from the recommended plan of improvements (both collection system and treatment plant) would be an increase of $4.86 per month for a typical residential dwelling unit and $48 per month for a typical acre of commercial/industrial development. These charges could be reduced by about 30 percent by year 2005 due to additional users entering the system, thereby diluting revenue requirements per user. System development fees have been levelized to hold them constant at $1,808 per typical residential dwelling and $17,858 per typical commercial/industrial acre.

Table 2-1
City of Woodland
Wastewater Facilities Plan

STAGED IMPROVEMENTS COST SUMMARY

		Estimated Capital Cost ($1,000)			Estimated Maintenance Cost Increase ($1,000/yr)		
Stage	Collection Period	Collection	Treatment & Disposal	Total	Collection	Treatment & Disposal	Total
I	1985-1988	2,638	11,420	14,058	2.1	558.0	560.1
II	1989-1995	2,238	2,850	5,088	35.8	138.0	173.8
III	1996-2010	939	4,130	5,069	0	204.0	204.0
		5,815	18,400	24,215	37.9	900.0	937.9

[a] ENR 5100, April 1985

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Table 2-2
City of Woodland
Wastewater Treatment Facilities Master Plan

RATE INCREASE IMPACTS OF THE RECOMMENDED SYSTEM IMPROVEMENTS[a]

	1986 Rate Impacts		1986-2005 Average Rate Impacts	
	Residential[b]	Commercial[c]	Residential[b]	Commercial[c]
Existing Users (Annual User Charges Increase)				
Collection System Upgrade	$11.72	$116.00	$ 9.85	$ 97.00
Treatment Plant Upgrade	46.58	460.00	37.55	371.00
TOTAL	$58.30	$576.00	$47.40	$468.00
New Users (One-Time System Development Fees)				
Collection System Expansion	$ 432.00	$ 4,267.00	$ 432.00	$ 4,267.00
Treatment Plant Expansion	1,808.00	13,591.00	1,376.00	13,591.00
TOTAL	$1,808.00	$17,858.00	$1,808.00	$17,858.00

[a]From Tables 10-4 and 10-5
[b]For a typical residential dwelling unit (D.U.).
[c]For a typical acre of commercial/industrial development.

RECOMMENDATIONS

As a result of the evaluation of the wastewater collection, treatment and disposal system, the following recommendations are presented:

1. The City of Woodland should begin to develop a program for implementing the recommended Stage I collection and treatment systems improvements. Stage I is scheduled for completion by 1988.

2. The City should implement a program to detect sources of I/I for input to a detailed cost-effective analysis. This analysis would compare costs of I/I source correction with costs of system improvements necessary to transport and treat I/I flows. The results of a preliminary evaluation to determine the effects of I/I reduction is presented in Appendix B.

3. The City should begin discussions with The Regional Board to finalize the effluent discharge requirements. Attention should be given to quality as well as the discharge period.

4. The City should begin negotiations for use of nearby agricultural land for wastewater effluent disposal during the period of April through October.

5. The City should implement a maintenance program similar to that described in Chapter 9 to efficiently maintain and upgrade the collection system. This program should maintain the I/I at a constant reduced level after initial reductions have been achieved by rehabilitation.

6. The City should provide for updating this master plan as necessary to incorporate changes in flow conditions as a result of I/I reduction or changes in the City's land use development policy. An update would also be necessary if changes occur in the Regional Board effluent discharge requirements.

SFR18/085

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CHAPTER 3
Existing Wastewater Facilities

Chapter 3
EXISTING WASTEWATER FACILITIES

The existing wastewater facilities within the City of Woodland include approximately 110 miles of pipeline with diameters ranging from 6 to 36 inches, the wastewater treatment plant, and the disposal field. This chapter presents a general description of each facility.

COLLECTION SYSTEM

The wastewater collection system was divided into three systems dictated by gravity flow to the Woodland Wastewater Treatment Plant, located at the southeast corner of the urban limit line. Within each system, basins were defined by natural drainage boundaries, determined during flow monitoring. The major sewers were identified as the significant collector pipelines in the basins and have been used to represent the collection system in the computer model.

SYSTEM CHARACTERISTICS

To the north, System A, consisting of four drainage basins, currently serves approximately 1,390 acres. System B serves about 2,080 acres in the central part of the City, and is divided into ten basins. In the southern portion of the City, System C serves approximately 1,670 acres and is comprised of seven drainage basins. Figure 3-1 illustrates the basin divisions and also the major trunk sewers.

The length of major trunk sewer modeled within a basin was defined by the tributary area in which the basin was located. The objective was to serve equally sized development areas by extending the modeled major sewer up to the development area. Table 3-1 summarizes the system characteristics for the planning area. A complete set of 1 in = 600 ft scale maps, provided as Appendix A, indicate additional detail for major sewers within the basins.

Within the major trunk system is the Kentucky Street Lift Station, located at the old Beamer Street Wastewater Treatment Plant. This lift station consists of two pumps, each with a 16 hp motor, rated at 1.6 mgd capacity. The maximum station capacity is 2.9 mgd if both are on together. The station discharge is routed through a 100-foot force main prior to entrance to the grit chamber.

FLOW MONITORING

During the period of December 17, 1984 through February 12, 1985, flow metering equipment was located at 18 key manholes throughout the City of Woodland for the purpose of monitoring wastewater flow during both "dry" and wet weather periods.

Table 3-1
City of Woodland
Wastewater Facilities Master Plan

SYSTEM CHARACTERISTICS

Basin	Sewered Area (Acres) Existing	Year 2020	Length of Major Sewer[a] (lf)
A01	290	520	7,885
A02	280	590	11,910
A03	800	900	21,375
A04	20	110	5,290
B01	150	150	5,670
B02	220	220	10,575
B03	100	100	5,935
B04	290	290	17,225
B05	260	260	8,925
B06	100	100	5,460
B07	220	220	5,985
B08	190	190	6,545
B09	450	450	14,475
B10	100	940	22,290
C01	140	140	5,825
C02	340	430	12,135
C03	180	180	8,210
C04	160	160	11,475
C05	300	300	9,255
C06	180	180	5,725
C07	370	690	16,370
TOTAL	5,140	7,120	218,540

[a]The length of major sewer is the amount of pipeline evaluated by the computer model.

Four of these monitors remained in place to measure flows in major collector lines during the period of February 12 through March 12, 1985. Dry weather flow, in this analysis, is non-rainfall periods during the winter monitoring period. There was some infiltration during these periods as a result of antecedent rainfall and the groundwater table. Rainfall data were continuously recorded during the flow monitoring period. The rainfall and flow data provided critical inputs to the computer model which is the basis for the master plan's recommendations. The key manholes where flow monitors were placed are located at the downstream point in each basin. Therefore, the collected flow data and design peak I/I flows calculated for each monitor can be applied directly to the upstream basin.

The monitoring program results are presented in this section, with separate discussions of dry and wet weather flow. The dry weather flow represents that wastewater flow collected during non-rainfall periods and includes the base sanitary flow plus groundwater infiltration (GWI). Wet weather flow includes the dry weather flow components plus a rainfall-dependent infiltration/inflow (RDI/I) component, which is defined as I/I directly influenced by a storm event. The sanitary flow and I/I components are summarized in Chapter 5.

Dry Weather Flow

Flow monitoring results during non-rainfall periods were evaluated for representative data. There were two objectives for selecting appropriate dry weather flow data. The first objective was to compare dry weather flows with flows during wet weather periods, which will be discussed later in this chapter. The second objective was to separate GWI from the base sanitary flow; Figure 3-2 is an example of a dry weather hydrograph which illustrates the separation. The resultant base flow data is entered directly into the computer model. GWI is the infiltration component which enters the system through pipeline defects located below the normal groundwater table. For this study, GWI was determined by subtracting the sanitary flow, determined from water consumption records, from the dry weather flow.

The dry weather flow data were also used to determine the basin peaking factor. Normal wastewater flows follow regular diurnal patterns; the maximum peaks typically occurring during the morning and a lesser peak occurs in the evening. These peaks correspond to periods of high water usage in homes, etc. During the planning procedure and computer flow modeling, it was necessary to project the average daily flow to peak conditions by use of a peaking factor. Individual basin peaking factors were calculated from the monitoring data as the ratio of maximum peak flow to the average daily flow. Figure 3-3 presents the actual peaking factors calculated for the City of Woodland and the relationship between the peaking factor and the average daily flow. As the average sanitary flow increases the peaking factor decreases. The peaking factor curve is representative of relatively large basins.

Wet Weather Flow

During the monitoring period, flow data from each basin were analyzed to establish peak I/I levels. To determine I/I responsiveness to rainfall, three rain gauges were installed during the monitoring period in Basins A01, B10, and C03. The rainfall data were distributed to each flow monitor based on the isohyetal pattern.

For each monitor, storm events were decomposed into the individual I/I components by subtracting the appropriate dry weather flow hydrograph from the total wet weather hydrograph as shown in Figure 3-4. Since the dry weather flows include GWI, the resultant flows after subtraction are RDI/I only. RDI/I flows are typically extremely variable with respect to antecedent rainfall, which affects the soil moisture. Therefore, prior to further analysis, the RDI/I flow values from each monitor were projected to a common design storm basis. This procedure and a tabulation of the design storm flows are presented in Chapter 5.

WASTEWATER TREATMENT AND DISPOSAL

The existing wastewater treatment and disposal system consists of the evaporation ponds at the Beamer Street Primary Plant site, domestic wastewater treatment facilities, and land at the sewage farm for disposal by irrigation and/or evaporation. The City also owns the site leased to Contadina for separate industrial waste treatment. The treatment and disposal facilities are discussed in detail in Chapter 8. All of the facilities are located to the east of the community, as shown in Figure 3-5.

BEAMER STREET PLANT

The old Beamer Street Primary Plant site is located north of Beamer Street and west of County Road 102. Within the plant site are three evaporation ponds, the Kentucky Street Lift Station, and the remnants of the old primary wastewater treatment plant, which has been out of service for about 15 years.

The Beamer plant originally consisted of a lift station where influent wastewater was pumped to a velocity-controlled grit removal channel. Following grit removal, the wastewater flowed through two rectangular primary settling tanks, where solid matter was allowed to settle and floating matter was skimmed off. The settled sludge and floating matter removed in these units were then transferred to an anaerobic digester for additional treatment prior to ultimate disposal.

Only the Kentucky Lift Station and grit removal channel of the old mechanical plant are still used. Flows from the Kentucky Lift Station enter the plant and are pumped through the grit chamber where the flow is conveyed by gravity to the trunk sewer along Beamer Street. The evaporation ponds are still in use and, as discussed in Chapter 8, provide an alternative for disposal of a small portion of the influent wastes.

WASTEWATER TREATMENT FACILITY

The City's wastewater treatment facilities are located about 2.5 miles east of the City's southeasterly boundary, south of Interstate 5, encompassing an area north and south of the easterly prolongation of Gibson Road beginning about 1/2 mile east of County Road 102. Facilities at this site include influent flow measurement and screening structures, waste stabilization and chlorination ponds, influent and intermediate pump stations, an irrigation lift station, and the control building.

The treatment system includes three separate sets of ponds: the Erskine Ponds, the Strong Ponds, and the Phase II Ponds. The layout of the ponds, the sewage farm, and the cannery land treatment site is shown in Figure 8-1.

SEWAGE FARM

The City's "Sewage Farm" is located about 5 miles due east of the City, just north of River Road. The Sewage Farm consists of about 300 usable acres located in the Yolo Bypass. In prior years, this land has been leased out to private interests for seasonal agricultural use.

INDUSTRIAL SITE

The industrial waste treatment site consists of 574 acres of land located due east of the City's Domestic Wastewater Treatment Facility. Waste treatment from the Contadina processing plant is accomplished by direct application to the land, which is used to grow various crops. This allows beneficial reuse of the water and nutrients in the waste stream from the cannery operations. Included at the site are four flow equalization and storage ponds, a pump station, and a surface water runoff (tailwater) return system.

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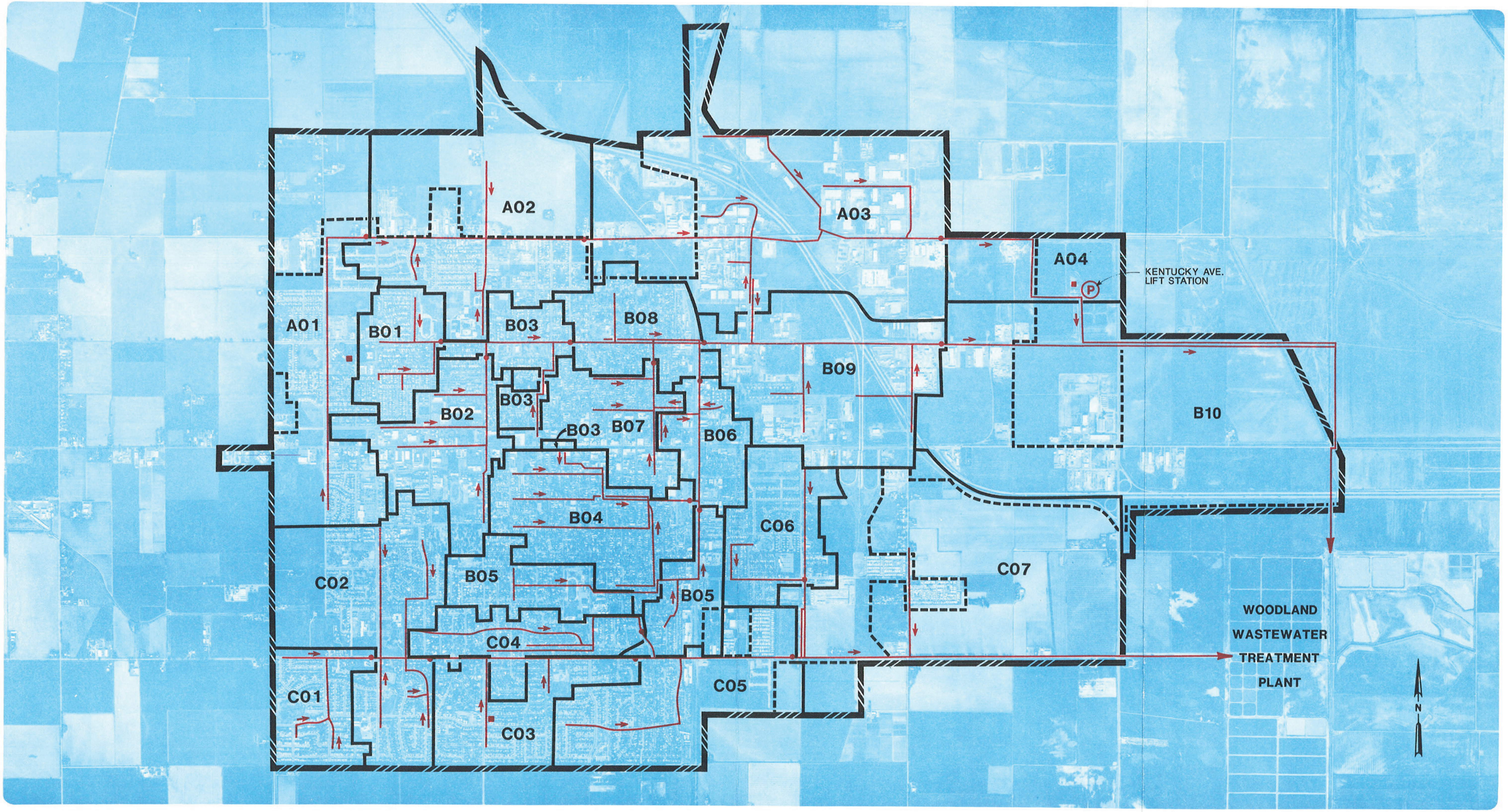

LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- A01 BASIN IDENTIFICATION
- MAIN SEWER LINE
- DIRECTION OF FLOW
- FLOW MONITOR LOCATION
- RAIN GAUGE LOCATION
- (P) PUMP STATION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1" = 1200'

MAJOR TRUNK SEWER SYSTEM

FIGURE 3-1

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

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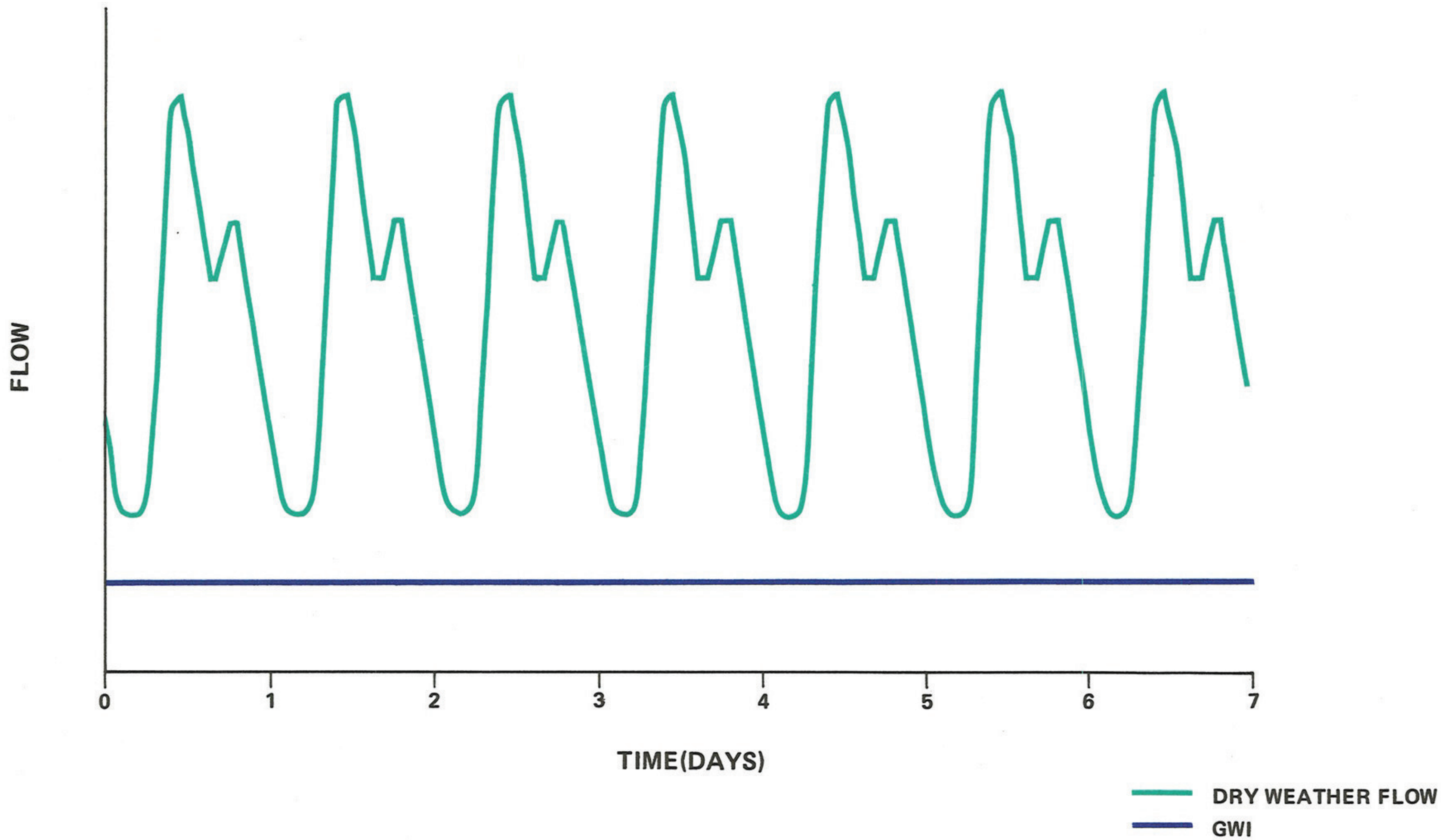

EXAMPLE DRY WEATHER
FLOW HYDROGRAPH

FIGURE 3 - 2

CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

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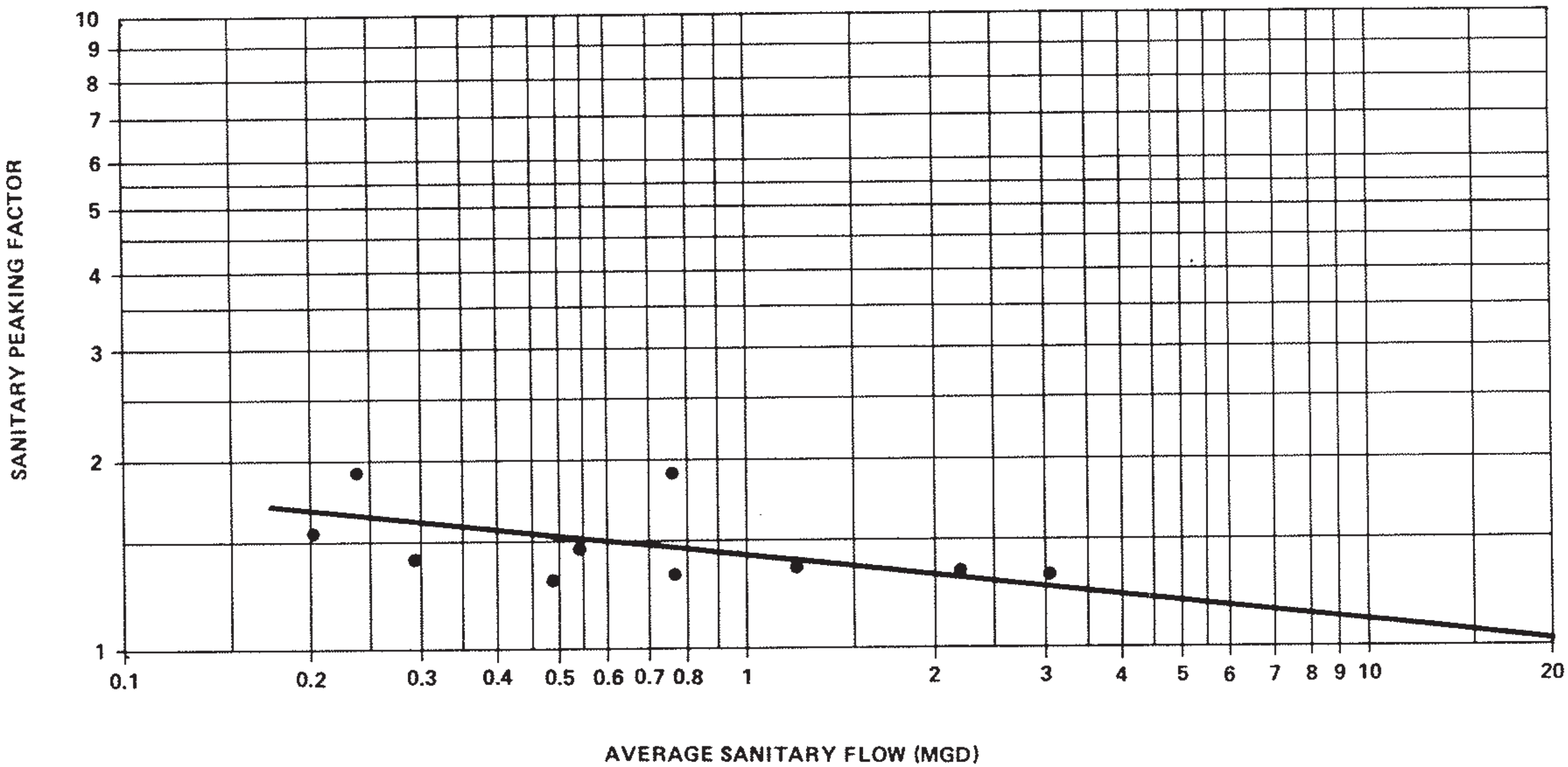


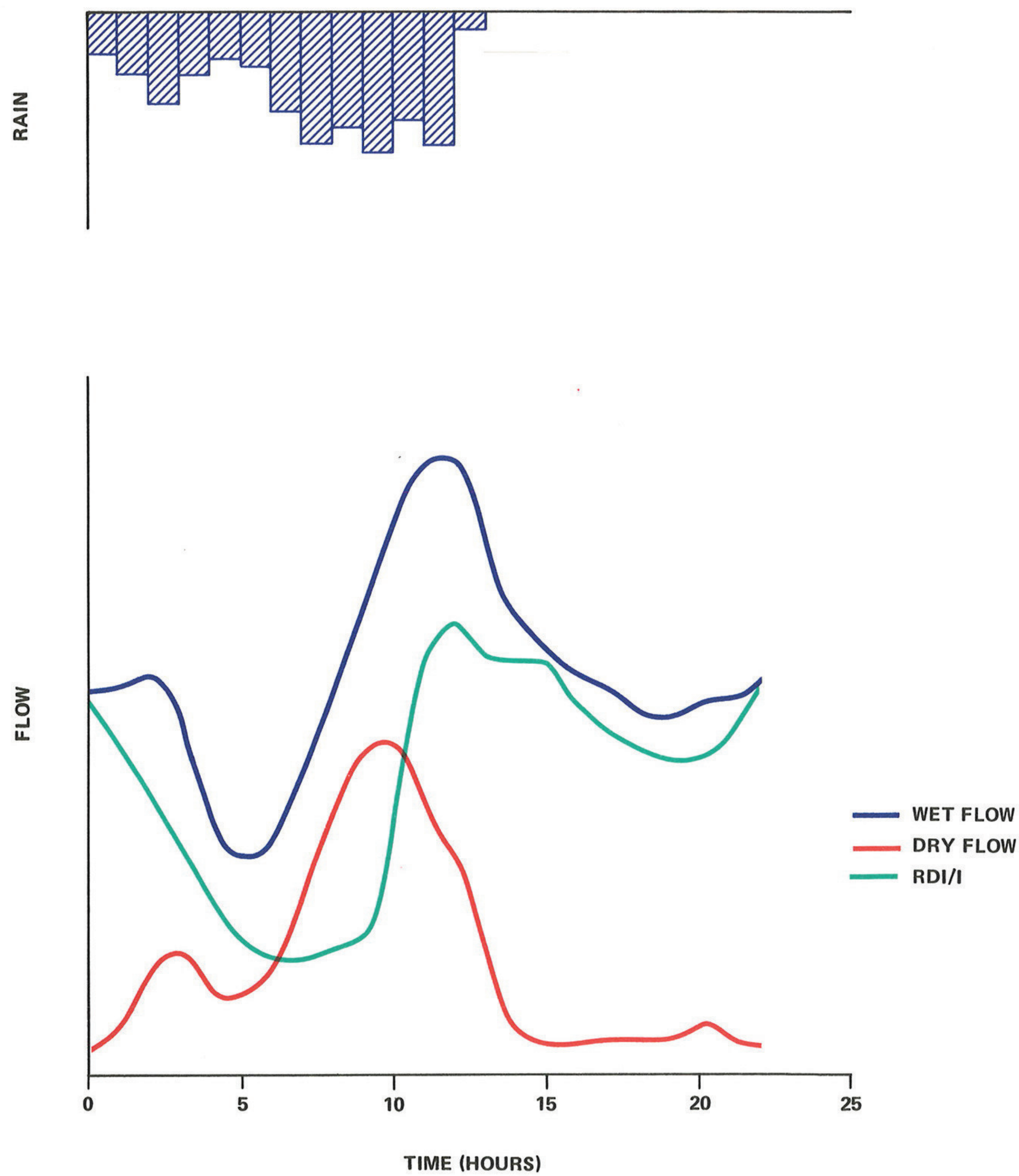
NOTE: Curve based on actual monitored flow at basin level.

COLLECTION SYSTEM
PEAKING CURVE

FIGURE 3 - 3
CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

M19047.A0

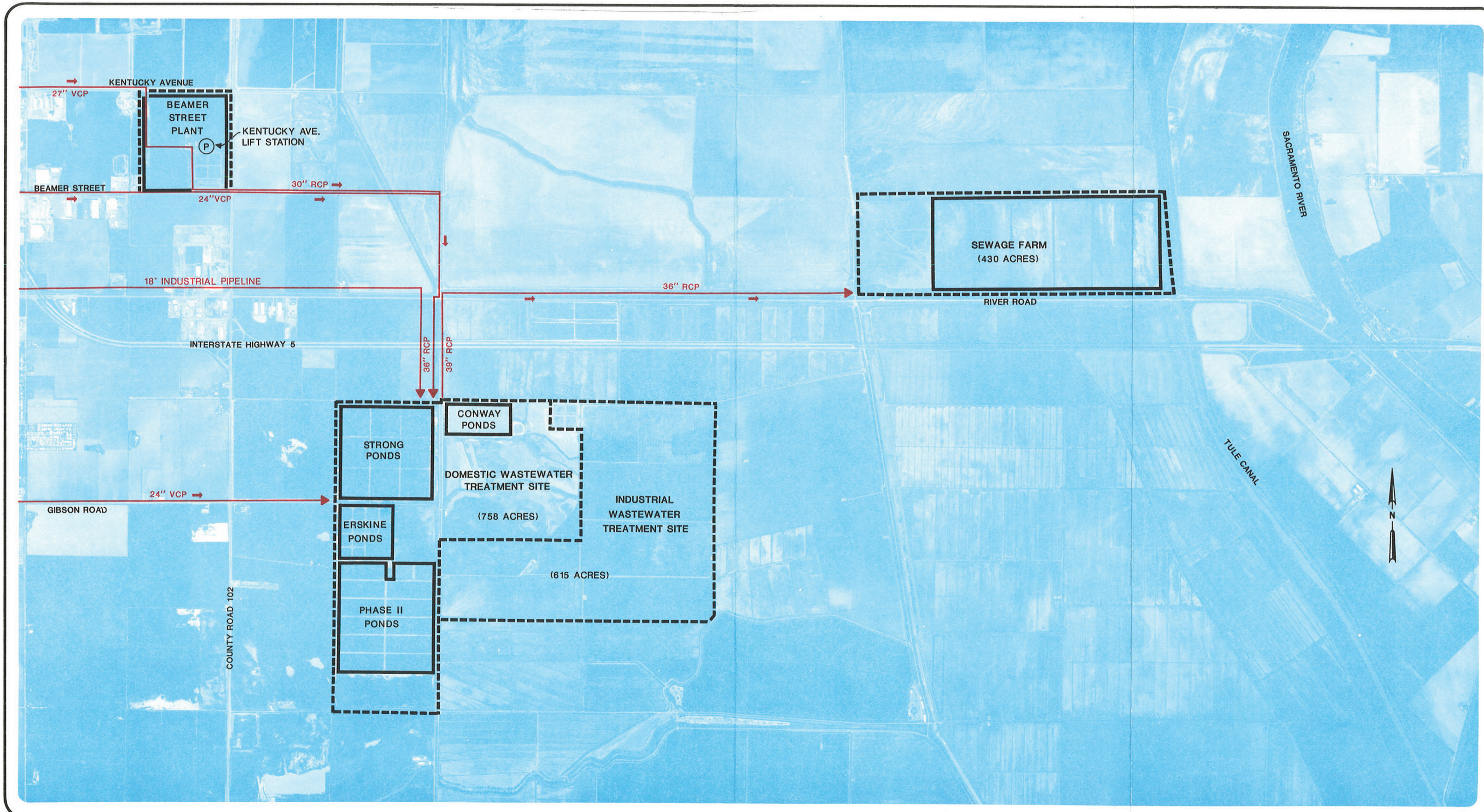


EXAMPLE RDI/I
SEPARATION

FIGURE 3 - 4
CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL

M19047.A0



LEGEND:
- PROPERTY LINE
- SEWER LINE
- EXISTING FACILITIES
- (P) PUMP STATION

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 ▬ 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1" = 1200'

EXISTING TREATMENT FACILITIES

FIGURE 3 – 5
CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

CH2M HILL

CHAPTER 4
Future Land Use

Chapter 4
FUTURE LAND USE

The purpose of the land use evaluation is to analyze the potential for residential, commercial, and industrial growth in the City of Woodland to its build-out, estimated to occur in the first quarter of the next century. In the early 1850's Woodland was settled as an agricultural community, became the County Seat of Yolo County in 1862 and grew to be the business and commercial center for the outlying settlements in the county. While a number of public policies affect the pace and location of future growth, Woodland has no topographic barriers to future growth.

POPULATION

From its settlement around 1853, Woodland has grown slowly in response to the increasing importance of its agricultural produce to other markets. The extension of railroad service to this community in 1869, connecting Woodland to the City of Davis, and the eventual acquisition of that railroad link by Southern Pacific were important factors influencing the growth of Woodland as well as its pattern of physical development.

At the time of its incorporation in 1871, Woodland had a population of 1,600 persons and comprised 736 acres. The city's first annexation occurred in 1912, with the addition of 159 acres south of Bartlett Street between East and West Streets. By 1930, the City had 5,542 persons and consisted of 1,043 acres. The 1950's saw a period of rapid growth with the City increasing by 4,000 persons to a 1960 population of 13,542 persons and 1,527 acres. The rate of growth between 1950-1960 (3.72%), 1960-1970 (4.34%), and the early 1970's (4.25%) remained fairly stable. However, the average annual rate of growth declined between 1975-1980 (to 3.50%) and between 1980-1983 (to 1.83%).

In developing population projections from the present to the year 2000 and beyond, the City Planning Department has assumed an annual population growth of 2.06%. As shown in Table 4-1, Woodland's population is projected to increase by 15,225 from 30,235 in 1980 to 45,460 in 2000. The average annual rate of growth for Woodland is projected to be about twice that for Davis, which will experience only very slow growth between now and the end of the century, and about 25 percent greater than for Yolo County.

Projections of Woodland's ultimate population at build-out, made in conjunction with the City Planning Department, call for a population of approximately 67,000 persons. This estimate is based on the following assumptions:

Table 4-1
City of Woodland
Wastewater Facilities Master Plan

YOLO COUNTY POPULATION

	1975	1980	1985	1990	1995	2000	Build-Out
Davis[a]	31,830	36,640	38,955	40,055	42,055	43,600	
Winters[a]	2,520	2,650	3,090	3,410	3,765	4,150	
WOODLAND[b]	25,455	30,235	33,480	37,070	41,050	45,460	67,000[a]
Unincorporated[a]	41,895	43,845	49,310	55,685	61,170	65,415	
Yolo County[a]	101,700	113,370	124,835	136,670	148,040	158,625	

Average Annual Percent Change

	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000
Davis	3.02%	1.26%	0.80%	0.77%	0.73%
Winters	1.03%	3.32%	2.07%	2.08%	2.05%
WOODLAND	3.76%	2.15%	2.14%	2.15%	2.15%
Unincorporated	0.93%	2.49%	2.59%	1.97%	1.39%
Yolo County	2.29%	2.02%	1.90%	1.66%	1.43%

a Sacramento Area Council of Governments, Draft Baseline Projections-Yolo County (8/22/84).

b City of Woodland, Draft Housing Element (1983). This projection assumes the build-out of Woodland to its sewer service boundary.

c This projection assumes build-out of Woodland to the urban limit line and that the currently urbanized portion of Woodland will not be redeveloped at densities greater than exist in 1985. The build-out population of 67,000 is used in this study.

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1) That urbanization will extend to the urban limit line and that city services will be phased to accommodate that growth.

2) That the population will continue to grow at an average annual rate of 2.06 percent.

3) That the currently urbanized portions of Woodland will not be redeveloped at densities greater than exist in 1985.

4) That the number of persons per household will decline to an average of 2.70 between now and build-out from an estimated present level of 2.74.

5) That for future residential, industrial and commercial development projections, net acreage will be assumed to comprise 80 percent of gross acreage. Net acres are defined as the total or gross acreage minus the acreage of rights-of-way, easements used for streets, railroads, flood control channels, utilities and other areas of land that will not be developed.

6) That the density for new residential construction will average 8 dwelling units per net acre for single-family units, 10 units per acre for duplexes, and 15 units per net acre for multi-family units.

For the purposes of determining the potential impacts of future residential growth on the City's sewer system, this master plan will use the projected build-out population of 67,000 persons.

PUBLIC POLICIES GOVERNING GROWTH

Policies guiding growth in Woodland are governed by the Woodland Area General Plan, approved by the Planning Commission in 1979 and last amended in December of 1984. The 55,250-acre land area included in the Woodland Area General plan is an area almost ten times greater than Woodland's present city limits and adjoining urban area, which comprise 6,150 acres.

According to the Land Use Element of the Woodland Area General Plan, the Woodland Area is bounded on the north by the north bank of Cache Creek, on the east by the west levee of the Yolo Bypass, on the south by County Road 27, and on the west by a line that is the extension of County Road 93. The Land Use Element states that "this area has been identified because the activities within this area are related to and centered upon the City of Woodland. Further, the area provided a definite buffer of agricultural land around the urban area of the City."

A goal expressed throughout the Land Use Element is the preservation of prime agricultural land. As a tool to implement this objective, the City has identified two sub-areas with similar boundaries within Woodland Area: the sewer service boundary and the urban limit line. Both sub-areas effect the type and timing of potential development permitted beyond Woodland's present city limits.

SEWER SERVICE BOUNDARY

The sewer service boundary sets the physical limits within which sewer service can be provided based on the existing capacities of sewer lines to the treatment plant. The planning process that established the boundary assumed a maximum population for Woodland of 45,000 persons with a per capita sewage generation factor of 125 gallons per day.

The sewer service boundary assumes build-out of presently undeveloped land at densities consistent with the guidelines contained in the Zoning Ordinance. The boundary, however, does not take into account potential, significant changes in future industrial land uses, which could significantly affect sewer capacity. For example, the decision to construct such industrial facilities as a brewery or a cannery would have an impact on sewer service within the Woodland Area.

URBAN LIMIT AREA

Within the Woodland Area is the urban limit line, a 7,120-acre area extending beyond the city's present limits in which future urbanization will occur. According to the Land Use Element, the reasons for establishing an urban limit line are twofold: first, to contain growth within its boundaries and second, to further define areas to be preserved for agricultural use. Generally, the boundaries of the urban limit line coincide on the north, south and west with the limit of service capabilities. The eastern line is ragged in anticipation of future growth.

The Land Use Element addresses conditions under which development will be permitted in the area between the urban limit line and the outer limit of the Woodland General Plan Area. Generally, only very low density development is allowed and then only under certain circumstances. Such development is designated rural residential land use and has a density range of 0-2 units per gross acre. Certain agricultural food processing industries may be allowed.

Among the factors governing the development of public facilities is the City's ability to provide sewer, water, and fire protection to the site. As directed by the City, this master plan study does not analyze the potential for development of land outside the urban limit line.

The Land Use Element also controls development within the urban limit line, where Woodland's future growth, other than in-filling within present city limits, will occur. The City's policy is to allow development within its city limits, consistent with the General Plan, and to limit development outside the city limits. The City also has the policy to annex development within the urban limit line as soon as economically feasible.

The Land Use Element calls for the development of the land within the urban limit line to occur in three phases. Phase I land is currently available for non-residential development and is discussed later in this chapter under Industrial Growth. Phase II and III lands are Residential Urban Reserve areas and are discussed under Residential Growth below. The major land use developments for each phase are indicated in Figure 4-1.

The analyses of residental, industrial and commercial growth that comprise the balance of this chapter are intended to be speculative rather than normative with the ultimate decisions for the future development of Woodland residing in the electorate and city officials.

RESIDENTIAL GROWTH

Estimates of the ultimate total residential build-out of Woodland are based on an analysis of each sewer basin regarding the pattern of housing, the amount of undeveloped land and the densities permitted under the General Plan. The build-out of Phase II and Phase III lands was calculated based on the acreage and permissible densities. This analysis, contained in Table 4-2, has yielded a projection of the City's ultimate population and its capacity for additional single family detached units, duplex units and multi-family units.

Overall, as shown in Table 4-2, Woodland can accommodate an additional 12,260 dwelling units of which 3,725 will be single family detached, 2,135 will be duplexes, and 6,400 will be multi-family. At an estimated 2.70 persons per household, the build-out of vacant land designated for residential use will result in a population gain of approximately 33,100 persons. The projected population of Woodland at build-out is 67,020 persons, which is the sum of Woodland's 1985 population (33,920) plus the estimated population gain of 33,100.

During the past twenty years, most of the residential growth has occurred in the south and west quadrants of the City, with some development east of East Street. While some

Table 4-2
City of Woodland
Wastewater Facilities Master Plan

RESIDENTIAL DEVELOPMENT

Basin	1985: Single Family Detached	1985: Duplex	1985: Multi-Family	1985: Total Units	1985: Population[a]	Additional Residential Capacity: Single Family Detached[b]	Additional Residential Capacity: Duplex[c]	Additional Residential Capacity: Multi-Family[d]	Additional Residential Capacity: Total Units	Additional Residential Capacity: Population Gain[e]	Residential Build-out: Single Family Detached	Residential Build-out: Duplex	Residential Build-out: Multi-Family	Residential Build-out: Total Units	Residential Build-out: Population
A01	515	85	210	810	2,220	930	75	115	1,120	3,025	1,445	160	325	1,930	5,245
A02	400	55	260	715	1,960	455	1,760	90	2,305	6,225	855	1,815	350	3,020	8,185
A03	10	5	70	85	235	0	190	0	190	515	10	195	70	275	750
A04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B01	470	10	0	480	1,315	20	0	0	20	55	490	10	0	500	1,370
B02	125	65	790	980	2,685	0	0	45	45	120	125	65	835	1,025	2,805
B03	345	40	40	425	1,165	0	10	0	10	25	345	50	40	435	1,190
B04	715	200	375	1,290	3,535	5	5	0	10	25	720	205	375	1,300	3,560
B05	520	55	275	850	2,330	0	10	0	10	25	520	65	275	860	2,355
B06	80	35	80	195	535	0	30	0	30	80	80	65	80	225	615
B07	300	100	245	645	1,765	0	15	0	15	40	300	115	245	660	1,805
B08	420	100	90	610	1,670	0	40	0	40	110	420	140	90	650	1,780
B09	10	0	0	10	25	0	0	0	0	0	10	0	0	10	25
B10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C01	435	0	15	450	1,235	65	0	40	105	285	500	0	55	555	1,520
C02	650	110	460	1,220	3,345	605	0	110	715	1,930	1,255	110	570	1,935	5,275
C03	600	0	100	700	1,920	0	0	0	0	0	600	0	100	700	1,920
C04	525	0	0	525	1,440	0	0	0	0	0	525	0	0	525	1,440
C05	665	20	440	1,125	3,085	245	0	105	350	945	910	20	545	1,475	4,030
C06	490	35	20	545	1,495	70	0	330	400	1,080	560	35	350	945	2,575
C07	35	10	670	715	1,960	1,330	0	5,565	6,895	18,615	1,365	10	6,235	7,610	20,575
TOTAL	7,310	925	4,140	12,375	33,920	3,725	2,135	6,400	12,260	33,100	11,035	3,060	10,540	24,635	67,020

[a] Assumes 2.74 persons per household.

[b] Assumes 8 du per net acre for single-family units.

[c] Assumes 10 du per net acre for duplex units.

[d] Assumes 15 du per net acre for multi-family units.

[e] Assumes 2.70 persons per household.

undeveloped residential land can be found within Woodland city limits, most of the vacant, residentially designated land lies between the city boundaries and the urban limit line.

Within the city limits, the largest undeveloped residential acreage is found in Basin C02, in the southwest portion of the City, south of Main Street. This basin, as shown in Table 4-2, can accommodate an additional 715 dwelling units of which 605 will be single family structures. If the present pace of housing continues, the City Planning Department estimates that the present inventory of vacant, residentially zoned land within the City will be absorbed by 1990.

As noted earlier, vacant residential land located outside the city limits and within the urban limit line are designated Phase II and Phase III lands. According to the Land Use Element, the residential development of Phase II land will begin when the inventory of vacant residential land within the City reaches a three-year supply, or the City Council adopts a specific plan for the area. Phase II land is located on the north side of Kentucky Avenue easterly to the Southern Pacific railroad tracks, traversing Basins A01 and A02. Phase II land contains 445 acres of which 439 acres (or 99%) are undeveloped. According to the City Planning Department, approximately 40 acres will be reserved for schools and parks, leaving about 399 acres for development. As shown in Table 4-2, Basins A01 and A02 can accommodate an additional 3,425 dwelling units. Because this area is mostly undeveloped, city services will have to be extended before urbanization can begin.

Phase III lands, located south of East Main Street, north of County Road 24 and between County Roads 101 and 102, encompass most of Basin C07. Phase III contains 343 acres, 341 of which are undeveloped. As shown in Table 4-2, Basin C07 can accommodate 6,895 additional units of which 5,565 units will be multi-family units and 1,330 single family units.

According to the Land Use Element, development of Phase III is not required for Woodland to reach a projected population of ±45,000 persons by year 2000. Development of this area will occur when the inventory of undeveloped residential land in Phase II reaches a three-year supply or if the City Council adopts a specific plan.

However, when the inventory of presently undeveloped residential land in Phase I falls below the three-year threshold, some uncertainty exists as to whether Phase II or Phase III land will be developed next. Several land owners control most of the acreage comprising Phase II lands and have not shown interest in selling their property for residential development. The City has received greater expressions of interest from property owners and developers to develop for Phase III than for Phase II. As a result, the phasing of growth within the urban limit line may be reconsidered at a future time.

INDUSTRIAL GROWTH

Woodland's first industrial area, between East Street and Fifth Street, consisted of warehouses and other industries needing access to the railroad. Today, the major concentration of industrial land uses is found east of East Street and north of East Main Street, an area encompassing Basins A03, A04, BO9, and B10. This industrial area has seen gradual growth at scattered locations over the past 20 years. Many of the new firms in this area are related to agriculture and the mobile home industry.

Table 4-3 calculates the built and vacant net acreage for land zoned industrial and light industrial in Woodland. The table shows a total of 1,772 acres of which 728 acres are developed and 1,044 acres are vacant. Table 4-3 also shows that Basins A03 and B10 contain the most industrial acreage and account for more than 80% of Woodland's vacant industrial acreage. Basin B10 contains 679 net acres of which 561 acres are undeveloped. Basin A03, with 537 net acres, ranks first as the basin with the most acres of industrial development (234) and second in terms of the number of vacant acres (303).

According to the Land Use Element, all of Woodland's industrial land is designated Phase I land, described as the portion within the urban limit line currently available for development. As shown in Figure 4-1, significant portions of Basins A04 and B10 lie outside the sewer service boundary. Basin A01 contains a small amount of vacant industrial acreage lying outside the sewer service boundary at the southwest quadrant of the intersection of West Main Street and County Road 98 at Browns Corner.

Development of Phase I land outside the sewer service boundary is permitted under certain limited circumstances. Both the development and expansion of non-residential use may be permitted if the proposed facility does not require City sanitary sewer, storm drainage and water services, and if on-site disposal of storm water run-off and the well and septic system receive governmental approvals. Lastly, the property owner must agree to annexation when required by the City.

COMMERCIAL AND INSTITUTIONAL GROWTH

General commercial growth and new institutional facilities within Woodland are limited to specific areas. Strip

Table 4-3
City of Woodland
Wastewater Facilities Master Plan

INDUSTRIAL LAND USE

	Industrial			Light Industrial	Total Industrial		
Basin	Total Acreage	Built Acreage	Vacant Acreage[a]	Vacant Acreage[a]	Total Acreage	Built Acreage	Vacant Acreage[a]
A01	42	39	3	0	42	39	3
A02	68	47	21	3	71	47	24
A03	537	234	303	0	537	234	303
A04	40	0	40	0	40	0	40
B01	0	0	0	0	0	0	0
B02	5	5	0	0	5	5	0
B03	0	0	0	0	0	0	0
B04	21	21	0	0	21	21	0
B05	17	16	1	4	21	16	5
B06	30	29	1	0	30	29	1
B07	10	9	1	0	10	9	1
B08	10	10	0	0	10	10	0
B09	286	184	102	2	288	184	104
B10	679	118	561	0	679	118	561
C01	0	0	0	0	0	0	0
C02	0	0	0	0	0	0	0
C03	0	0	0	0	0	0	0
C04	0	0	0	0	0	0	0
C05	5	5	0	0	5	5	0
C06	3	3	0	2	5	3	2
C07	8	8	0	0	8	8	0
TOTAL	1,760	726	1,034	11	1,772	728	1,044

a Rounded to nearest acre. Vacant acreage expressed as net acre (80% of gross acre).

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commercial uses along the main thoroughfare were created early in the City's development and continues to this day. The Main Street corridor, extending from County Road 101 to County Road 98 (Brown's Corner), forms the commercial spine of Woodland.

The two significant institutional facilities are Yuba Community College and the Yolo County Jail. These adjoining facilities are planned near the intersection of County Roads 24 and 102, a location just outside Woodland's urban limit line.

GENERAL COMMERCIAL

The most intensive portion of the general commercial corridor lies between Fourth Street to Elm Street and Lincoln Avenue to Court Street and North Street. To the west of the downtown core along Main Street, between Elm Street and Ashley Avenue, lies a mix of uses including small offices and shops, financial institutions, community shopping centers, and automobile sales and repair shops. The outer portions of Main Street are zoned service commercial, reflecting the emphasis on heavy commercial uses such as large lumber and hardware stores.

Table 4-4 examines commercial land uses in Woodland, presenting the net acreage figures for built and vacant business and professional uses as well as for commercial and retail uses. Overall, Woodland has a total of 429 net acres of commercially zoned land, of which 292 acres are developed and 137 acres are vacant. Of the 429 acres, 324 acres are zoned commercial and retail, and 105 acres, business and professional. Basin B02, which is bisected by Main Street, contains the greatest amount of commercial development (97 acres), followed by B07, also bisected by Main Street, with 50 acres.

The greatest amount of vacant commercially zoned acreage is found in Basin A01 (35 acres), followed by C05, near the County Fairgrounds, with 30 acres.

YUBA COMMUNITY COLLEGE

The Yuba Community College District plans to relocate its campus to the southwest corner of the intersection of County Roads 24 and 102 from its present site on California Street near the Holy Rosary School. The new site will consist of 120 acres.

Following the selection of an architect, a decision will be made whether it is feasible to relocate some or all of the existing buildings to the new site, or whether an entirely new campus will be constructed. The new campus will be built in phases, with the first phase, at an estimated cost

Table 4-4
City of Woodland
Wastewater Facilities Master Plan

COMMERCIAL LAND USE

	Business and Professional			Commercial and Retail			Total Commercial		
Basin	Total Acreage	Built Acreage	Vacant Acreage	Total Acreage	Built Acreage	Vacant Acreage	Total Acreage	Built Acreage	Vacant Acreage
A01	4	2	2	56	22	34	60	24	36
A02	2	2	0	15	13	2	17	15	2
A03	1	1	0	43	38	5	44	39	5
A04	0	0	0	0	0	0	0	0	0
B01	0	0	0	0	0	0	0	0	0
B02	32	15	17	65	65	0	97	80	17
B03	3	3	>1	4	4	0	7	7	>1
B04	7	5	2	17	17	0	24	22	2
B05	0	0	0	10	10	0	10	10	0
B06	2	2	0	11	11	0	13	13	0
B07	15	12	3	35	35	0	50	47	3
B08	0	0	0	3	3	0	3	3	0
B09	0	0	0	17	10	7	17	10	7
B10	0	0	0	25	0	25	25	0	25
C01	0	0	0	0	0	0	0	0	0
C02	3	3	0	0	0	0	3	3	0
C03	0	0	0	0	0	0	0	0	0
C04	0	0	0	2	2	0	2	2	0
C05	30	0	30	2	2	0	32	2	30
C06	6	0	6	14	14	0	20	14	6
C07	0	0	0	5	1	4	5	1	4
TOTAL	105	45	60	324	247	77	429	292	137

[a] Rounded to nearest acre. Vacant acreage expressed as net acre (80% of gross acres).

SFR2/2

of $2.225 million, essentially replicating the existing facilities of the California Street site. The earliest opening of the new campus would be for the September, 1989 semester with an estimated enrollment of 1,200 students, who may attend the campus on either a part-time or full-time basis. No dormatories will be built.

A second phase, to be completed in the mid-1990's, would include physical education facilities and playing fields. The Community College District estimates that by the year 2000, the Woodland campus will have an enrollment of 2,000 students.

Present plans call for the Community College District to drill on-site wells to provide water service. The Community College District has participated in an agreement with the Yolo County Jail, which will occupy a site adjacent to the new campus, to share the expense of constructing a trunk line connecting with the City's treatment plant.

YOLO COUNTY JAIL

Yolo County is about to begin construction of 110,000-square foot, 280-bed jail on a 16-acre parcel adjacent to the Yuba Community College District site. The new jail, to be built at an estimated cost of $14 million, will be open in 1987.

The facility will use on-site wells for water service, and under the terms of an agreement with the Community College District, will share in the expense of constructing a sewer trunk line to the City's treatment plant.

SUMMARY

Woodland has experienced moderate growth in the past and will continue to do so into the next century. This growth will be guided by land use policies that will provide urban services to new residential, industrial and commercial development within the urban limit line, while preserving and protecting existing agricultural land from the pressures of future urbanization. Table 4-5 summarizes Woodland at build-out, at which time it will have a population of approximately 67,020 persons, 24,635 dwelling units, 1,772 acres of developed industrial land, and 427 acres of developed commercial land.

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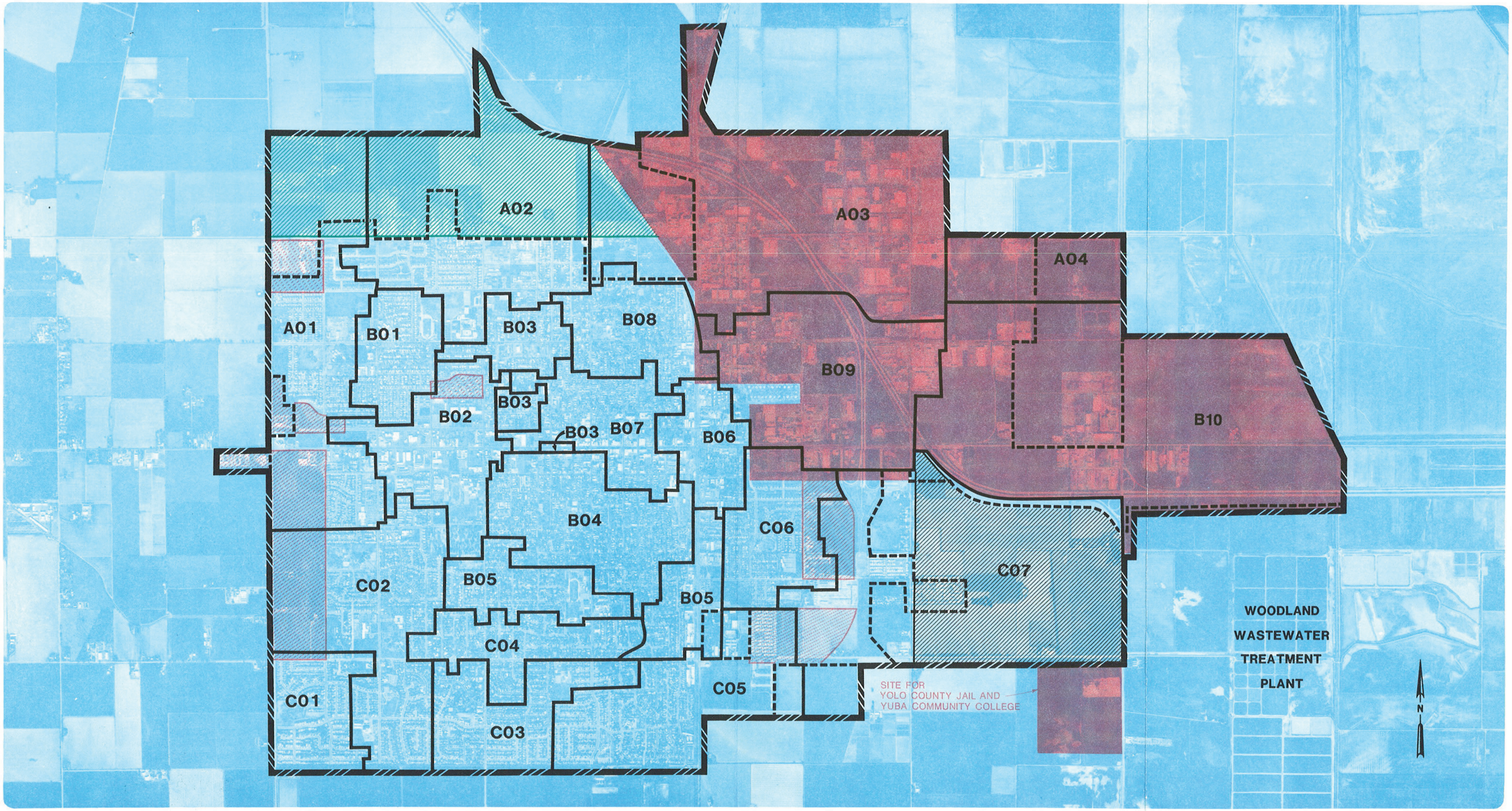
Table 4-5
City of Woodland
Wastewater Facilities Master Plan

POPULATION AND LAND USE SUMMARY AT BUILD-OUT

Basin	Total Population	Single Family Detached Units	Duplex Units	Multi-Family Units	Total Units	Total Industrial Acreage	Total Commercial Acreage
A01	5,245	1,445	160	325	1,930	42	60
A02	8,185	855	1,815	350	3,020	71	17
A03	750	10	195	70	275	537	44
A04	0	0	0	0	0	40	0
B01	1,370	490	10	0	500	0	0
B02	2,805	125	65	835	1,025	5	97
B03	1,190	345	50	40	435	0	7
B04	3,560	720	205	375	1,300	21	24
B05	2,355	520	65	275	860	21	10
B06	615	80	65	80	225	30	13
B07	1,805	300	115	245	660	10	50
B08	1,780	420	140	90	650	10	3
B09	25	10	0	0	10	288	17
B10	0	0	0	0	0	679	24
C01	1,520	500	0	55	555	0	0
C02	5,275	1,255	110	570	1,935	0	3
C03	1,920	600	0	100	700	0	0
C04	1,440	525	0	0	525	0	2
C05	4,030	910	20	545	1,475	5	32
C06	2,575	560	35	350	945	5	2
C07	19,535	1,040	10	6,175	7,225	8	5
TOTAL	67,020	11,035	3,060	10,540	24,635	1,772	427

SFR2/2



LEGEND :

URBAN LIMIT LINE
CITY BOUNDARY
BASIN BOUNDARY
A01 BASIN IDENTIFICATION

PHASE I RESIDENTIAL
PHASE I INDUSTRIAL/COMMERCIAL
PHASE II RESIDENTIAL
PHASE III RESIDENTIAL

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1" = 1200'

MAJOR LAND USE DEVELOPMENTS

FIGURE 4-1
CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

CH2M HILL

CHAPTER 5

Collection System Design Flow Analysis

Chapter 5
COLLECTION SYSTEM DESIGN FLOW ANALYSIS

From the results of the flow monitoring program and evaluation of the land use projections, design wastewater flows have been selected for input to the computer model. Wastewater flow is the sanitary flow plus I/I. This Chapter presents the future expected sanitary flows developed for the desired maximum land use development in accordance with the Land Use Element of the City's General Plan. The existing sanitary and design I/I flows developed from the monitoring program, are also presented.

SANITARY FLOW

Estimates of sanitary flow for both existing and future conditions were calculated based on the land use data presented in Chapter 4 and the unit flow rates presented in Table 5-1. These unit flow rates were developed from water consumption data, previous studies completed for similar areas, and discussions with the City staff.

The unit flow rate of 2,000 gpad for future industrial land uses is based on the assumption of a mixture of factory and warehousing activities. A possible alternative growth scenario is an increase in more water intensive industries, such as food processing. For this type of industrial growth, an industrial wastewater flow allowance of 5,000 gpad should be employed. These alternatives were examined in the collection system analysis described in Chapter 7.

The total sanitary flows for existing and future connections are summarized in Table 5-2. Also included is the corresponding peaking factor from the curve developed in Chapter 3. The residential unit flow rates of 65 gpcd and 75 gpcd (existing and future conditions) are less when compared with the current City standard of 125 gpcd. The unit rates used in this master plan analysis were developed using flow monitoring data and basin populations. The calculated residential flow is multiplied by a peaking factor and then combined with the I/I hydrograph. The unit rate of 125 gpcd includes the I/I component.

DESIGN I/I FLOW

I/I flows collected during the monitoring period discussed in Chapter 3 were further analyzed to project peak I/I flows which could be expected under design conditions. The design storm concept is used to eliminate the effects of different antecedent rainfall and soil moisture conditions on I/I flows collected for different storms during the monitoring period.

Table 5-1
City of Woodland
Wastewater Facilities Master Plan

MASTER PLAN DESIGN CRITERIA[a]

Item	Criteria
Minimum Velocity	2.0 fps for half-full pipe
Minimum Slope	Pipe diameter to maintain minimum velocity according to following table:

Pipe Diameter (in.)	Slope (ft./100 ft.
8	0.33
10	0.24
12	0.19
15	0.14
18	0.11
21	0.09
24	0.08
27	0.07
30	0.06
33	0.05
36	0.04

Item	Criteria
Manning's "n"	0.013
Maximum Depth	20 feet from ground surface to pipe crown
Minimum Depth	5 feet from ground surface to pipe crown
Peaking Factor	For average flows greater than 0.2 mgd, use Figure 3-3. For average flows less than 0.2 mgd, use the following equation: $PF = 0.69(SF)^{-0.54}$ Where : PF = Collection Peaking System Factor; SF = Average Sanitary Flow, mgd
Minimum Pipe Diameter	8-inch diameter
Oversize Policy	This master plan only includes new trunk sewers with required diameter greater than 18 inches
Pipe Diameter Selection Existing System	Pipe diameter is selected for pipes flowing full. For existing pipelines without sufficient capacity to convey design flow, additional capacity will be supplied by either installation of an overflow sewer or replacement with a larger diameter pipeline. Actual selection of an overflow sewer or pipe replacement should be based on structural integrity of the existing pipeline. For the master plan analysis, the following criteria were used: o For a specific pipeline section where required overflow pipe and replacement pipe are relatively equal in diameter and length, the replacement is selected.

Table 5-1
(Continued)

Item	Criteria
Pipe Diameter Selection Existing System (continued)	o Existing pipeline sections would be replaced in areas where overflow pipe would not be practical. These areas include streets with complicated piping arrangements and/or high utility congestion. o For all other pipelines, overflow pipes are selected.
Pipe Diameter Selection New System	For extensions of the existing system to serve a new development, diameter selection is based on required capacity. If the slope is variable along the alignment, then the pipe diameter will also be variable. The objective is to determine the total estimated cost; the actual pipe diameter should be selected during a predesign phase.
Unit Flow Allocation[b]	
Residential	
Existing	65 gpcd
Future	75 gpcd
Commercial	
Existing[c]	2,000 gpad
Future	2,000 gpad
Industrial	
Existing[c]	1,200 gpad
Future	2,000 gpad
I/I Allowance-unsewered areas	600 gpad

[a]Design criteria used for the master plan analysis.

[b]Unit flow rates for commercial and industrial land use categories are expressed in gallons per net acre per day (net acre is the total area minus an allowance for non-developed area, i.e., streets, offsite parking, etc.)

[c]Based on calculated average water consumption data for all commercial and industrial discharges.

Table 5-2
City of Woodland
Wastewater Facilities Master Plan

COLLECTION SYSTEM DESIGN SANITARY FLOW[a]

Basin	Average Sanitary Flow (mgd) Existing	2020	Peaking Factor[b]	Total Peak Sanitary Flow (mgd) Existing	2020
A01	0.24	0.60	1.50	0.39	0.89
A02	0.22	0.79	1.45	0.36	1.15
A03	0.37	1.22	1.39	0.59	1.70
A04	0.00	0.08	1.83	0.00	0.15
B01	0.09	0.10	1.78	0.16	0.18
B02	0.34	0.41	1.55	0.54	0.64
B03	0.09	0.10	1.78	0.16	0.18
B04	0.30	0.35	1.58	0.48	0.56
B05	0.19	0.24	1.64	0.32	0.39
B06	0.09	0.13	1.74	0.17	0.23
B07	0.22	0.26	1.63	0.36	0.42
B08	0.13	0.16	1.71	0.22	0.27
B09	0.24	0.61	1.49	0.40	0.91
B10	0.15	1.91	1.37	0.26	2.61
C01	0.08	0.11	1.76	0.15	0.20
C02	0.22	0.40	1.56	0.37	0.62
C03	0.12	0.14	1.72	0.22	0.25
C04	0.10	0.11	1.77	0.17	0.20
C05	0.21	0.37	1.57	0.35	0.59
C06	0.13	0.24	1.63	0.22	0.40
C07	0.14	1.46	1.36	0.24	1.98
TOTAL	3.67	9.79		6.13	14.52

[a]Sanitary flow is defined as wastewater without I/I.

[b]Peaking factors are taken from Figure 3-3 for future flow conditions. Peaking factors are for relatively large basins. A higher factor can be expected from smaller tributary areas within each basin.

SFR18/019

This study defined design conditions as the storm event with a 2-year return period falling over the planning area concurrently with saturated soil conditions. A storm occurring with saturated soil conditions will result in maximum I/I. For this study, the design storm event was selected from the Intensity-Duration-Frequency Curve developed for the Yolo County area:

Return Period:	2 Years
Duration:	4 Hours
Intensity:	0.23 Inches/Hour
Total Volume:	0.92 Inches

A design storm with a 2-year recurrence was chosen based on an analysis of the level of service the wastewater collection system should provide for the City. Level of service is the design storm recurrence interval used to determine collection system capacity. A minimum 2-year level of service is necessary to reduce the public health hazard associated with sanitary sewer overflows during wet weather. The storm drainage system is capable of handling storm water runoff from a 2-year design storm in the downtown area.

The analysis described in the following paragraphs also was conducted for 5- and 10-year design storm events. These events have the following characteristics:

	Return Period:	5 Years
	Duration:	4 Hours
	Intensity:	0.30 Inches/Hour
	Total Volume:	1.20 Inches
and	Return Period:	10 Years
	Duration:	4 Hours
	Intensity:	0.35 Inches/Hour
	Total Volume:	1.40 Inches

To complement the flow monitor data, several storm events were selected from the historical plant flow records to represent saturated soil conditions. These storms were of small enough rainfall quantity to allow unrestrained flow, avoiding any complication of lost flow due to overflow. Synthetic hydrographs were developed for each rain event and flow monitor to closely approximate the actual RDI/I hydrographs.

The synthetic hydrograph was based on the ratio of RDI/I volume to the volume of rainfall in the contributing sewered area. This analysis was completed for all rain events, both monitored and historical, and the best apparent synthetic characteristics were selected. These characteristics were used to obtain a synthetic unit hydrograph to analyze the response from any rainfall event which could be expected.

Examination of the ratio of RDI/I volume to the volume of rainfall, for both monitored and historical rain events, yielded a relationship which could be used to predict the RDI/I volume resulting from a given rainfall for either dry or wet antecedent soil conditions. This relationship was used to predict the total design storm volume of RDI/I at each flow monitor site and at the wastewater treatment plant for saturated soil conditions.

RDI/I flows at each monitor were used to project the flow rate expected from the 2-year design storm. Table 5-3 summarizes the design I/I flows, RDI/I and GWI for each basin. The I/I flow in gallons per acre per day (gpad) is also presented to show the potential I/I potential for each basin. The basins with the greatest I/I are more susceptible to I/I.

COLLECTION SYSTEM DESIGN FLOW

Combining the flow information presented in Tables 5-2 and 5-3, the total peak design flows for each basin were developed. Table 5-4 summarizes the peak dry weather flow (PDWF) and peak wet weather flow (PWWF) to be used for analysis of the collection system, lift station, and treatment plant. PDWF is the sum of the peak sanitary flow and GWI, and PWWF is the sum of PDWF and peak RDI/I. GWI was increased in proportion to the areas of new development. The RDI/I flows were kept constant for both existing and future conditions. Actually, I/I contributions increase with time as the system continually deteriorates. To prevent a gradual flow increase within the existing system, the City's maintenance program must incorporate source detection techniques followed by system rehabilitation, as necessary.

Figure 5-1 presents a schematic of the wastewater collection system with the modeled PWWF for year 2020. Included with the figure are peak sanitary and I/I flows for each basin.

SFR20/097

Table 5-3
City of Woodland
Wastewater Facilities Master Plan

DESIGN I/I FLOW[a]

Basin	GWI[b] (mgd)	RDI/I (mgd)	Design Peak Hour I/I[c] (mgd)	Design Peak Hour I/I[c] (gpad)
A01	0.02	0.16	0.18	350
A02	0.03	0.11	0.14	240
A03	0.03	0.11	0.14	150
A04	0.00	0.03	0.03	270
B01	0.07	0.07	0.14	930
B02	0.08	0.20	0.28	1,270
B03	0.02	0.23	0.25	2,500
B04	0.12	0.47	0.59	2,030
B05	0.02	0.07	0.09	350
B06	0.05	0.17	0.22	2,200
B07	0.03	1.08	1.11	5,050
B08	0.02	0.68	0.70	3,680
B09	0.13	1.14	1.27	2,820
B10	0.13	5.20	5.33	5,670
C01	0.04	0.07	0.11	790
C02	0.10	0.04	0.14	330
C03	0.04	0.13	0.17	940
C04	0.06	0.26	0.32	2,000
C05	0.04	0.15	0.19	630
C06	0.06	0.13	0.19	1,060
C07	0.07	0.21	0.28	400
TOTAL	1.16	10.71	11.87	1,670

[a] I/I flows are presented for the 2-year design storm. Design flows may not correspond exactly with modeled flows shown in Figure 5-1 due to the effects of flow routing.

[b] GWI flow presented for future (2020) conditions only.

[c] I/I flow in gpad is calculated by dividing the total peak I/I flow by the year 2020 sewered area.

SFR18/020

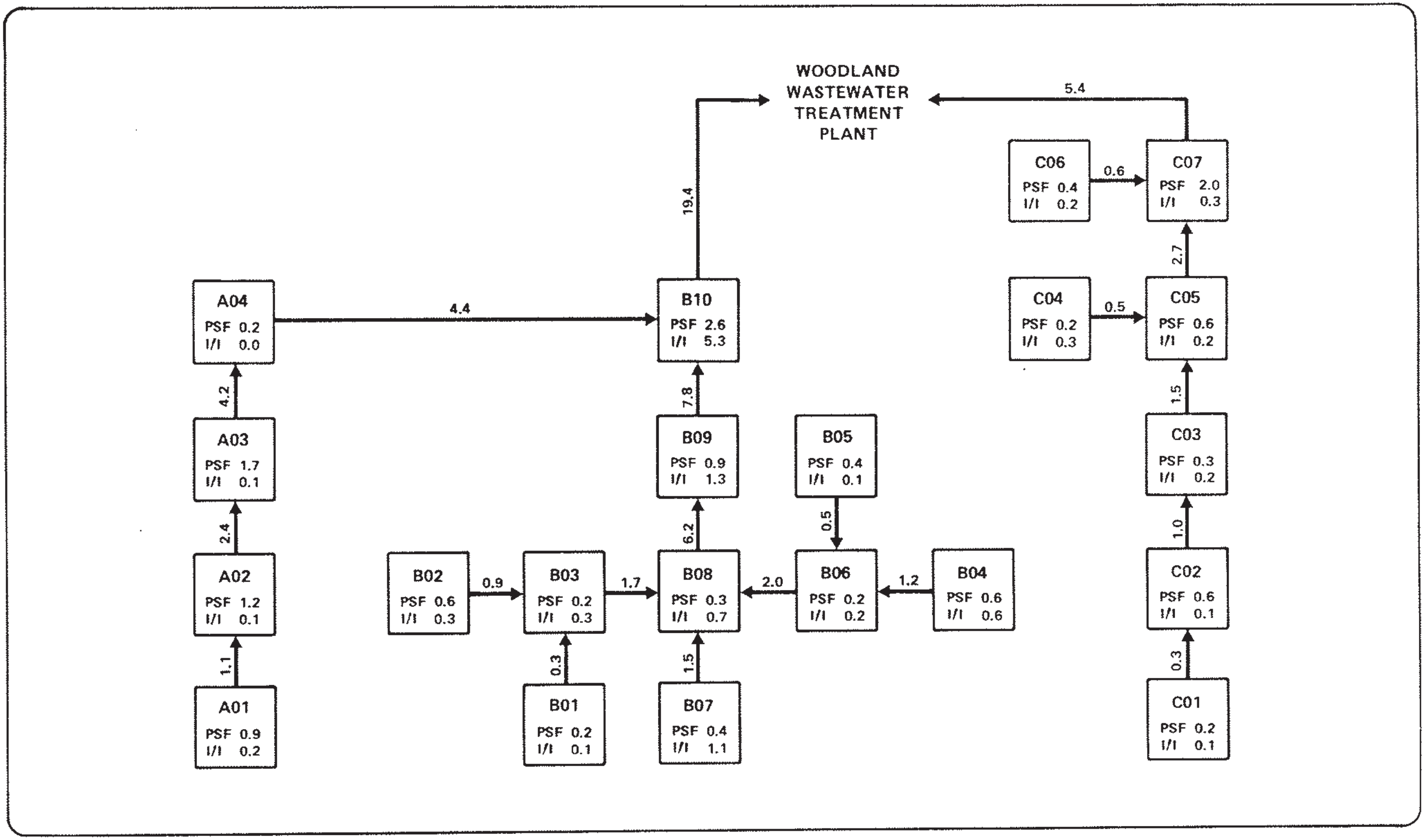
Table 5-4
City of Woodland
Wastewater Facilities Master Plan

COLLECTION SYSTEM DESIGN FLOW[a]

Basin	PDWF (mgd)		PWWF (mgd)	
	Existing	2020	Existing	2020
A01	0.39	0.91	0.55	1.07
A02	0.36	1.18	0.50	1.29
A03	0.59	1.73	0.70	1.84
A04	0.00	0.15	0.03	0.18
B01	0.23	0.25	0.30	0.32
B02	0.62	0.72	0.82	0.92
B03	0.18	0.20	0.41	0.43
B04	0.60	0.68	1.07	1.15
B05	0.34	0.41	0.41	0.48
B06	0.22	0.28	0.39	0.45
B07	0.39	0.45	1.47	1.53
B08	0.24	0.29	0.92	0.97
B09	0.52	1.04	1.66	2.18
B10	0.31	2.74	5.59	7.94
C01	0.19	0.24	0.26	0.31
C02	0.46	0.72	0.50	0.76
C03	0.26	0.29	0.39	0.42
C04	0.23	0.26		0.48
C05	0.39	0.63	0.54	0.78
C06	0.28	0.46	0.41	0.59
C07	0.26	2.05	0.47	2.26
TOTAL	7.06	15.68	17.39	26.35

[a]Peak design flows to evaluate collection system and treatment capacity. PDWF equals peak sanitary flow plus GWI. PWWF equals PDWF plus peak RDI/I. Design flows may not correspond exactly with modeled flows shown in Figure 5-1 due to the effects of flow routing in the model.

SFR18/021



LEGEND:

A01 BASIN NUMBER

PSF PEAK SANITARY FLOW, mgd

I/I INFILTRATION/INFLOW, mgd

4.4 → TOTAL DESIGN FLOW, mgd

DESIGN PWWF SUMMARY YEAR 2020

FIGURE 5 - 1

CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

M19047.A0

CHAPTER 6
System Analysis Model

Chapter 6
SYSTEM ANALYSIS MODEL

A complex model developed by CH2M HILL was used to route present and future flow information through the major sewer lines in the City of Woodland. The System Analysis Model (SAM) was used to simulate time varying flow conditions in the existing system and calculate the required improvements to transport peak flows through the system without surcharge or overflow.

MODEL DESCRIPTION

SAM makes use of several routines to simulate flow conditions. Under open-channel flow conditions, SAM routes flow using a modified kinematic wave routine which is based on continuity, momentum, and energy considerations. The resulting equations are solved using finite-difference techniques applied for each time step throughout a specified analysis period. If full pipe conditions are encountered, the kinematic wave routine is abandoned in the affected section, and a surcharge routine based on intersecting energy and hydraulic grade lines is implemented until the surcharge condition passes.

Actual flow quantities, pipe capacity, and sizing calculations are based on Manning's equation for uniform flow applied on a pipe-by-pipe basis. SAM enables flow from various upstream sources to be combined and routed through the system realistically with respect to time and distance traveled. The small head loss through manholes is not included in the SAM analysis. The resulting final information includes peak flows and overflow or replacement pipelines required to relieve system surcharge. SAM is flexible and can be expanded or flows can be rerouted, as necessary, to include new developments or system modifications.

MODEL INPUT DATA

SAM has been organized to represent the actual major trunk pipelines within the Woodland wastewater collection system. The input data to SAM includes physical pipeline information and flow data for the identified present and future conditions.

PIPELINE DATA

The pipeline data, which define the system geometry, represent a continuous system of pipes and nodes (manholes) within the system. The data include manhole invert and rim elevations, pipe length, diameter, shape, slope, and roughness.

This information was obtained from the Woodland sewer maps and field checks as necessary.

FLOW DATA

Input flow data for flow routing was divided into upstream hydrographs and basin hydrographs. Upstream hydrographs represent flow entering a downstream basin from an upstream basin. For example, the flow hydrograph from Basin B02 is an upstream input hydrograph for Basin B03. These hydrographs are input to the model at manholes where flow monitors were located.

Basin hydrographs represent the flow originating within the basin and are the resultant hydrographs obtained by incrementally subtracting upstream hydrographs from downstream hydrographs which represent the flow originating within the basin. In the case of terminal upstream basins, i.e., Basin B02, the downstream hydrograph becomes the basin hydrograph. The basin hydrographs were allocated to all manholes within the basin upstream of the flow monitor based on the ratio of individual pipe length to total pipe length. This provides an even distribution of flow throughout the basin.

Flow hydrographs were developed from the data presented in Chapter 5 during dry and wet weather, for existing and future flow conditions. Actual flow data collected during the monitoring period were used to calibrate and verify the computer model. The model results for existing dry weather conditions were compared with the observed flow monitor hydrographs and modifications to model calibration were made as necessary.

MODEL OUTPUT RESULTS

The model results provide specific locations within the major trunk system where the available capacity is exceeded by the input flow condition. SAM printouts for each basin are presented in Appendix C, and the format is illustrated and briefly described below.

NODE	DISCH. PIPE	SIZE (IN)	SHAPE CODE	SLOPE	CAPACITY (MGD)	PEAK Q AT NODE (MGD)	TIME (MIL)	MAX DEPTH (FT.)	MAX HGL	LID ELEV	SURCH. DURATION (HHMM)	REQ. DIA. AT PIPE SLOPE(IN)	REQ. DIA. AT GROUND SLOPE(IN)	OVFLW PIPE REQ. DIA. AT PIPE SLOPE(IN)	PCT. CAP.
3120	3120	12.0		0.0020	1.029	0.009	2300	0.0	76.56	999.99	0	2.0	0.5	0.0	0.86
3118	3118	12.0		0.0030	1.257	0.022	2300	0.1	76.23	72.40	0	2.6	0.0	0.0	1.75
3111	3111	12.0		0.0004	0.441	0.034	200	0.2	75.57	999.99	0	4.6	0.0	0.0	7.73
3108	3108	12.0		0.0029	1.236	0.047	400	0.1	75.40	999.99	0	3.5	0.0	0.0	3.80
3101	3101	12.0		0.0031	1.283	0.079	600	0.2	74.70	999.99	0	4.2	0.0	0.0	6.13
1742	1742	15.0		0.0017	1.715	0.101	300	0.2	72.74	999.99	0	5.2	0.0	0.0	5.88
1736	1736	15.0		0.0016	1.679	0.127	2300	0.2	72.02	999.99	0	5.7	0.0	0.0	7.55
1724	1724	15.0		0.0017	1.714	0.139	700	0.2	71.18	999.99	0	5.9	0.0	0.0	8.14
1725	1725	15.0		0.0028	2.219	0.147	700	0.2	70.72	999.99	0	5.4	0.0	0.0	6.61
1716	1716	15.0		0.0019	1.819	0.171	2300	0.3	70.36	999.99	0	6.2	0.0	0.0	9.42
1708	1708	18.0		0.0003	1.184	0.206	0	0.4	69.60	999.99	0	9.3	0.0	0.0	17.28
1446	1446	18.0		0.0017	2.757	0.228	0	0.3	69.22	999.99	0	7.1	0.0	0.0	8.25
1437	1437	18.0		0.0017	2.762	0.245	0	0.3	68.52	999.99	0	7.3	0.0	0.0	8.87
1427	1427	18.0		0.0031	3.790	0.257	0	0.3	67.90	999.99	0	6.6	1.7	0.0	6.79
1423	1423	18.0		0.0049	4.745	0.266	0	0.2	67.08	67.10	0	6.1	0.0	0.0	5.61
1420	1420	18.0		0.0017	2.770	0.269	0	0.3	66.30	999.99	0	7.5	1.4	0.0	9.71
1451	1451	18.0		0.0015	2.678	0.270	0	0.3	66.21	67.43	0	7.7	0.0	0.0	10.28
1417	1417	18.0		0.0016	2.702	0.290	0	0.3	66.19	67.58	0	7.8	0.0	0.0	10.75
1408	1408	18.0		0.0018	2.899	0.310	0	0.3	65.54	999.99	0	7.8	0.0	0.0	10.70
1404	1404	18.0		0.0018	2.879	0.335	2200	0.4	64.83	999.99	0	8.0	0.0	0.0	11.63

- The first five columns identify the pipe, and manhole and provide physical data. Locations are identified by their manholes. Each manhole was assigned with a five-digit number identifying the map number, quadrant, and manhole location. For example, manhole 1-7-08 refers to map number 1, quadrant 7, and manhole 8 within quadrant 7. The pipe is designated the upstream manhole. For example, the discharge pipe from the above manhole is pipe 1-7-08. The "Size" column shows the diameter in inches. The "Slope" column indicates the slope of each line in feet-per-foot of pipe. "Shape Code" is used when pipes are not circular.

- The theoretical "Capacity" of the discharge pipe, computed in million gallons per day, uses the Manning equation that relates slope, wetted perimeter, hydraulic radius, and coefficient of roughness. A default value of 0.013 is used for pipes with no known Manning coefficient value. The next column, "Peak Q at Node," shows the peak flow in the discharge pipe in that line under the modeled conditions. The "Time" column shows the actual time when the peak flow occurs.

- "Maximum Depth," shows the maximum depth, in feet, that sewage reaches in each discharge pipe. If the maximum depth exceeds the pipe size, the line is surcharged. This surcharge could result from inadequate capacity of the line, or downstream surcharged line causing the sewage to backup. Thus, even if a discharge line has adequate capacity, it could still be surcharged.

- The column titled "Max HGL" indicates the elevation in feet of the maximum hydraulic grade line. The next column, "Lid Elevation," shows the elevation of the manhole rim. Theoretically, if the hydraulic grade line shown is higher than the lid elevation, the manhole will overflow. Unfortunately, not all lid elevations are available for Woodland at this time. Therefore, overflow locations cannot be established for all pipes. The "Surcharge" column shows the duration of surcharge in hours and minutes, from the discharge line.

- The next three columns are the pipe size required to carry the modeled peak flows. "Required Diameter At Pipe Slope" shows the diameter required to transport the total flow at the existing pipe slope. "Diameter At Ground Slope" is the size required if the pipe is at the same slope as the ground surface above the pipe. "Overflow Pipe" is the size of pipe needed in addition to the existing pipe, to carry only the excess peak flow, if the new pipe is adjacent and parallel to the existing pipe. This column appears as zero unless the existing discharge pipe is above capacity.

- The "Percent Capacity" column compares the "Capacity" of the line with the "Peak Q" and shows this ratio as a percent of capacity. If the percent capacity is greater than 100, there is inadequate capacity in the line.

SFR18/089

CH2M HILL

CHAPTER 7
Collection System Analysis

Chapter 7
COLLECTION SYSTEM ANALYSIS

A comprehensive analysis was performed, using SAM, on the major sewer lines in the planning area. Wastewater flow was simulated under various conditions and compared with the existing system capacity. The objective is to analyze the pipeline capacity based on total basin flows to the trunk sewer system. Capacity analysis of the smaller branch pipelines was beyond the scope of this report.

This Chapter presents specific capacity deficiencies identified by SAM where the simulated flow exceeds existing capacity. Also presented is an analysis of alternative flow scenarios developed to demonstrate the effect of varying levels of service and industrial growth assumptions.

CAPACITY ANALYSIS

SAM was used to analyze major sewer lines in the planning area for existing and future flow conditions as developed in Chapter 5. Future flow conditions were developed for the year 2020. The results of the SAM analysis, presented in Table 7-1, show those pipeline sections where the existing capacity has been exceeded by existing and future design PDWF and PWWF conditions. The percent capacity utilization of these sections is presented to note the relative severity of the capacity restrictions. Figure 7-1 presents the locations of the deficient pipe sections. Only those sections where the capacity is exceeded by more than 110 percent are shown in the Figure. The modeling has shown that the system is capable of handling existing PDWF without surcharge. However, during periods of wet weather (including I/I) and after the predicted growth, several problems become apparent.

The results of the flow monitoring program indicate that some areas of the system are susceptible to large amounts of I/I, producing high peak flows during wet weather. Modeling has shown that these areas are lacking capacity for present design peak wet weather flows. In addition, dry weather flows due to projected growth through the year 2020 will exceed system capacity in some areas. These problems are due in part to the relatively flat pipe slopes necessitated by the flat topography of the area. Pipeline sections where the capacity is exceeded by existing PWWF should be considered as critical areas for correction unless I/I flows can be reduced by rehabilitation work.

In addition to Figure 7-1, detailed maps in Appendix A include the modeled sewers and manhole numbers. The reader can review the pipeline alignments, as necessary, for clarification.

Table 7-1
City of Woodland
Wastewater Facilities Master Plan

SUMMARY OF SYSTEM CAPACITY DEFICIENCIES[a]

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PDWF (mgd) Existing	PDWF (mgd) Year 2020	PWWF (mgd) Existing	PWWF (mgd) Year 2020	Percent Capacity[b] PDWF	Percent Capacity[b] PWWF
B04	Oak Avenue	4-1-29/ 4-1-31	12	1.00	0.58	0.66	1.02	1.11	66	111
	Fourth Street	4-1-42/ 4-1-35	8	0.21	0.14	0.16	0.24	0.26	75	124
	Fourth Street	4-1-35/ 4-1-27	8	0.13	0.25	0.28	0.43	0.47	220	362
	Fourth Street	4-1-57/ 4-1-43	8	0.14	0.08	0.09	0.15	0.16	68	114
	Fourth Street	4-1-43/ 4-1-35	8	0.13	0.10	0.11	0.17	0.19	87	146
B06	East Street	4-2-07/ 4-2-05	15	1.48	0.96	1.12	1.49	1.64	76	111
	East Street	4-2-05/ 4-2-01	15	1.46	0.98	1.14	1.50	1.68	78	115
	East Street	4-2-01/ 2-7-67	15	1.47	0.99	1.15	1.52	1.70	79	116
	East Street	2-7-67/ 2-7-53	15	1.41	1.01	1.18	1.54	1.74	83	123

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Table 7-1
(continued)

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PDWF (mgd) Existing	PDWF (mgd) Year 2020	PWWF (mgd) Existing	PWWF (mgd) Year 2020	Percent Capacity[b] PDWF	Percent Capacity[b] PWWF
	East Street	2-7-53/ 2-7-42	15	1.69	1.03	1.20	1.58	1.78	71	105
	East Street	2-8-06/ 2-8-05	18	1.99	1.14	1.34	1.77	2.01	68	101
B07	Fourth Street	2-7-37/ 2-7-27	12	0.52	0.23	0.27	0.86	0.90	52	173
	Fourth Street	2-7-27/ 2-7-17	12	0.50	0.26	0.30	0.98	1.02	60	200
B07	Fourth Street	2-7-16/ 2-7-10	12	0.74	0.39	0.45	1.46	1.52	61	205
	Clover Street	2-7-15/ 2-7-17	8	0.35	0.10	0.12	0.37	0.39	33	111
B08	Beamer Street	2-7-04/ 2-7-05	18	3.11	1.56	1.79	3.51	3.47	58	120
	Beamer Street	2-7-05/ 2-7-06	18	2.81	1.57	1.80	3.54	3.78	64	135
	Beamer Street	2-7-06/ 2-7-07	18	2.88	1.57	1.80	3.56	3.80	63	132
	Beamer Street	2-7-07/ 2-7-08	18	2.89	1.59	1.83	3.64	3.87	63	134

Table 7-1
(continued)

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PDWF (mgd) Existing	PDWF (mgd) Year 2020	PWWF (mgd) Existing	PWWF (mgd) Year 2020	Percent Capacity[b] PDWF	Percent Capacity[b] PWWF
	East Beamer Street	2-7-08/ 2-5-29	18	4.22	2.82	3.28	5.68	6.16	78	146
B09	East Beamer Street	2-5-29/ 2-5-30	24	5.91	2.85	3.33	5.77	6.27	56	106
	East Beamer Street	2-5-30/ 2-5-31	24	5.51	2.86	3.37	5.80	6.34	61	115
	East Beamer Street	2-5-31/ 2-5-32	24	4.87	2.94	3.52	6.04	6.65	72	137
B09	East Beamer Street	2-5-32/ 2-5-33	24	5.95	2.97	3.58	6.14	6.78	60	114
	East Beamer Street	2-5-33/ 2-6-10	24	5.97	3.10	3.84	6.47	7.33	64	123
	East Beamer Street	2-6-10/ 2-6-11	27	6.93	3.10	3.85	6.48	7.34	56	106
	East Beamer Street	2-6-11/ 2-6-12	27	7.01	3.13	3.90	6.56	7.44	56	106
	East Beamer Street	2-6-15/ 2-6-16	24	5.45	3.18	4.00	6.67	7.54	73	138
	East Beamer Street	2-6-16/ 2-6-17	24	5.66	3.31	4.26	7.08	8.08	75	143

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Table 7-1
(continued)

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PDWF (mgd)		PWWF (mgd)		Percent Capacity[b]	
					Existing	Year 2020	Existing	Year 2020	PDWF	PWWF
	East Beamer Street	2-6-17/ 2-6-18	24	5.42	3.34	4.32	7.17	8.20	80	151
B10	East Beamer Street	2-6-18/ 5-2-16	24	5.42	3.35	4.35	7.36	8.42	80	155
	East Beamer Street	5-2-16/ 5-2-17	24	5.42	3.36	4.39	7.56	8.64	81	159
	East Beamer Street	5-2-17/ 5-2-18	24	5.42	3.37	4.42	7.76	8.86	82	163
	East Beamer Street	5-2-18/ 5-2-19	24	5.42	3.38	4.46	7.96	9.09	82	168
	East Beamer Street	5-2-19/ 5-2-20	24	4.62	3.38	4.46	7.96	9.09	97	197
	East Beamer Street	5-2-20/ 5-2-21	24	5.12	3.39	4.47	8.01	9.15	87	179
	East Beamer Street	5-2-21/ 5-2-22	24	5.13	3.40	4.51	8.24	9.40	88	183
	East Beamer Street	5-2-22/ 5-2-23	24	5.40	3.41	4.55	8.45	9.64	84	179
	East Beamer Street	5-2-23/ 5-2-24	24	5.10	3.42	4.59	8.66	9.88	90	194

Table 7-1
(continued)

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PDWF (mgd)		PWWF (mgd)		Percent Capacity[b]	
					Existing	Year 2020	Existing	Year 2020	PDWF	PWWF
	East Beamer Street	5-2-24/ 5-2-25	24	5.68	3.43	4.63	8.88	10.12	81	178
	East Beamer Street	5-2-25/ 5-2-26	24	3.64	3.45	4.66	9.10	10.37	128	285
	East Beamer Street	5-2-26/ 5-2-27	24	3.91	3.46	4.70	9.32	10.61	120	271
	East Beamer Street	5-2-27/ 5-2-13	24	3.48	3.47	4.74	9.53	10.86	136	312
	County Road 103 line	5-2-13/ 5-2-08	36	14.05	4.93	9.09	13.14	17.43	65	124
	County Road 103 line	5-2-08/ 5-2-09	36	13.96	4.95	9.14	13.34	17.76	65	127
	County Road 103 line	5-2-09/ 5-2-10	36	14.22	4.95	9.15	13.28	17.80	64	125
	County Road 103 line	5-2-10/ 5-2-11	36	14.55	4.97	10.01	13.66	19.03	69	131
	County Road 103 line	5-2-11/ 5-2-12	36	12.54	4.99	10.07	13.85	19.40	80	155

Table 7-1
(continued)

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PDWF (mgd)		PWWF (mgd)		Percent Capacity[b]	
					Existing	Year 2020	Existing	Year 2020	PDWF	PWWF
C06	Gum Avenue	4-5-18/ 4-5-19	8	0.31	0.16	0.26	0.23	0.33	84	106
C07	Matmor Road line	4-5-24/ 4-5-35	10	0.60	0.30	0.57	0.47	0.71	96	118

[a]The summary of capacity deficiencies is presented for existing conditions (1985) and future conditions (2020).
[b]Percent (%) capacity is calculated for year 2020 flows only.

ALTERNATIVE DEVELOPMENT

Further analyses were performed to examine the effect of varying the design level of service beyond the 2-year design storm and the industrial growth assumptions used in Chapter 5. Both present and future wet weather flows were again modeled assuming a design level of service corresponding to a 5- and 10-year storm event. The analysis showed that increasing the level of service would cause capacity problems in the same pipes as for the 2-year level of service, with a few exceptions, but there would be a significant increase in the pipe size required to carry this flow.

New industrial development in the City is currently expected to include factory and warehousing industries which will generate wastewater at an expected rate of 2,000 gpad. For more water intensive industries, such as food processing, a unit flow allowance of 5,000 gpad should be employed. The collection system was modeled for both future PDWF and PWWF to determine the effect of this type of industrial development on required collection system capacity. As with increasing the level of service, increasing the industrial wastewater flow allocation resulted in little change in the location of capacity problems, but the pipe sizes required to relieve these problems were larger.

Where SAM has calculated the existing capacity as insufficient, the guidelines listed in Table 5-1 were used to select either an overflow pipe or pipe replacement. As a rule, overflow pipes were selected to provide the additional capacity. However, during design, older pipes may require replacement where an overflow pipe has been indicated. This determination will be based on actual field observations not available for this master plan.

COST ESTIMATING CRITERIA

Preliminary cost estimates were developed using the unit costs and criteria presented in Table 7-2. All costs were estimated based on ENR 5100, which corresponds to April 1985. Prior to design and construction, these costs should be reviewed and updated as necessary to reflect changes in the ENR index.

The pipeline unit costs include pipe, manholes, miscellaneous appurtenances (service connections), installation, excavation, bedding and backfill, pavement removal and replacement, traffic control testing, and contractor's overhead and profit. Based on known soil and sometimes high groundwater conditions in the Woodland area, allowances for sheeting, shoring and limited dewatering were included.

Table 7-2
City of Woodland
Sewer System Master Plan

UNIT COST DATA[a]

Pipe Diameter (in)	Pipeline[b] Construction Cost ($/lf) Less Than 8-Foot Cut	Greater Than 8-Foot Cut	Open Field Installation[c]	Force Main[d] Construction Cost ($/lf)
4	-	-	-	16
6	-	-	-	24
8	100	133	66	32
10	106	140	72	40
12	113	147	80	48
15	124	160	90	60
18	136	175	104	72
21	154	190	118	84
24	173	211	138	96
27	185	224	151	108
30	197	235	165	120
33	220	258	184	132
36	239	282	206	144
39	255	293	218	-
42	260	310	230	-

[a]ENR 5100, April 1985

[b]Costs include pipes, manholes, miscellaneous appurtenances, installation, excavation, bedding and backfill, sheeting and shoring, limited dewatering, pavement removal and replacement, traffic control, testing, and contractor's overhead and profit.

[c]Unit costs for pipe installed in open fields or on gravel roads do not include sheeting and shoring, traffic control, and pavement removal and replacement.

[d]Unit costs for force mains are based on updating costs from the EPA Contract Cost Data Report No. 430 and include all construction costs except engineering.

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Costs for unusual construction conditions such as creek, freeway, or railroad crossings have been added to the pipeline construction costs as necessary. An additional unit cost of $100/lf was added for pipelines to be installed in these conditions to account for construction cost over and above the normal unit cost.

Average annual cost for maintenance of gravity sewers over the useful life is assumed to be 0.7 percent of the construction cost. The normal useful life for a pipeline is approximately 50 to 70 years. However, using an aggressive maintenance program, including current rehabilitation techniques, the useful life could be increased to 100 years. An example of a full scale maintenance program, discussed in Chapter 9, includes routine maintenance, testing, inspection for I/I detection rehabilitation, and data management.

These maintenance costs were included for only additional pipe added to the system such as overflow pipes and new construction.

COMPARISON OF ALTERNATIVES

SAM was run for each alternative level of service and industrial growth scenario to evaluate the effects of either increased or decreased flows on the system. Cost estimates were developed for each of the alternatives, using the cost-estimating criteria outlined in the previous section. A comparison of the estimated costs is presented in Table 7-3. To account for design engineering, administration, and contingencies, a 30 percent allowance has been included.

The most cost-effective plan which meets the City's expected future needs is based on a level of service corresponding to a 2-year design storm and an industrial flow allocation of 2,000 gpad. Design for a 5- or 10-year level of service is not recommended, since the storm drainage system in a large area of the City will only be designed to provide a 2-year level of service. Based on current projections of future growth, a 2,000 gpad industrial flow allocation is appropriate to provide the City with sufficient flexibility for varied industrial growth. The cost associated with a 5,000 gpad industrial wastewater flow alternative demonstrates the level of investment which would be required if these projections include more water-intensive industries. It should be noted that the increased costs associated with these alternatives are mainly due to increases in required pipe sizes rather than to an increased number of overflow or replacement pipes.

The cost-effective alternative includes changing the existing system in Basin B10. A bypass pipe along the levee

Table 7-3
City of Woodland
Wastewater Facilities Master Plan

CAPITAL COST ALTERNATIVE ANALYSIS

Alternative[a]	Level of Service[b] (year)	Industrial Allocation (gpad)	Estimated Cost ($1,000)
1985 PWWF			
	2	1,200	0
	5	1,200	4,726
	10	1,200	7,573
2020 PDWF			
	-	1,200	55
	-	2,000	2,726
	-	5,000	4,927
2020 PWWF			
	2	2,000	7,333
	5	2,000	8,582
	10	2,000	10,529
	5	5,000	11,631

[a]PDWF = Peak Dry Weather Flow
PWWF = Peak Wet Weather Flow

[b]Level of service refers to the design storm recurrence interval used to determine collection system capacity.

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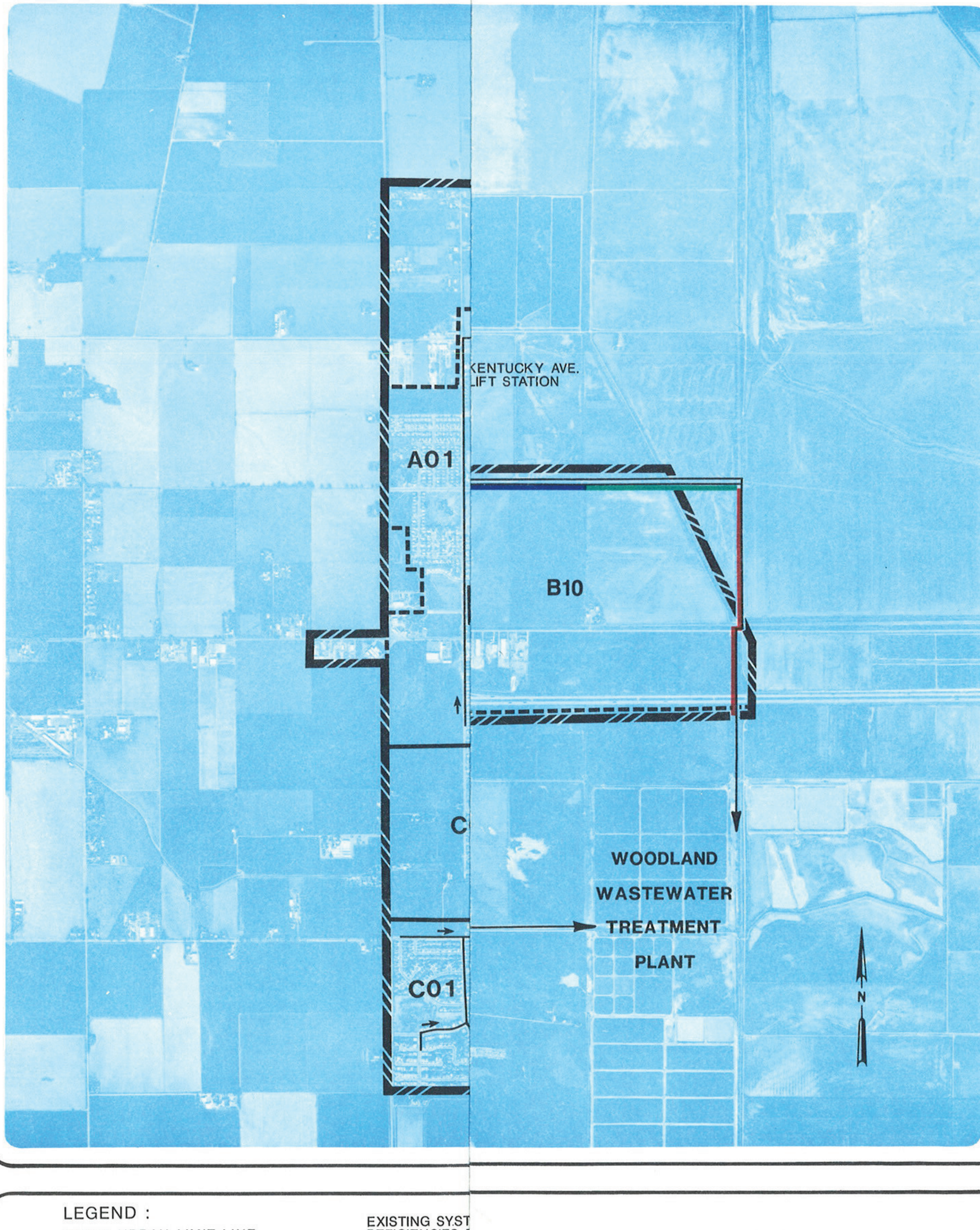
of the Cache Creek Settling Basin north of County Road 22 is more cost effective than providing parallel overflow capacity to pipes on the other side of the levee in the Cache Creek Settling Basin. The existing pipe alignment in the settling basin is nearly impossible to maintain and is a potential source of both inflow and infiltration. New cross-country pipelines would not require complicated trenching, traffic control, and repaving, thereby reducing placement costs.



LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- A01 BASIN IDENTIFICATION
- MAIN SEWER LINE
- DIRECTION OF FLOW
- (P) PUMP STATION

EXISTING SYST
DEFICIENCIES E

- PRESENT PWW
- PRESENT PWW FOR YEAR 202
- PWWF FOR YE

NOTE: DEFICIEI
THE 2-

FIGURE 7-1

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

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CH2M HILL

CHAPTER 8
Treatment and Disposal System Analysis

Chapter 8
TREATMENT AND DISPOSAL SYSTEM ANALYSIS

As part of the Wastewater Facilities Master Plan, the existing capacity of the domestic wastewater treatment and disposal system has been evaluated. This chapter continues the discussion from Chapter 3 with a summary of waste discharge requirements, existing capacity and limiting factors, and a discussion of alternatives to meet present and future flow conditions.

WASTE DISCHARGE REQUIREMENTS

The most current waste discharge requirements modified in 1982 by the Regional Board and State Board are summarized below for the domestic and industrial waste treatment facilities.

DOMESTIC WASTE TREATMENT

The direct discharge of wastewater to surface waters is prohibited annually between March 1st and November 1st. During November through February, when treated wastewater may be discharged to the Tule Canal, the 30-day average concentrations of BOD and total suspended solids are each limited to 30 mg/l. In addition, the discharge of effluent to the Sewer Farm is annually limited to a period from April 1st though September 30th, and direct discharge of any surface runoff water from wastewater irrigation is prohibited. Water quality requirements for discharge to the Sewer Farm is 40 mg/l BOD_5 and 40 mg/l for suspended solids.

INDUSTRIAL WASTE TREATMENT

Industrial wastewater discharge requirements, limitations, and provisions were defined by the State Board in 1981.

These requirements are pertinent to the evaluation of the domestic system capacity because the potential exists to use treated domestic wastewater to irrigate the industrial site when the cannery is not in full operation. The direct discharge of any waste is prohibited from the industrial site, and any reclaimed wastewater must meet the criteria contained in Title 22, Division 4, of the California Administrative Code.

CAPACITY EVALUATION

The existing domestic wastewater treatment system and disposal facilities have been evaluated to determine the actual current capacity. The following sections present a summary of the existing treatment and disposal methods and capacities.

CURRENT TREATMENT PROCESS REVIEW

Domestic wastewater from the City of Woodland is treated in a series of facultative waste stabilization ponds. The water depth in facultative ponds usually ranges from 4 to 8 feet. The water near the surface in this type of pond system is aerobic (with air), overlying a zone of septic or anaerobic (without air) water which contains sludge deposits. Anaerobic conditions and decomposition occur in the lower layer, while aerobic waste stabilization occurs in the upper layer. Water in the upper layer of the pond is kept aerobic by oxygen produced through photosynthesis by algae and by surface reaeration. Oxygen is utilized by aerobic bacteria in the upper layer, stabilizing the organic material in the influent.

Effluent BOD concentrations in facultative ponds normally range from 20 to 60 mg/l. Suspended solids concentrations usually range from 30 to 150 mg/l. Algae presence contributes to the suspended solids and therefore are a serious performance problem for the Woodland facilities.

The Woodland ponds were previously operated in a continuous discharge mode, meaning there was no provision for regulating effluent flow and the discharge rate essentially equaled the influent rate. When the waste discharge requirements were modified in 1982, the operation of the pond system was restricted to controlled discharge. A controlled discharge system must have long hydraulic detention times, and effluent is discharged only when receiving water quality will not be adversely affected by the discharge. Controlled discharge ponds are designed to hold the wastewater until the effluent and receiving water quality are compatible.

EXISTING TREATMENT CAPACITY

The existing domestic treatment system was designed to provide initial treatment in the Erskine and Strong ponds, with additional treatment provided in the newer Phase II pond system. Stabilization of the influent wastewater was expected to occur in the Erskine, the Strong, and the first six Phase II "parallel" ponds. The subsequent five Phase II "series" ponds were designed for algae removal, with further removal of suspended solids and algae in the final two chlorination ponds.

Organic Waste Treatment Capacity

An evaluation of loading rates and detention times of pond systems revealed that the organic loading rates should be limited to a maximum of 35 pounds of BOD_5 per day per acre of pond. Although higher rates may allow successful operation, this lower rate should minimize concern about the possible overloading, which could result in septic conditions and the release of objectionable odors.

Based on organic loading, the existing plant waste treatment capacity was determined to be approximately 2.9 mgd.

Suspended Solids (Algae) Limitations

The ability of the Woodland pond system to meet suspended solids discharge requirements is limited due to algae growth. To increase the performance of the Woodland pond system, special polishing ponds were constructed with the Phase II project and designed for algae removal. Algae removal was anticipated to occur as nutrients needed for survival by the algae were depleted, followed by eventual die-off and settling to the pond bottom.

The efficiency of sedimentation in the polishing ponds was limited by factors such as wind mixing and algae species. The initial startup of Woodland's polishing ponds has not resulted in a noticeable reduction in suspended solids concentrations through the pond system. In addition, based on the plant's operational test records, it appears that very little reduction in algae concentrations is being achieved through the ponds. Thus, without further modifications, the plant is currently unable to remove sufficient algae from the effluent to meet discharge limitations.

EXISTING DISPOSAL METHODS

The City has a number of existing methods for wastewater disposal within its current treatment system. Some of these methods are implemented now by the City, while others are available with a minimum of effort.

Direct Evaporation from Treatment Ponds

Woodland is in a climatic zone where net evaporation occurs. Currently, two areas are used to pond and treat wastewater: the old Beamer treatment facility, where about 82 acres of water surface area are available for evaporation, and the City's domestic wastewater treatment facility, where about 282 acres of water surface area is available from the extensive series of treatment ponds.

Sewer Farm Disposal

The City has not used the sewer farm to dispose of treated wastewater in the recent past. This is because a surface water runoff, or tailwater, return flow system does not exist at this site. Previous agricultural use of the sewer farm did not require a return flow system.

The sewer farm could be used in two ways to dispose of treated wastewater, as either evaporation basins or cropped farmland. Use of the sewer farm as evaporation basins would be the easiest to implement in the short term.

Irrigation of Industrial Treatment Facility Lands

Treated wastewater can be provided by the City to Contadina for early-season irrigation of crops at the industrial treatment facility. Last season, the City did dispose of a fraction of its treated wastewater at this site.

No contractual arrangement currently exists between Contadina and the City to dispose of wastewater. However, through cooperation between the City plant operators and the Contadina operator, the City is prepared to deliver treated wastewater as desired by Contadina.

Discharge to Tule Canal

For the immediate future, the discharge of treated wastewater to the Tule Canal is the predominant disposal method during the winter months from November 1st to February 28th.

DISPOSAL CAPACITY

The following sections present the rated disposal capacity of the available sites, including the Beamer Treatment Facility, the Domestic Waste Treatment Plant, and the Industrial Treatment site.

Beamer Treatment Facility

A portion of the wastewater from the Kentucky Avenue interceptor is currently evaporated from the Beamer ponds. A wastewater disposal capacity of about 180,000 gpd is available from the Beamer ponds. However, the Beamer facilities will soon be abandoned for other uses. Further disposal at this site has not been considered.

Domestic Waste Treatment Facility

Treated wastewater can be discharged from the domestic waste treatment facility by direct evaporation, application to the sewer farm, or discharge to the Tule Canal. It was conservatively assumed that minimal deep percolation from the ponds occurs due to the native clay soils, perched water table, and natural sealing action of the ponds.

To determine the disposal capacity, a water budget was developed. A water budget compares influent water volumes with expected losses through evaporation, percolation, direct discharge, and/or land disposal. The water budget was based on Woodland's average precipitation volumes and on Sacramento Valley evaporation rates. No percolation was assumed for the ponds. This conservative assumption was based on the low permeabilities associated with the native clays, the likely presence of a perched water table, and the natural tendency of the ponds to seal small voids in the soil structures.

The water budget for the City's pond system calculated a limiting storage capacity of 878 acre-feet within the treatment and evaporation ponds. The resulting water budget from this analysis showed that the average annual wastewater disposal capacity is limited to about 3.8 mgd. This budget requires an average monthly discharge to the Tule Canal during the winter months of about 6.6 mgd. It should be noted that this analysis assumed that no treated wastewater was discharged to the industrial treatment facility.

Industrial Site Disposal

The ability to dispose of treated wastewater at the industrial treatment facility could increase the overall disposal capacity. The City currently has the ability to provide irrigation water for Contadina, but a contractual agreement is not in place to provide a firm request for water.

To assess the disposal potential of this site, a water budget analysis was performed on the 574-acre industrial site. The City could annually dispose of approximately 330 million gallons of treated wastewater at the Contadina site.

Using this information, the City's overall disposal capacity was reevaluated. This showed use of the industrial site could increase the overall disposal capacity to about 5.1 mgd.

EXPANSION ALTERNATIVES

One of the primary purposes of wastewater facilities planning is to analyze practical alternative technologies and techniques to determine which alternative is the most cost-effective and environmentally sound. This section presents a review of water quality objectives for the area and a discussion of alternatives.

WATER QUALITY OBJECTIVES

Water quality objectives and goals for the Sacramento River and the Sacramento-San Joaquin Delta Basins were reviewed to assess probable discharge requirements for an expanded plant. It was necessary to review the Delta plan because the Tule Canal discharges into Delta waters when it drains into Cache Slough.

From these reviews, it was concluded that continuous discharge to the Tule Canal would probably be allowed if the average monthly BOD and total suspended solids of the plant effluent were each less than 10 mg/l. It was also concluded that a rigorous analysis of the appropriate rivers and water courses could reveal that the continuous discharge of plant effluent with higher average concentrations might be acceptable.

If higher average effluent concentrations can meet water quality goals, this would reduce construction and operational cost. For evaluation purposes, it was assumed that monthly average concentrations effluent of BOD and suspended solids below 20 mg/l might be acceptable for continuous year-round discharge, with the most critical periods being the summer and early fall months when stream flows are minimum.

The water quality control plans also revealed the State Board's desire to encourage the disposal of wastewater on land where practical. Where studies have shown that year-round land disposal is not practical, the State Board, through the Regional Board, requires the evaluation of dry season land disposal as an alternative.

ALTERNATIVE DEVELOPMENT

Consistent with State Board water quality objectives and goals and probable future effluent limitations, several alternatives were developed and analyzed. The following five alternatives were seriously considered:

1. Existing system expansion
2. Aerated lagoon with dry season land disposal
3. Complete land disposal
4. Activated sludge treatment
5. Oxidation ditch treatment

Figures 8-1 through 8-5 schematically illustrate the major components, seasonal operational variations, and effluent water quality expected with each alternative. A description follows of each alternative and its design considerations. Alternatives 4 and 5 require year-round discharge and are included for cost comparison only.

As shown by the dashed boxes in Figures 8-1 through 8-5, it is not certain if effluent filtration will be required. Effluent filtration will be needed if average monthly BOD and suspended solids concentrations less than 10 mg/l in the final effluent are required. If higher average concentrations (20 mg/l or less) are acceptable, filtration will not be needed. This is a very important factor due to the relatively high costs associated with filter construction and operation.

Alternative 1 - Existing System Expansion

The existing pond system can be upgraded and expanded to meet future needs by converting the new Phase II ponds into waste treatment ponds, by constructing new treatment ponds to the south of the Phase II ponds and on the Conway site, and by adding methods to reduce the effluent suspended solids. To contain the influent flows for controlled winter-only discharge, construction of additional storage ponds would also be required.

To minimize the yearly operation and maintenance cost for wastewater pumping, it was assumed that the tops of the berms of the Strong and Erskine pond systems would be raised, allowing water to flow by gravity from one pond to the next, as needed, without intermediate pumping. To provide the soil needed to raise the berm height, the berm slopes would be steepened to a 3:1 sideslope. The 9 Strong and 13 Erskine ponds would be converted into 5 large (approximately 40 acres each) rectangular ponds. In addition to reducing pumping costs, these modifications would increase the storage volume and total surface area available, increasing net evaporation, while reducing the cost of maintenance, (mowing, dike maintenance, etc.).

To further increase the treatment capacity of the facultative pond system, additional ponds would be constructed to the south of the Phase II ponds and on the Conway site, where two evaporation ponds have already been built. To meet design year loadings, the entire Conway site would be used for additional facultative pond construction.

Because influent flowrates will still exceed the net evaporation rate during the spring, summer, and fall, additional storage will be needed. This storage would be provided by relatively deep ponds with a 10-foot operating depth. Due to concerns about interference with the natural groundwater table, the ponds would be built up from the existing ground surface, requiring additional fill material, and pumping of water into the ponds. To maximize volume and minimize maintenance needs, relatively large earthen ponds (approximately 40 acres of water surface area) would be constructed adjacent to the existing plant site.

New dissolved air flotation (DAF) units would also be constructed for "polishing" the effluent prior to discharge during the winter months. Based on work done elsewhere, dissolved air flotation can be expected to consistently meet 20/20 (mg/l BOD/mg/l suspended solids) discharge limitations using the effluent from facultative pond systems, with alum or polymer addition. If 10/10 standards are imposed, rapid sand filters will also need to be constructed and used as a final polishing step after treatment by the DAF units. Other polishing treatment methods considered included microscreening, intermittent sand filters, and in-pond rock filters.

Alternative 2 - Aerated Lagoon with Dry Season Land Disposal

Partial off-site land disposal is another way the existing pond system can be upgraded and expanded. For any alternative which uses land disposal combined with treated effluent discharge, additional treatment would be needed. The treatment would be needed for the discharged water and the potentially objectionable odors, resulting from the storage of discharge water to land disposal.

Numerous combinations of partial land disposal and discharge could be considered. For this analysis, it was assumed that discharge would be limited to the wet-season winter period of November to March, consistent with State Board policies and goals. During the remainder of the year, water would be treated through the pond system to provide required primary treatment and odor control; then applied to the sewer farm, the Contadina industrial site, and off-site agricultural land under a well defined management plan to balance influent flows to capabilities.

To implement this alternative, modifications to the Strong and Erskine pond systems discussed under Alternative 1 would be needed. The new facultative ponds to be constructed on the Conway site, discussed under the previous alternative, would also be needed.

With the existing pond modifications and the new facultative pond construction, sufficient storage would be provided to operate the land disposal system without additional storage ponds. However, for wet-season operation, additional secondary ponds would need to be constructed; or, as an alternative, the operation of the pond series could be changed. Considering the relatively high capital cost for additional secondary ponds and the relatively short duration of the period in which they will be needed each year, it was assumed that the pond operation would be changed during the wet season.

During the wet season, the pond system would be operated as an aerated lagoon system. With the change in operation, all the influent wastes would be treated in a portion of the total pond system by supplying additional oxygen to the influent wastewater. The additional oxygen would be supplied through surface mechanical aerators or through a diffused aeration system. With this operation, the rest of the expanded pond system would be primarily used as settling ponds prior to final effluent polishing, disinfection, and discharge. Effluent polishing would be accomplished by the use of a DAF unit similar to that discussed under the first alternative, except under the alternative the size and operating costs would be lower due to reduced discharge rates.

Implementation of this alternative would also require purchase or development of cooperative contractual agreements with the owners of nearby farmland to allow development and controlled operation of the land disposal system. By cooperative agreement, in exchange for treated water supplied at no cost to the farmer(s), the City would be allowed to construct improvements on the land, control the crops grown, and control the water application rates. The farmer would be responsible for planting and crop harvesting, weed control, and land maintenance (dike upkeep, etc.). The revenues generated through the use of free irrigation water from this operation could provide the economic incentive for the farmer(s) to enter into agreement with the City. This approach has been successfully used elsewhere in Northern California.

For this alternative, approximately 1,050 acres of agricultural land would be needed for land disposal. This acreage includes land area lost to the tailwater return system and other surface area not used for crop production. To make this approach viable, the total acreage could not be scattered in different directions. Instead, a single large property or several contiguous properties would need to be developed. For cost estimating purposes, it was assumed these conditions could be met within a mile of the existing plant site.

Wastewater can be reclaimed for beneficial reuse to irrigate land as long as the treatment requirements are met for defined irrigation use. These treatment requirements are stated in Title 22 of the California Administrative Code. A synopsis of this law is contained in Appendix E (Table E-7). Planned use of the effluent from the Woodland treatment plant is for irrigation of fodder, fiber, and seed crops, this is consistent with the general cropping patterns of the surrounding agricultural lands. Specific crops which may be considered to be grown on the application site include corn, alfalfa, sudan grass, milo, and canning tomatoes.

A review of the property records of the area around the treatment plant revealed that adequate land is available. Depending on the approach desired by the City, sufficient land could be leased or purchased from negotiations with as few as one or two landowners. Pumping some or all of the water under Willow Slough might be needed, depending on the final properties used. If this were needed, the pipeline construction cost might be increased slightly to account for the crossing. Pumping the water to the south of the slough might, however, provide the best long-range flexibility to the City and keep land north of the slough available for development.

Alternative 3 - Complete Land Disposal

The existing pond system can also be upgraded and expanded using complete land disposal. This alternative is similar to the partial land disposal alternative in that additional off-site agricultural land would be used for effluent disposal. Implementation of this alternative would be different from the previous alternative in that additional storage ponds would be needed to contain winter flows and more agricultural land would be needed for disposal. This alternative also differs from partial land disposal in that the need to construct effluent polishing and disinfection facilities is eliminated.

Implementation of this alternative would require the modification and expansion of the facultative pond system as described under the first alternative (Existing System Expansion). Similar to the first alternative, additional deep storage ponds would need to be constructed. To contain the winter flows until land disposal could be achieved, approximately ten 40-acre (water surface area) ponds with 10-foot operating depths would be needed. Full implementation of this alternative would also require purchase of, or cooperative farming agreements for about 1,900 acres of contiguous land located within a mile of the existing plant site.

Alternative 4 - Activated Sludge Treatment

The construction of some type of mechanical wastewater treatment plant is an alternative to upgrading and expanding the existing pond system. This method of waste treatment would require less land but would demand significantly more energy and a more skilled operational staff.

To meet expected waste discharge requirements, two types of mechanical wastewater treatment plants were considered. The first type considered was a conventional activated sludge treatment plant. This type of plant can be designed to consistently meet 20/20 standards and, with filtration, can be expected to produce an effluent containing less than 10 mg/l each of BOD and total suspended solids.

To meet advanced secondary standards (less than 20 mg/l each of BOD and suspended solids), a plant equipped with more than the most basic equipment would be needed. For this analysis, it was assumed that the following liquid treatment unit processes would be provided: influent pumping, preliminary treatment to remove grit and large solid objects, primary clarification, secondary treatment (aeration basins with secondary clarifiers), disinfection, and effluent pumping. Further, it was assumed anaerobic digestion would be provided followed by sand drying beds with the ultimate disposal of dry solids in the landfill. If treatment to produce a final effluent containing less than 10 mg/l each of BOD and suspended solids is required, tertiary filtration would also be required.

Alternative 5 - Oxidation Ditch Treatment

An oxidation ditch treatment plant was the only other mechanical plant alternative considered. An oxidation ditch is a special type of activated sludge treatment which is generally cost competitive for flows in the range projected for Woodland. This type of plant would require fewer treatment components than Alternative 4 with somewhat lower capital costs at the expense of higher overall energy costs.

EVALUATION OF ALTERNATIVES

The alternative plans were evaluated with respect to cost (both capital cost and the longer term O&M costs), energy requirements, and reliability by present work analysis and goals. Consideration was also given to implementation (construction phasing).

COST ESTIMATES

To allow the evaluation of the economic consequences of the various alternatives, capital and O&M cost estimates were prepared and are summarized in Table 8-1. In this table the cost estimates have been shown with and without effluent filtration to illustrate its impact on project costs.

Also listed in this table are the respective capital and O&M costs for the different alternatives at expected discharge standards. Based on a review of water quality goals stated in the Sacramento-San Joaquin Delta Basin Plans, it was assumed that effluent filtration would be expected for any alternative which involved summer discharge of treated effluent (Alternatives 4 and 5). It was also assumed that filtration would be required for Alternative 1, Existing

Table 8-1
City of Woodland
Wastewater Facilities Master Plan

TREATMENT AND DISPOSAL ALTERNATIVES
COST SUMMARY[a]

Alternative	Discharge Period[b]	Discharge Flow (mgd)	Expanded Plant ($ Million)		Expanded Plant w/Filters ($ Million)		Cost at Expected Discharge Standards[c] ($ Million)	
			Capital Cost[d]	Annual O&M Cost[e]	Capital Cost[d]	Annual O&M Cost[e]	Capital Cost[d]	Annual O&M Cost[e]
Existing System Expansion	Winter	20	16.1	1.0	22.0	1.2	22.0	1.2
Aerated Lagoon with Dry-Season Land Disposal	Winter	10	18.4	0.9	22.2	1.0	18.4[f]	0.9
Complete Land Disposal	None	0	31.9	0.8	--	--	31.9	0.8
Activated Sludge Treatment	Annual	10	13.2	1.1	17.0	1.4	17.0	1.4
Oxidation Ditch Treatment	Annual	10	13.0	1.9	16.9	2.2	16.9	2.2

[a]All capital costs indexed to reflect April 1985 construction cost levels (ENR = 5100).
[b]Discharge to Tule Canal.
[c]Expected allowable discharge standards are 20 mg/l BOD and 20 mg/l suspended soilds in winter and 10 mg/l BOD and 10 mg/l suspended solids in summer, spring, and fall.
[d]Includes land cost for additional storage and disposal, as needed.
[e]Labor costs adjusted to an average rate of $25/hr, including fringe benefits. Material costs indexed to reflect April 1985 ENR material cost index = 1612. Power costs indexed to $0.085/kWh.
[f]Filters not required.

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System Expansion, due to the mass of BOD_5 and TSS, total suspended solids, which would be discharged at the high rate unless a lower concentration limit is imposed.

Effluent filtration was not assumed for Alternatives 2 and 3. With the implementation of Alternative 2, which would include dissolved air flotation clarification of the treated pond effluent to reduce the algae concentration, the increase in the mass of pollutants (measured as BOD_5 and TSS) discharged to the Tule Canal is assumed to be within an acceptable range. Alternative 3 would not discharge treated waste to the Tule Canal, thus, filtration would not be needed. Filtration would be needed, however, if the Regional and State Water Quality Control Boards decided that any increase in pollutant mass discharge was unacceptable or if the land application program was modified to irrigate crops not currently anticipated for the reuse program. These conditions are unlikely, however.

The cost estimates have been prepared for guidance in project evaluation and implementation from the information available at the time of the estimate. The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors as they occur. As a result, the final project costs could vary from the estimates presented herein. Because of this, project feasibility and funding needs must be carefully reviewed prior to making specific financial decisions to help ensure proper project evaluation and adequate funding. Appendix E presents tables with detailed cost estimate breakdowns for each alternative.

<u>Capital Costs</u>

The capital cost estimates include costs for construction, such as material and labor, and a 15-percent allowance for engineering, legal, and administrative costs. These estimates were derived by estimating the cost to construct treatment units using EPA cost curve values and indexing the numbers to approximate the April 1985 ENR index of 5100. Any land requirements for effluent disposal were obtained by purchase at $4,500 per acre. It should be recognized, however, that significant cost savings could be realized by obtaining a cooperative agreement with nearby farmers. Under a cooperative use agreement, the City would be allowed to construct improvements on the land, control the crops grown, and control the ratio of treated effluent to supplemental water used to grow the crops. The farmer would benefit from this type of arrangement through the use of free irrigation water provided to the site. The City would also benefit through a contractual arrangement for effluent disposal without entering into farming operations.

Although more difficult to arrange, this type of approach would eliminate the cost to purchase and maintain the land. This would save an estimated $4,700,000 for Alternative 2 and $8,600,000 for Alternative 3 in the initial cost for land acquisition. The land cost shown in Tables 8-1 and 8-2 includes additional land needed to construct the storage ponds. Given the potential savings if lease agreements can be negotiated, every effort should be made to lease the land, despite the difficulties inherent in property owner negotiations.

O&M Costs

Annual O&M costs, also presented in Table 8-1, include the cost of labor, chemicals, electric power, fuel, maintenance, parts, and treatment plant administration. Like the capital costs discussed above, the O&M costs were derived from EPA cost curves and indexed to represent current (April 1985) values. Labor costs were adjusted to an average rate of $25 per hour, which includes fringe benefits. Material costs were indexed to the April 1985 ENR materials cost index of 1612. Power costs were indexed to the current rate of $0.085/kWh.

Present Worth Analysis

The total life-cycle costs for the facilities (including annual O&M costs) are presented in Table 8-2. These costs are based on a typical 20-year planning period using the current federal discount rate of 8-3/8 percent.

As shown, the land disposal combined with winter discharge alternative has the lowest life-cycle cost. However, the activated sludge treatment plant alternative is cost competitive.

IMPLEMENTATION CONSIDERATIONS

The capital costs presented in the preceding section represent the total costs estimated to upgrade and expand the wastewater treatment plant to meet current and future needs expected through year 2020. However, by phasing the construction sequence, it may be possible to delay significant capital expenditures until future loadings require additional treatment capacity. Construction phasing also allows the opportunity to modify and revise the implementation plan at a future date. The following discusses implementation phasing considerations.

Table 8-2
City of Woodland
Wastewater Facilities Master Plan

TREATMENT AND DISPOSAL ALTERNATIVES
PRESENT WORTH COST SUMMARY

Alternative	Discharge Period[a]	Discharge Flow (mgd)	Expanded Plant Life Cycle Cost[b] ($ Million)	Expanded Plant with Filters Life Cycle Cost[b] ($ Million)	Life Cycle Cost at Expected Discharge Standards[c] ($ Million)
Existing System Expansion	Winter	20	25.7	33.5	33.5
Aerated Lagoon with Dry-Season Land Disposal	Winter	10	27.0	31.8	27.0
Complete Land Disposal	None	0	39.5	---	39.5
Activated Sludge Treatment	Annual	10	23.7	30.4	30.4
Oxidation Ditch Treatment	Annual	10	31.1	37.9	37.9

[a]Discharge to Tule Canal.

[b]Based on full initial construction and a 20-year planning period.

[c]Expected allowable discharge standards are 20 mg/l BOD and 20 mg/l suspended soilds in winter and 10 mg/l BOD and 10 mg/l suspended soilds in summer, spring, and fall.

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Existing Plant Expansion

The construction of a new raw sewage pump station, modification of the Strong and Erskine pond systems, and construction of new primary facultative ponds are common elements of Alternatives 1 through 3. Implementation of these elements could be accomplished with nominal impact on existing waste treatment needs by sequencing construction operations to provide new facilities before taking existing facilities out of operation for modification.

It would be possible to construct two or three new treatment ponds on the adjacent Conway property and put these ponds in operation before taking either the Strong or Erskine ponds out of service for modification. Similarly, modifications could be made to either the Strong or Erskine pond systems without taking the other pond series out of operation. Thus, initial expansion of the primary treatment system could be undertaken, since all of the land needed is owned by the City. Later construction of additional treatment ponds at the Conway site would allow for phasing of the total treatment needs.

The design of the pump station and effluent polishing system would be for construction in modules to allow for phased construction.

The storage ponds needed to implement this alternative could also be phased by initially constructing only those needed for current and near future needs. Because additional land would be needed for these ponds, the time required to acquire the property could temporarily delay the full implementation of the existing plant expansion alternative.

Aerated Lagoon with Dry-Season Land Disposal

As discussed previously, the modification of the treatment system could be accomplished by phased expansion. Phased construction of the effluent polishing system could also be accomplished by designing this element to be built in modules of appropriate size.

Phased implementation of the land disposal system may require some advance work and construction as part of the initial effort to install a pipeline which can handle future flows as well as current needs. It may also require negotiations with landowners now for future water disposal rights to ensure that the system can be expanded at the selected site as needed. Some phasing of the pumping equipment could be accomplished, but the pumping station structure will probably need to be sized for the future pump installation, negating most of the savings. Phasing of the land disposal distribution system and tailwater return system could be accomplished by installing these improvements only for lands needed for current and near-future use.

Complete Land Disposal

Phased implementation considerations for this alternative would be identical to those for the previous alternative, except that effluent disposal polishing system improvements would not be needed and the land disposal phasing considerations would be magnified due to the increased area required.

Activated Sludge Treatment

Phased implementation could be achieved by designing the unit processes for modular construction. However, because an entirely new plant would be needed, higher initial costs would be incurred to implement this alternative.

Oxidation Ditch

Due to the basic configuration and layout of an oxidation ditch type treatment plant, this alternative would be the most difficult to phase. Most of the facilities would need to be phased with the initial construction project, requiring a high initial investment.

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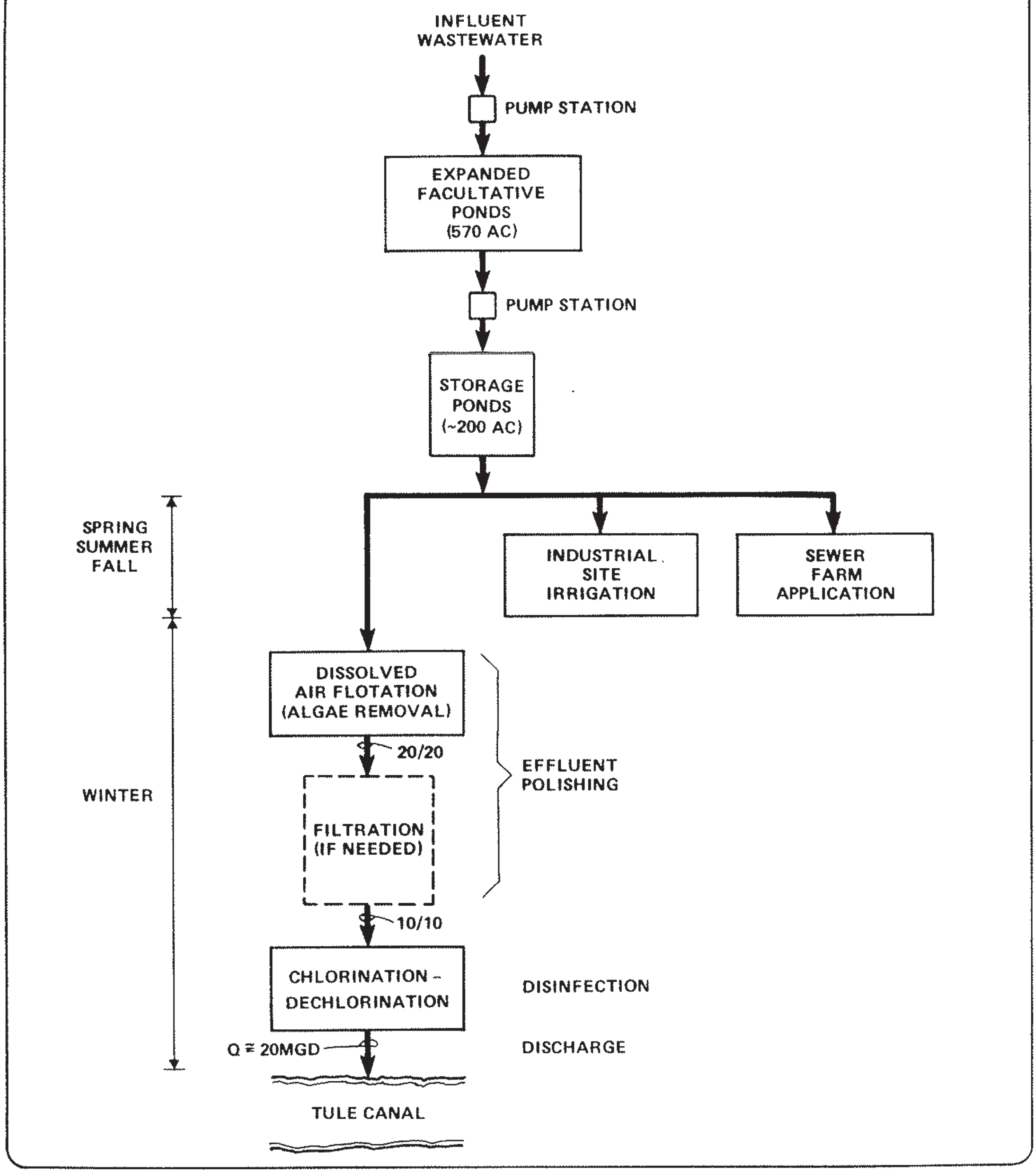

WASTE TREATMENT ALTERNATIVE 1
EXISTING SYSTEM EXPANSION

FIGURE 8 - 1

CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL

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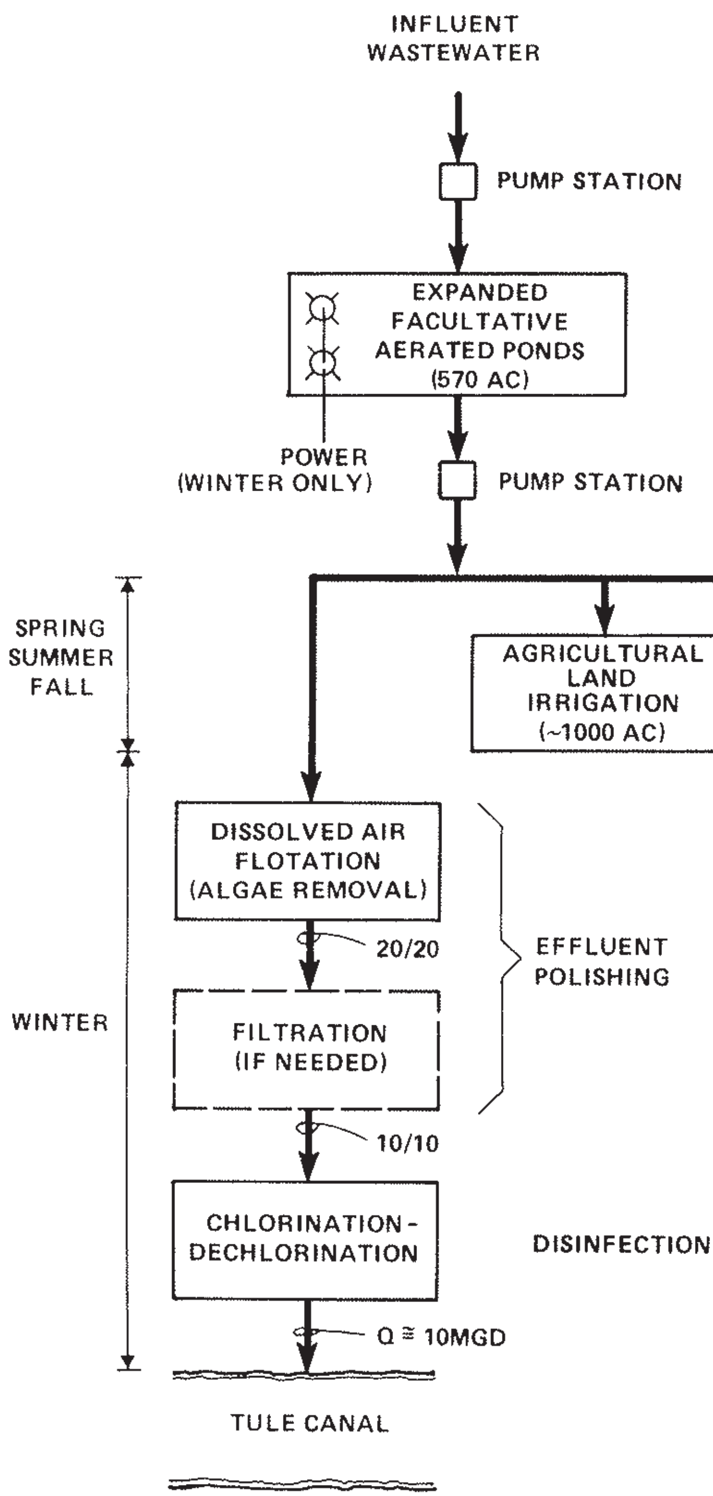
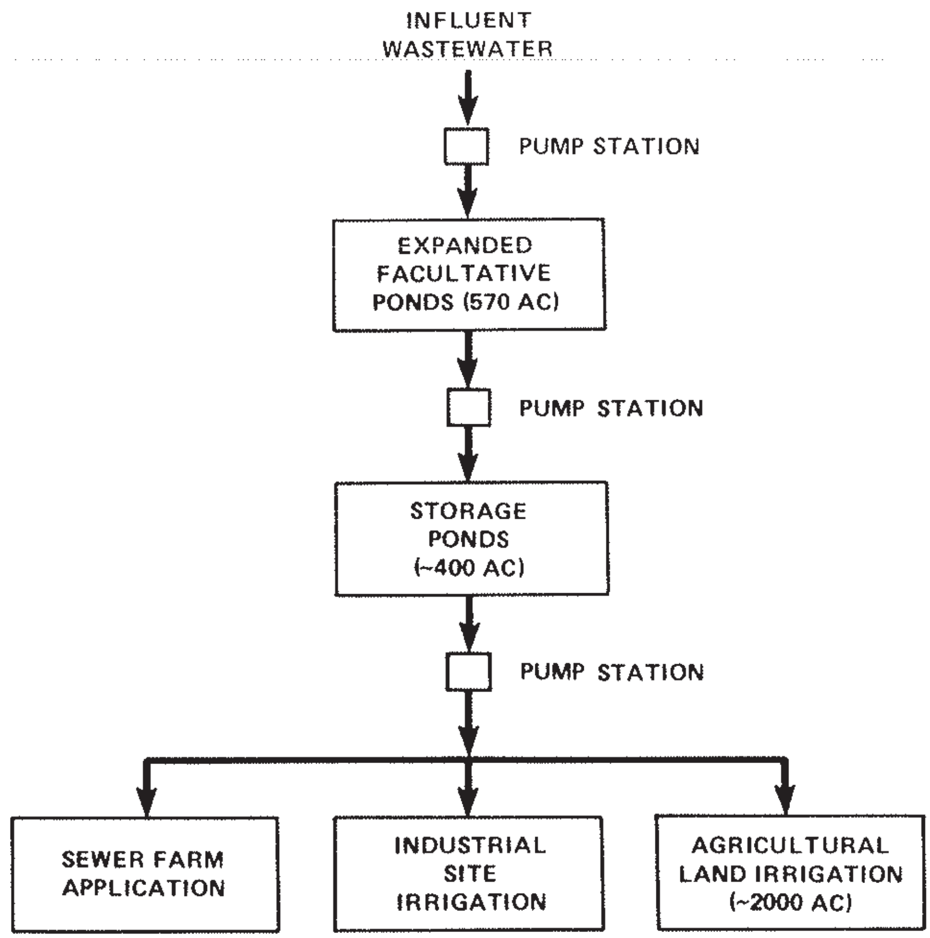


WASTE TREATMENT ALTERNATIVE 2
AERATED LAGOON WITH DRY-SEASON
LAND DISPOSAL

FIGURE 8 - 2

CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL



WASTE TREATMENT ALTERNATIVE 3
COMPLETE LAND DISPOSAL

FIGURE 8 - 3

CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL

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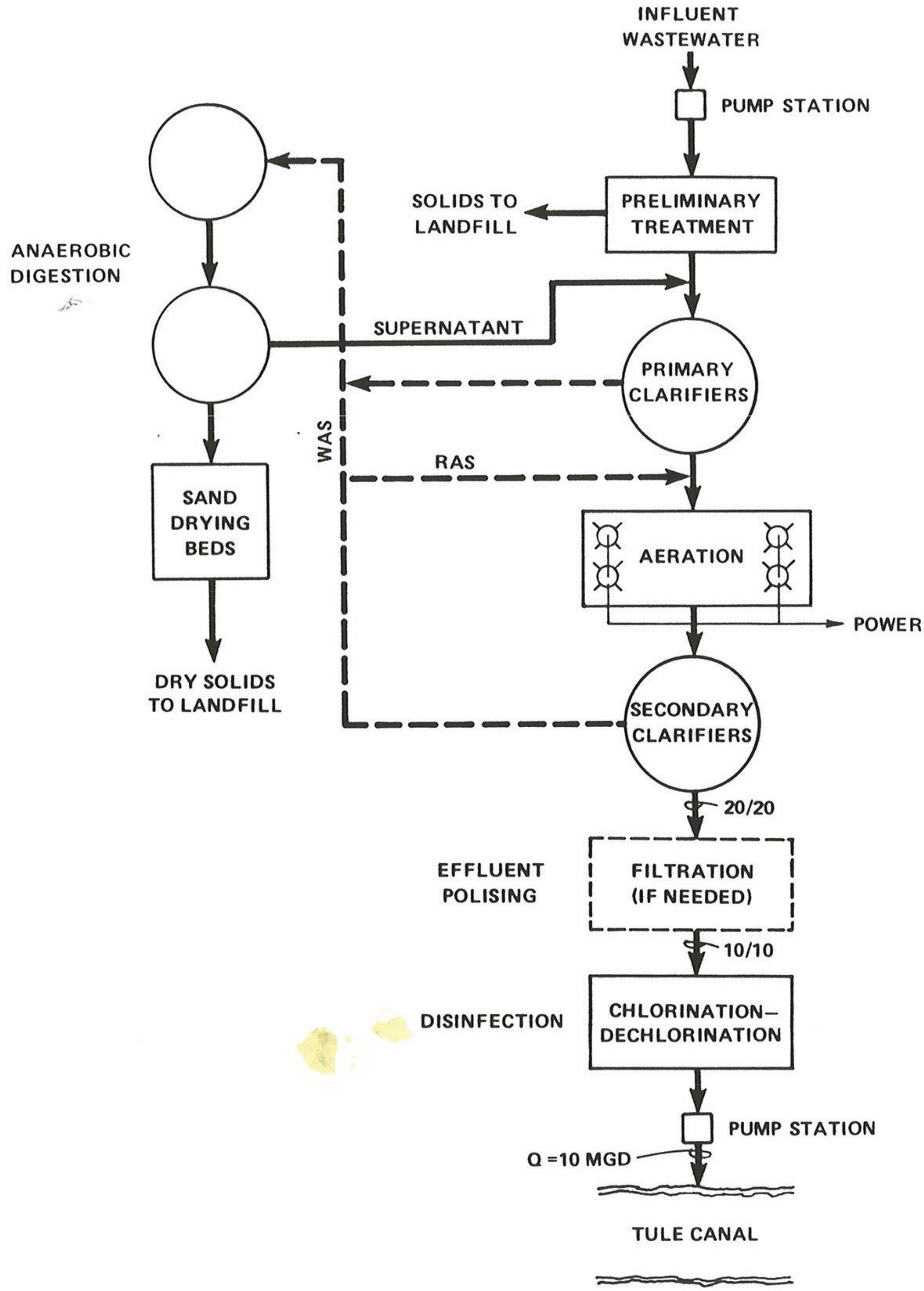


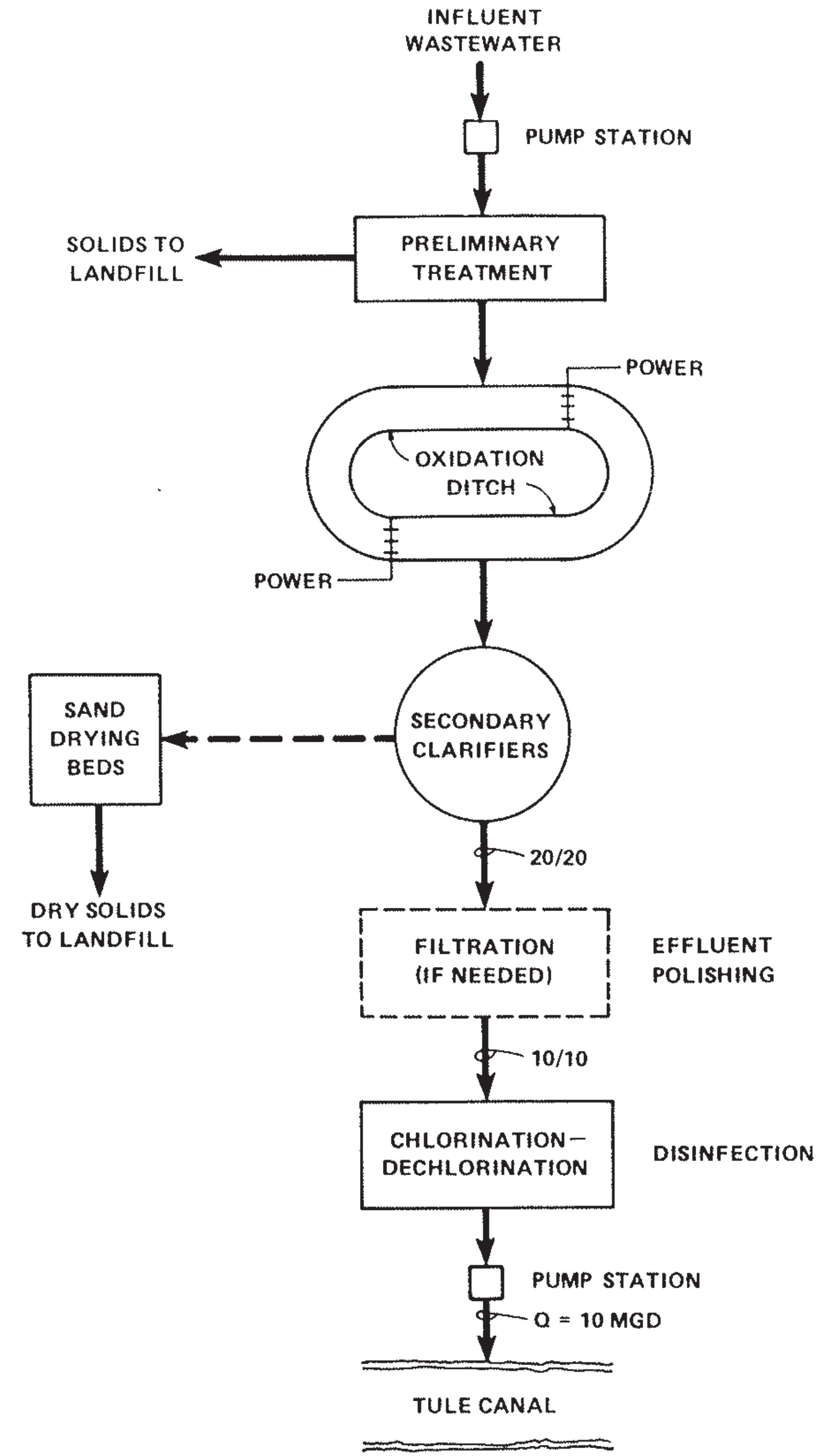
WASTE TREATMENT ALTERNATIVE 4
ACTIVATED SLUDGE TREATMENT

FIGURE 8 - 4

CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL

M19047.A0



WASTE TREATMENT ALTERNATIVE 5
OXIDATION DITCH TREATMENT

FIGURE 8 - 5

CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL

M19047.A0

CHAPTER 9
Recommended Plan

Chapter 9
RECOMMENDED PLAN

This chapter presents the recommended master plan for the wastewater collection system, pump station, and treatment and disposal improvements for the City of Woodland. The staged capital improvements program and cost estimate are presented for the proposed improvements; these improvements are recommended to relieve portions of the system with insufficient capacity under year 2020 PWWF conditions (2-year design storm). Recommendations are also presented for a collection system maintenance program.

PROPOSED SYSTEM IMPROVEMENTS

The proposed improvements to the wastewater collection, treatment and disposal systems are recommended to improve capacity and avoid overflows. SAM identified pipeline sections in the system with limited capacity and the preliminary corresponding solutions. SAM also provided flow information used as the basis of this plan. The recommended improvements have been developed for future peak sanitary flows expected during the year 2020, combined with peak I/I flows calculated for a 2-year design storm. These I/I flows do not include any reduction which could be achieved from a comprehensive rehabilitation program.

COLLECTION SYSTEM

The major collection system improvements include a program of 6,700 lf of parallel overflow pipe and 15,700 lf of new pipe or pipeline replacement. Pipe replacement is recommended for areas without sufficient capacity where the existing pipeline section is already a complicated parallel pipe arrangement or where the replacement pipe size recommended by SAM is roughly equivalent to the overflow pipe size. The recommended plan is shown in Figure 9-1, and a description of each project is summarized in Table 9-1. A further description of project staging is presented later in this chapter.

The improvements resulting from the system analysis by SAM were modified to develop the recommended plan. During the system analysis , SAM calculated required improvements for each individual pipeline section when the routed flow exceeded the pipeline capacity. For system continuity, all of the calculated improvements were evaluated together to avoid problems such as frequent pipeline diameter changes. Eventhough the capacities may be compatible because of different

Table 9-1
City of Woodland
Wastewater Facilities Master Plan

RECOMMENDED COLLECTION SYSTEM IMPROVEMENTS

Basin	Construction Stage[a]	Proposed System Improvements	Upstream/ Downstream Manholes	Design Flow[b] (mgd)	Estimated Cost[c]: Capital Cost ($)	Estimated Cost[c]: Incremental Maintenance Cost ($/yr)
B04	I	Replace 430 lf with 10-in pipe along Fourth Street	4-1-42/ 4-1-35	0.3	59,300	--
	I	Replace 305 lf with 15-in pipe along Fourth Street	4-1-35/ 4-1-27	0.5	63,400	--
B07	I	Install 435 lf of 15-in pipe along Fourth Street	2-7-37/ 2-7-27	0.9	90,480	650
	I	Replace 905 lf with 18-in pipe along Fourth Street to Grafton Street	2-7-27/ 2-7-10	1.5	205,888	1,400
B09	I	Replace 1,345 lf with 27-inch pipe along East Beamer Street	2-6-15/ 2-6-18	--	350,100	--
B10	I	Replace 3,210 lf with 30-in pipe along East Beamer Street	2-6-18/ 5-2-20	8.4	822,081	--
	I	Install 140 lf of 15-in bypass pipe along County Road 21 south of Beamer Street Treatment Plant	5-2-20/ 5-2-02	2.9	22,500	100
	I	Replace 1,355 lf with 33-in bypass pipe along East Beamer Street	5-2-25/ New Manhole	7.2	299,455	--
	I	Install 2,700 lf of 36-in pipe along Cache Creek Settling Basin levee	5-2-06/ 5-2-10	17.1	724,800	--
A04	II	Move and Expand Kentucky Avenue Lift Station	-	4.4	560,000	25,400
B06	II	Install 1,210 lf of 8-in overflow pipe along East Avenue	4-2-07/ 2-7-67	1.7	209,200	1,500
	II	Install 420 lf of 10-in overflow pipe along East Street to Court Street	2-7-67/ 2-7-53	1.8	76,440	550

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Table 9-1
(continued)

Basin	Construction Stage[a]	Proposed System Improvements	Upstream/ Downstream Manholes	Design Flow[b] (mgd)	Estimated Cost[c] Capital Cost ($)	Incremental Maintenance Cost ($/yr)
B08	II	Replace 1,215 lf with 21-in pipe along East Beamer Street	2-7-04/ 2-5-29	6.2	300,100	--
B09	II	Install 450 lf of 12-in overflow pipe along East Beamer Street	2-5-30/ 2-5-31	6.3	85,995	600
	II	Replace 1,750 lf with 15-in overflow pipe along East Beamer Street	2-5-31/ 2-6-10	7.3	364,000	2,550
B10	II	Install 25 lf of 36-inch to connect Northline to Southline	5-2-06/ New Manhole	9.13	6,143	--
	II	Install 1,569 lf of 24-in overflow pipe along County Road 103 line	5-2-10/ 5-2-11	19.0	307,995	2,400
	II[d]	Unusual construction conditions	5-2-10/ 5-2-11	---	26,000	--
	II	Install 1,335 lf of 30-in overflow pipe along County Road 103 line	5-2-11/ 5-2-12	19.4	301,977	2,800
	III	Replace 3,727 lf with 27-in pipe along East Beamer street	5-2-20/ 5-2-25	7.0	939,439	--
		TOTAL			5,815,293	37,950

[a]The construction stage refers to the time period when construction would occur, Stage I: 1985-1988, Stage II: 1989-1995, Stage II: 1996-2010.

[b]Design flows are indicated for year 2020 PWWF.

[c]Estimated costs were developed from unit cost data presented in Table 7-2 and include 30 percent for engineering, administration, and contingencies. Incremental maintenance costs are based on the full-scale program presented in Chapter 10, not inlcuding cyclic replacement.

[d]Costs for unusual construction represent additional costs only.

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slopes, pipeline diameters for required improvements were selected to minimize discontinuity and to simplify construction. Also, if the existing capacity was exceeded by only a small amount, (less than 10 percent) an improvement has not been indicated. Although minor surcharge may occur during peak flow conditions, an overflow would not occur.

As shown in Figure 7-1, the majority of improvements to existing pipelines are required to accommodate flows due to existing PWWF conditions and would be required even without growth. In Basin B10 the construction of a 15-inch bypass pipe from manhole 5-2-20 to manhole 5-2-02 is recommended to divert flow from the existing 24-inch line to the parallel 30-inch line which has excess capacity. However, to provide capacity for future flow conditions, the 24-inch line should be replaced by 27- and 33-inch pipe sections.

One area of sewer pipeline is currently outside the urban limit line in the Cache Creek Settling Basin. Rather than providing overflow or replacement pipelines in the same area, construction of a single replacement pipeline on the southwest side of the levee was found to be more cost-effective. The potential for groundwater infiltration into the pipeline will be reduced, allowing the City to abandon approximately 5,200 lf of pipe in the Cache Creek Settling Basin.

KENTUCKY AVENUE LIFT STATION

The results of an analysis of the existing Kentucky Avenue Lift Station have shown that capacity is insufficient for future PWWF. There are currently two pumps at the lift station, each driven by a 16-horsepower, 1175-rpm motor. The total peak flow to be pumped was evaluated for present (1985) and future (2020) PWWF and compared with the lift station capacity. Lift station capacity was evaluated using the system/pump curve relationships shown in Figure 9-2.

The system curves were prepared by plotting total flow versus headloss, or pressure in the forcemain. The pump curves include allowances for local friction losses at the lift station. Three pump curves were prepared to analyze the station capacity with one, two, or three pumps operating, each with a 16-horsepower motor. In addition, a curve showing the effect of increasing the motor and impeller sizes for the third pump was prepared. The existing pump lift configuration allows for only two pumps. The lift station operating capacity was determined for each of the various alternative configurations at the intersection of the system curve with the pump curve.

The existing lift station capacity is approximately 2.9 mgd, which is sufficient to handle the 1985 design PWWF of

1.6 mgd. The design PWWF projected for year 2020, however, is 4.4 mgd or approximately 150 percent of the current capacity. The cost required to expand the lift station capacity would include a new pump and motor, as well as remodeling to make room for the additional pump.

The Kentucky Avenue lift station is located at the Beamer Street Primary plant which is to be abandoned. It is preferred, therefore, to move the station from the center of the property to the southwest corner (on Beamer Street). An analysis was conducted to determine the least costly alternative between relocating the lift station, or abandoning the station and deepening the trunk sewers downstream to the Waste Water Treatment Plant.

The results of the cost analysis indicate that relocation of the lift station would cost approximately $560,000 (salvage of existing equipment was not considered) plus a present worth of the annual operation and maintenance costs of $250,000 for a total of $810,000. The differential cost of improvements to the trunk sewers without the lift station was approximately $890,000. The alternative of relocating the Kentucky Avenue Lift Station was selected.

TREATMENT AND DISPOSAL SYSTEM

From the alternative discussion and evaluation presented in Chapter 8, Alternative 2, Aeration Lagoon with Dry Season Land Disposal was selected as the recommended plan for improving and expanding the treatment and disposal system. The major components of this plan include modifications to the existing pond system, new facultative ponds, mechanical surface aeration, pump station, modification and installation, disinfection, effluent polishing by dissolved air flotation, and facilities for land disposal. These facilities (modifications and installations) are presented in Table 9-2 and Figure 9-3. The total plant capacity would be increased to approximately 10.6 mgd. A discussion on implementation stages is presented later in this chapter.

This selected alternative would require a significant amount of agricultural land for effluent disposal during the period between March and October. It may be possible that the City could negotiate for cooperative use agreements with interested farmers owning land near the existing plant site. However, because this type of agreement could be difficult to arrange, the purchase of land may be necessary.

Modification to Existing Pond System

The existing pond system would be upgraded and expanded by conversion of the Phase II ponds from a polishing capability into waste treatment. The Strong and Erskine ponds would

Table 9-2
City of Woodland
Wastewater Facilities Master Plan

TREATMENT AND DISPOSAL FACILITIES
IMPLEMENTATION STAGING

Construction Stage	Rated Capacity (mgd)	Description
I 1985-1988	6.3	o Modification Existing Pond System o New 40 Acre Pond o New Influent Pump Station o Mechanical Surface Aeration o First Module of DAF o Effluent Disinfection o New Effluent Pump Station o Land Application Facilities and Site Improvements
II 1989-1995	8.0	o Expansion of Influent Pump Station o Three New 40 Acre Ponds o Increase of Hydraulic Capacity - DAF - Disinfection - Effluent Pumping - Land Application Facilities
III 1996-2010	10.6	o Expansion of Influent Pump Station o Three New 40 Acre Ponds o Increase of Hydraulic Capacity - DAF - Disinfection - Effluent Pumping - Land Application Facilities

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be converted from the 22 existing ponds into 5 large rectangular ponds of approximately 40 acres each. In addition to these conversions, the berms of each pond would be reshaped to increase the height. The purpose would be to allow gravity flow through all ponds without the need for intermediate pumping. A new 40-acre pond will be constructed to the south of the Phase II ponds.

New Facultative Ponds

On the Conway site, to the east of the existing Phase II ponds, 5 additional facultative ponds would be constructed. These new ponds would be rectangular with a surface area of approximately 40 acres, each similar to the converted existing pond system.

Mechanical Surface Aeration

During the winter season, operation of the system would be modified to include supplemental aeration. The influent flows would be treated in a portion of the total pond system with the remainder used primarily for settling prior to discharge. Treatment within the first portions of the pond system would be possible with the installation of mechanical surface aeration.

Pump Stations

To handle the increased flows and flow routing, new pump stations would be required. Influent pumping would be necessary to overcome the increased water surface levels. New pumping capacity would also be required for discharge to either the Tule Canal or land disposal.

Disinfection

After reconstruction of the existing Phase II ponds, additional facilities would be required for disinfection. A new pond would be provided for disinfection by chlorination.

Dissolved Air Flotation

New DAF units would be constructed for use during the winter season for removal of suspended solids, including algae, prior to discharge. The DAF units operate by injecting air into the pressurized influent. After pressure release, the entrained air comes out of solution as fine bubbles which attach to suspended solids, floating them to the surface. Rotating skimmers remove the float for recycle to the influent flow. Effluent from the DAF unit should at this point then meet the winter effluent discharge requirements.

Land Disposal

For the period between April through October when discharge to the Tule Canal is not allowed, the effluent would be pumped to nearby agricultural land for disposal. For the recommended plan, approximately 1,050 acres would be required. The land disposal facilities include a piping and distribution system, as necessary for coverage of the entire area. A tailwater return system would also be required. Flexibility would be built in to allow for routing the water to specific areas, depending on the application rates.

PROJECT COST

Preliminary cost estimates for construction and increased annual maintenance were developed for the recommended plan using the unit costs and criteria presented in Chapters 7 and 8. All costs were estimated based on ENR 5100, which corresponds to April 1985. Prior to design and construction, these costs should be reviewed and updated as necessary to reflect changes in the ENR index.

Cost estimates for the individual projects of the recommended collection system improvements are presented in Table 9-1 and Table 9-3. The capital costs excluding land acquisition include an allowance of 30 percent for engineering, administration, and contingencies. Maintenance provides for increased costs because of additional pipeline. Although the maintenance costs are calculated to increase as a percentage of the increased pipe length, the actual costs may decrease slightly because of the existing problems of surcharge and overflow which would be eliminated.

STAGED CAPITAL IMPROVEMENT PLAN

Utilizing the recommended improvements described in the previous sections, a staged construction schedule has been developed. The schedule is divided into three stages based on the relative degree of restricted capacity and expected growth potential upstream. Stage I, representing the most critical areas, should be completed by 1988. Stages II and III are for new developments and are scheduled for completion by 1995 and 2010, respectively. The total cost for each stage is summarized in Table 9-4. Collection system and treatment disposal system improvements scheduled within each stage are presented in the following sections.

This master plan is intended to be used as a flexible working program by the City to incorporate planned developments and peak design I/I levels. The staged construction schedule

Table 9-3
City of Woodland
Wastewater Faclilties Master Plan

RECOMMENDED TREATMENT AND DISPOSAL

Facility	Estimated Cost ($ Million)[a]
Modification to Existing Pond System	$ 0.6
New Facultative Ponds	2.8
Mechanical Surface Aeration	0.5
Pump Stations	3.2
Disinfection	0.7
Dissolved Air Flotation	1.3
Land Disposal (1,050 acres ±)	4.6
Land Cost	4.7
Total Cost	$18.4

[a]Estimated capital cost indexed to April 1985 (ENR 5100).

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Table 9-4
City of Woodland
Wastewater Facilities Plan

STAGED IMPROVEMENTS COST SUMMARY

		Estimated Capital Cost ($1,000)			Estimated Maintenance Cost Increase ($1,000/yr)		
Stage	Collection Period	Collection	Treatment & Disposal	Total	Collection	Treatment & Disposal	Total
I	1985-1988	2,638	11,420	14,058	2.1	558.0	560.1
II	1989-1995	2,238	2,850	5,088	35.8	138.0	173.8
III	1996-2010	939	4,130	5,069	0	204.0	204.0
		5,815	18,400	24,215	37.9	900.0	937.9

[a]ENR 5100, April 1985

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allows program implementation to be in order of priority in a logical sequence. Each stage is compatible with and expands the stage previously completed. Periodically, this master plan should be reviewed and updated to evaluate actual development and to adjust land use assumptions in Chapter 4. Future changes in the City's development policy could be easily incorporated into Stages II or III.

COLLECTION SYSTEM

Improvements for Stage I, presented in Table 9-1, include pipeline construction in areas where the existing pipeline capacity is significantly less than the 1985 PWWF. This stage also includes construction of a bypass pipeline to bypass pipelines outside the urban limit line in Basin B10.

Stage II improvements include projects to alleviate capacity problems due to existing PWWF, as well as some projects required for future development. Stage III consists of all remaining projects.

TREATMENT AND DISPOSAL SYSTEM

Implementation of the recommended plan improvements for the treatment plant and disposal system has also been scheduled into three stages which correspond to the collection implementation. Table 9-2 summarizes the treatment and disposal projects for each stage. Stage I provides for plant performance improvement and capacity expansion from 3.8 mgd to 6.3 mgd. These improvements include modifications to the existing pond system, a new 40 acre pond to the south, an influent pump station, mechanical surface aeration, the first module of DAF, effluent disinfection and pumping, and facilities for land application.

For immediate improvements to meet the requirements set by the Regional Board, the DAF unit would be constructed first. The sequencing of the remaining improvements is not as critical, because existing flows are within the rated 3.8 mgd capacity.

Stages II and III improvements include incremental expansion of the pond system pump stations, DAF, disinfection, and land application facilities to meet the required capacities of 8.0 and 10.6, respectively. The expected average flow for future growth through year 2020 is 10.6 mgd.

RECOMMENDED COLLECTION SYSTEM MAINTENANCE PROGRAM

This section describes a suggested maintenance program necessary to maintain a wastewater collection system at an acceptable level and use available funds most efficiently.

An effective maintenance program will help reduce the number of problems and citizen complaints and also potentially reduce the number of emergency repairs required, reducing the City's liability.

This program consists of routine maintenance, testing and inspection for I/I detection, cyclic pipeline replacement, and data management.

ROUTINE MAINTENANCE

A routine program for maintenance provides for systematic cleaning, root control, and television (TV) inspection within the collection system. These activities should keep the system flowing at maximum levels. Problems associated with restricted capacity due to accumulated material and roots include overflows, flooding, corrosion, and odors. The entire system would be cleaned at least every one or two years with root control performed as necessary. Areas with a history of frequent problems should be scheduled for cleaning as often as appropriate.

Routine TV inspection would be used to observe and document pipelines which may require prompt attention because of structural defects, root intrusion, etc. TV inspection is discussed further in the following section. Repair and replacement of detected structural problems would be part of the routine maintenance.

TESTING AND INSPECTION FOR I/I DETECTION

The four major testing and inspection procedures are smoke testing, manhole inspection, flow isolation, and TV inspection. All of these procedures should be applied to the entire collection system every 10 years. Flow isolation, TV and manhole inspection would be conducted during periods of high groundwater for optimum infiltration detection.

Smoke testing is a procedure where smoke is forced into a pipeline section using an air blower. The smoke surfaces through pipeline connections and defects. This technique is used to detect inflow sources and infiltration sources located close to the ground surface. These sources include downspouts, yard and area drains, catch basin connections, and defective laterals.

Manhole inspection would be used to observe physical characteristics of the manhole and, as necessary, the inlet and outlet sewers. Information including dimensions, construction materials, structural conditions, and presence of infiltration is noted. This technique is useful in conjunction with TV inspection as a complete evaluation of the collection system.

During flow isolation, flows are measured in the sewer at key manholes. The procedure is conducted during the early morning when actual wastewater flows are minimal and the measured flow is mostly infiltration. Each isolated pipe section could then be characterized by rate of infiltration and listed in order of priority for later TV inspection and rehabilitation.

TV inspection would be used to detect infiltration into the sewer pipe through pipe defects and open or broken joints. During the wet weather season, when groundwater is high, TV inspection for infiltration detection would be combined with routine inspection in the areas identified by flow isolation as possibly contributing significant infiltration.

Any I/I sources located during this phase would be documented for rehabilitation work. A continuous rehabilitation program should be implemented for ongoing correction work. If the rehabilitation work is performed promptly, then the I/I should be maintained at acceptable levels (approximately 600 gallons per day per sewered acre).

CYCLIC PIPELINE REPLACEMENT

Based on a review of many existing systems, the useful life of a sewer pipeline is estimated to be about 100 years. This is increased from the typical 40- to 70-year life by assuming proper maintenance, including periodic cleaning, testing, inspection, and rehabilitative work would be performed to maintain structural integrity and to control I/I within the system. The 100-year life is an average figure and it is expected that specific pipes would deviate from this average to some degree. The routine inspection program would be utilized to determine the most appropriate time for replacement. Using this 100-year average figure, a cyclic replacement program would replace about one percent of the system each year. Replacement of sewers should be scheduled as part of street reconstruction projects as much as possible.

DATA MANAGEMENT

An effective and successful maintenance program requires that accurate records of each activity be stored for use in analyzing costs and the conditions of the existing collection system. This data can then be used as a planning tool to determine annual maintenance budgets, equipment requirements, and personnel needs. The City would be able to determine problem areas which may require work other than that under the routine programs. This data can also be used to identify and prioritize sections of the collection system for proper maintenance activities.

Maintaining an accurate sewer system inventory, tracking maintenance activities, and scheduling routine maintenance on a sewer collection system can be easily implemented on a microcomputer. System inventory would include pipe length, diameter, invert and manhole rim elevations, material, manhole number, date of construction, number of laterals, etc.

When developing a maintenance management system, the voluminous amount of information describing the wastewater collection system is organized and entered into a computer database. The database is an inventory of the system; it provides for updating of the collection system records, and is the foundation for documenting and scheduling the routine maintenance activities, I/I testing and inspection, and cyclic replacement. Once the database is established, computer modelling activities, including SAM, can later be performed on the system. SAM could be used by the City as necessary to update the flow information used in the preparation of this master plan.

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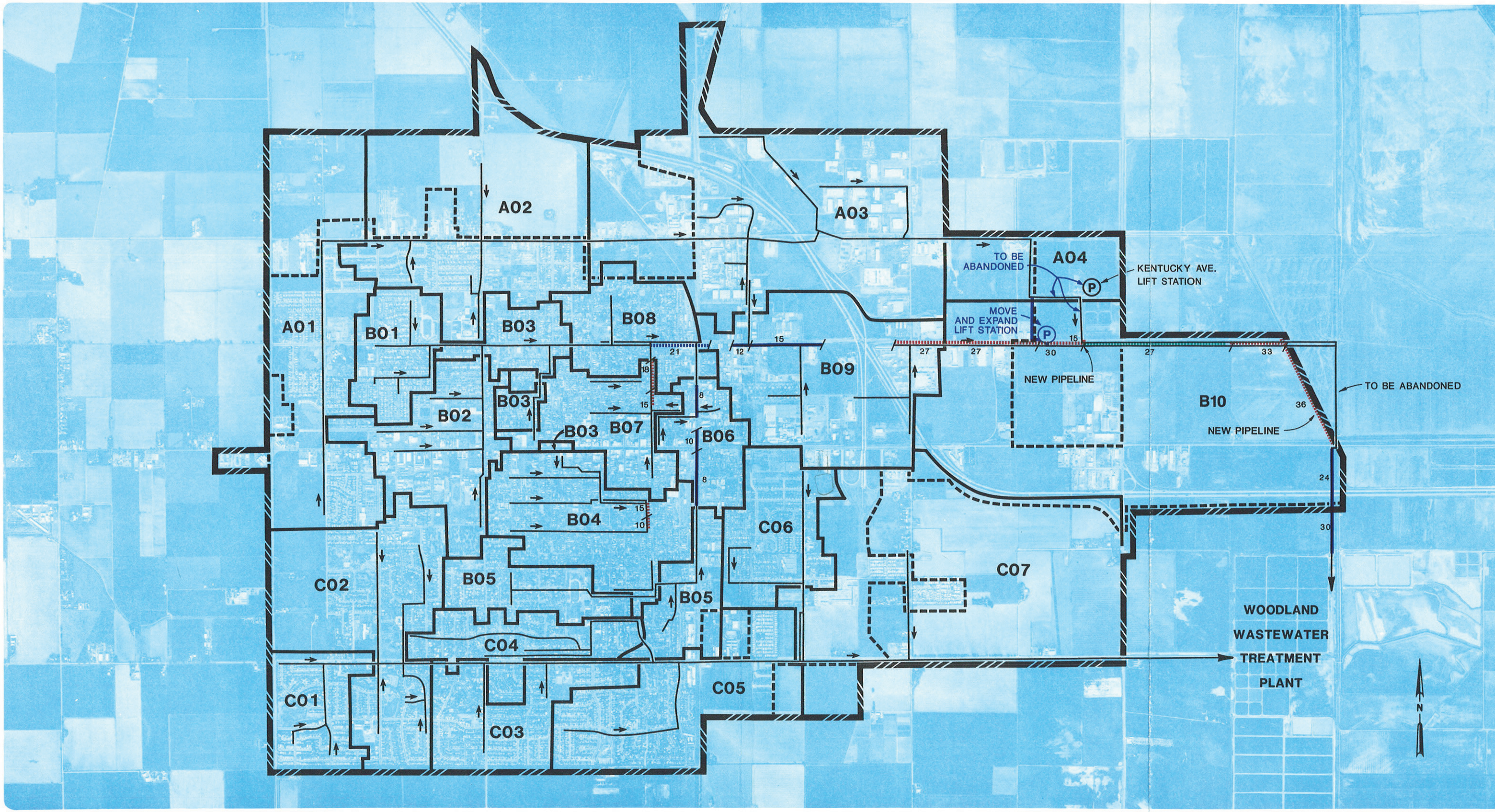


LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- A01 BASIN IDENTIFICATION
- MAIN SEWER LINE
- DIRECTION OF FLOW
- 10 PIPELINE SIZE (IN.)
- (P) PUMP STATION
- } STAGE I IMPROVEMENTS
- } STAGE II IMPROVEMENTS
- } STAGE III IMPROVEMENTS

NOTE: SOLID LINES INDICATE PARALLEL PIPELINE. DASHED LINES INDICATE PIPELINE REPLACEMENT OR NEW CONSTRUCTION.

VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING.

0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1" = 1200'

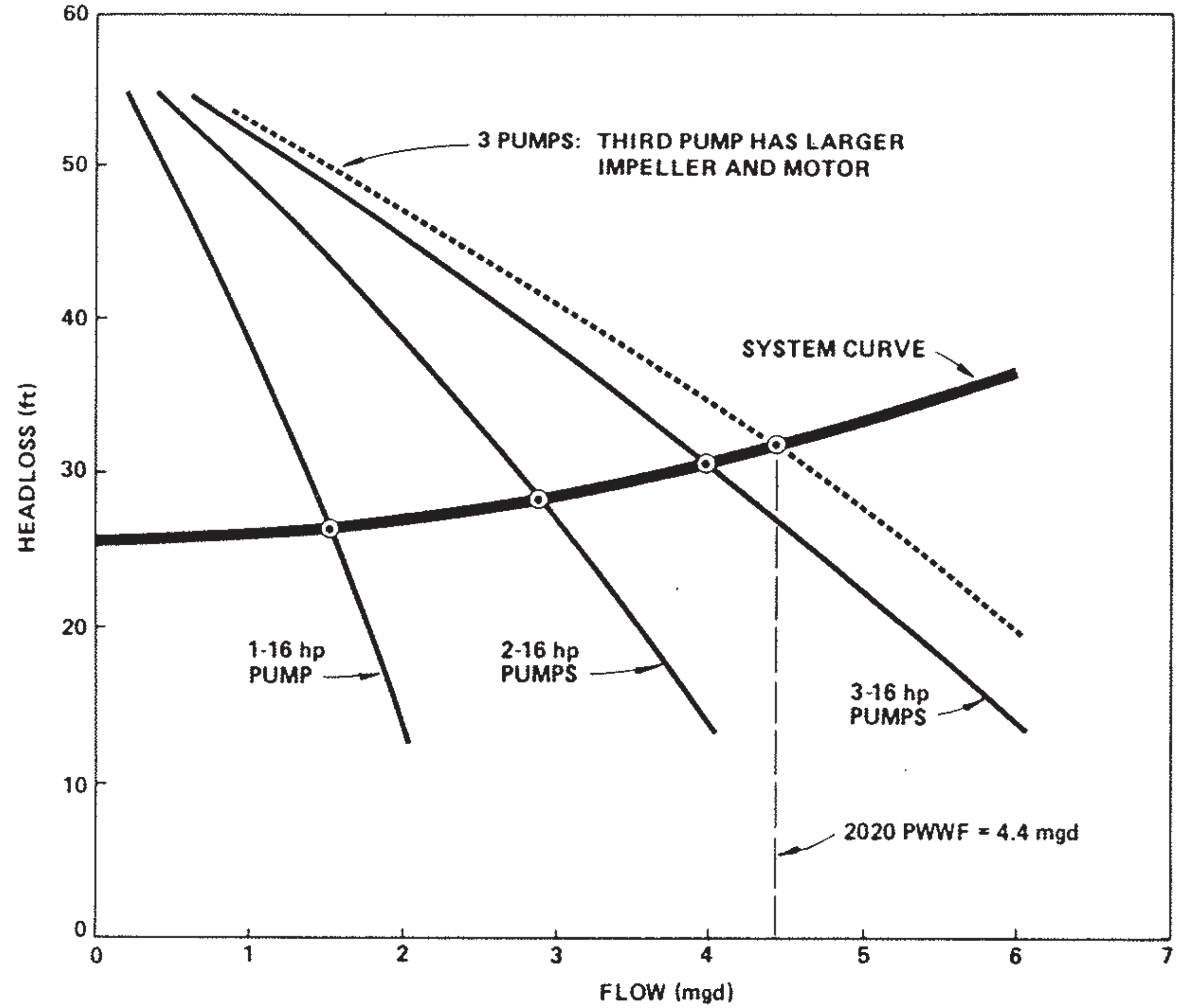
RECOMMENDED PLAN – COLLECTION SYSTEM

FIGURE 9-1

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

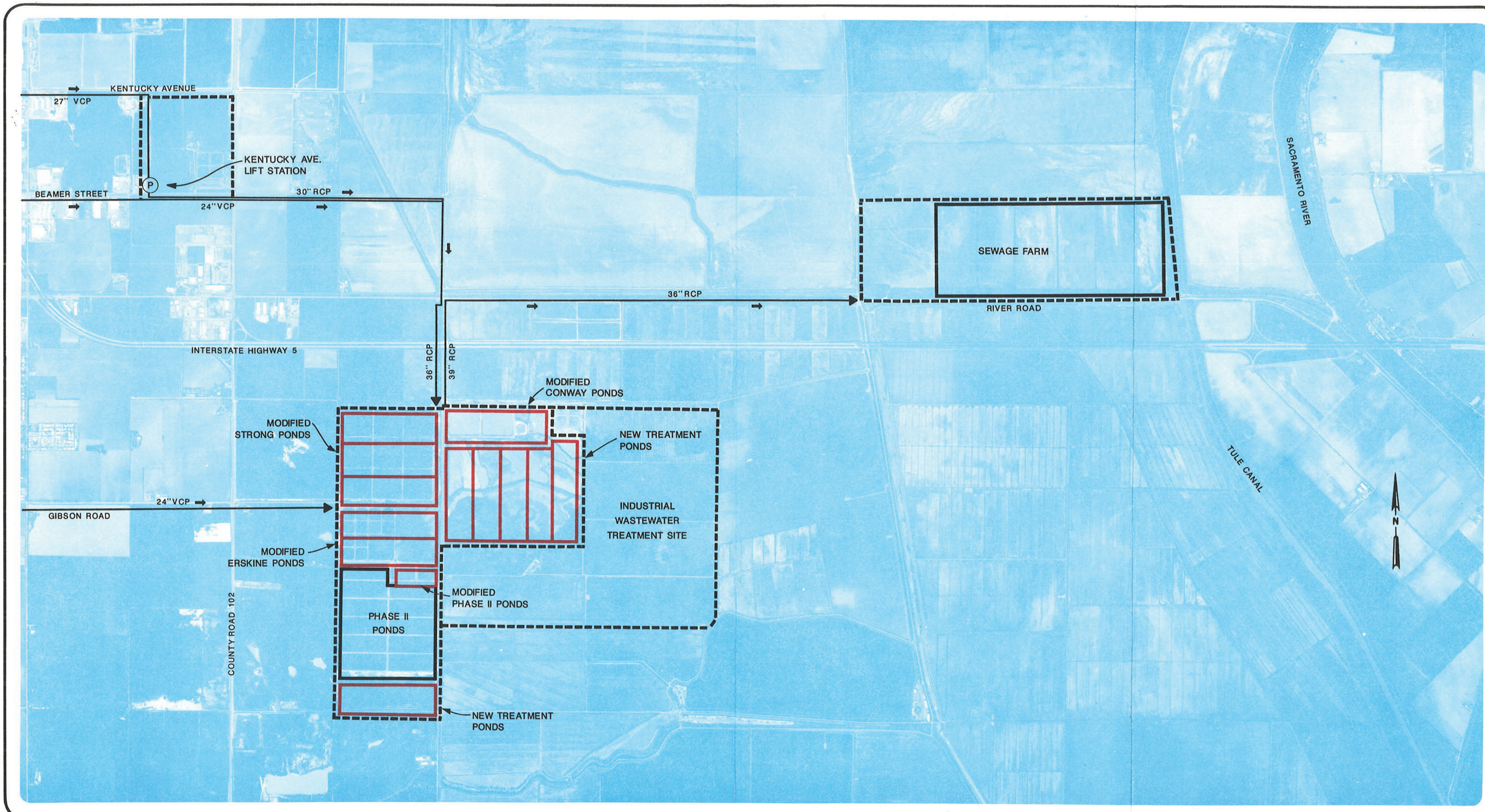


SYSTEM PUMP CURVES
KENTUCKY AVENUE LIFT STATION

FIGURE 9 - 2

CITY OF WOODLAND
WASTEWATER FACILITIES
MASTER PLAN

CH2M HILL



LEGEND:

- PROPERTY LINE
- SEWER
- EXISTING FACILITIES
- (P) PUMP STATION
- RECOMMENDED TREATMENT FACILITY IMPROVEMENTS

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING.
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APPROXIMATE SCALE: 1" = 1200'

RECOMMENDED PLAN – TREATMENT FACILITIES

FIGURE 9 – 3
CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

CH2M HILL

CHAPTER 10
Financial Analysis

Chapter 10
FINANCIAL ANALYSIS

To plan the implementation of the recommended City of Woodland wastewater facility improvements described in Chapter 9, a financial analysis has been prepared. This chapter presents cost allocation between existing and future users, financing alternatives, existing financial conditions, potential financing scenarios, and finally, steps for implementation.

ALLOCATION OF COSTS

The costs of both the collection system and treatment and disposal system improvements can be allocated into costs that should be paid by existing users (to upgrade the existing system) and those that should be paid by new users (for additional capacity). The relative proportion of costs allocated to existing versus new users affects the financing of these improvements.

COLLECTION SYSTEM COSTS

Table 10-1 summarizes the collection system capital costs that are allocated to existing users (upgrade) and new users (for system expansion). This table shows that short-term improvements (Stage I of construction) are allocated approximately two-thirds (62 percent) to existing users, with intermediate-term improvements (Stage II of construction) 90 percent allocated to new users, and long-term improvements (Stage III of construction) approximately 40 percent allocated to existing users.

Table 10-1
City of Woodland
Wastewater Facilities Master Plan

ALLOCATION OF COLLECTION SYSTEM COSTS[a]

	Construction Stage			
	Stage I 1985-1988	Stage II 1989-1995	Stage III 1996-2010	Total
Existing Users	$1,648,770	$ 230,850	$575,500	$2,455,120
New Users	989,230	2,007,150	363,500	3,359,880
Total	$2,638,000	$2,238,000	$939,000	$5,815,000

[a]ENR 5100 (April 1985)

Costs were allocated between upgrade and expansion by comparing system improvement costs to handle the PWWF for a 2-year storm event in 1986 and the PWWF for a 2-year storm at build-out. The 1986 costs were allocated to upgrade while the build-out costs were allocated to expansion. Costs were allocated among user classes (such as residential versus commercial) based on peak flow capacity.

It was also assumed that construction occurs uniformly within each stage of construction voted in Table 10-1.

Costs were allocated between upgrade and expansion by comparing system improvement costs for a 2-year storm event in 1985 and the PWWF for 2-year storm event at build-out. The 1986 costs were allocated to upgrade while the build-out costs were allocated to expansion. Costs were allocated among user classes (for example, residential versus commercial) based on peak flow capacity.

It was assumed that construction occurs uniformly within each stage of construction.

TREATMENT AND DISPOSAL COSTS

The allocation of treatment and disposal costs between existing and future users was made by assigning costs for upgrading the treatment and disposal system to existing users. Upgrade refers to improving the existing treatment capability to comply with discharge regulations. All expansion costs were assigned to new users. These costs are detailed in Table 10-2. Because these improvements cannot be phased uniformly over time like collection system improvements, costs for treatment and disposal improvements are shown by the year of anticipated construction.

Table 10-2
City of Woodland
Wastewater Facilities Master Plan

ALLOCATION OF TREATMENT AND DISPOSAL COSTS[a]

	1986	1995	2005	Total
Upgrade	$ 7,160,000	$ 0	$ 0	$ 7,160,000
Expansion	4,260,000	2,850,000	4,130,000	11,240,000
TOTAL	$11,420,000	$2,850,000	$4,130,000	$18,400,000

[a]ENR 5100 (April 1985)

Treatment and disposal costs were further allocated to loading parameters. For the upgrade, costs were allocated 85 percent to flow, 10 percent to BOD, and 5 percent to suspended solids. For the expansion, costs were allocated 52 percent to flow, 46 percent to BOD, and 2 percent to suspended solids. Calculations for the allocation of upgrade and expansion improvements are shown in Table 10-6. The percentage allocations were developed based on a cost-weighted coverage along with the treatment fuction of the treatment components. For example, the purpose of a pump station is exclusively flow-related. Therefore, the cost of the pump station is allocated 100 percent to flow. The cost of treatment plant components are allocated to flow, BOD, and suspended solids depending on the proportion of each of these parameters they treat.

FINANCING ALTERNATIVES

Financing capital projects may be accomplished by a variety of methods ranging from full pay-as-you-go to total financing with long-term debt. This section discusses four financing alternatives: pay-as-you-go, revenue bonds, assessment bonds, and a combination of pay-as-you-go and bonds.

Pay-as-you-go is a method more feasible and appropriate for smaller, less expensive facilities such as pipelines because it avoids debt service costs. The pay-as-you-go method is often used in combination with revenue bond financing. In this case, revenue accumulated through connection and other fees is typically used to pay preliminary planning and design work. The construction of the facility is then financed through a revenue bond issue.

Revenue bonds are more commonly used in financing larger facilities. With revenue bonds, capital costs are repaid over a period of time. Because of this, revenue bonds that are repaid from service charges involve repayment by both existing and new users.

Revenue bond issues are subject to interest rate limitations set by the State. Recently revised, the current limit on revenue bond interest rates is 12 percent, although the bond can be sold at a discount to raise the effective interest rate to the buyers.

With revenue bonds, fees (revenues) are set at a level sufficient to cover interest and principal payments plus a reserve fund to assure bond buyers that the funds necessary for repayment of the bond will be available. The total of these fees, collectively referred to as coverage, is usually between 1.25 and 1.4 times the actual amount needed to make principal and interest payments.

It was assumed that the treatment and disposal improvements were not likely to be funded by grant funding and therefore this alternative was not evaluated herein.

Assessment bonds are also commonly used to raise capital by forming a special assessment district, the members of which agree to pay an assessment (usually on an annual basis) for specific benefits they will receive. The bond is ultimately secured by liens on property parcels in the assessment district. If assessment bonds are used to finance improvements, the City would avoid the financing of these facilities.

The following lists the major advantages and disadvantages for the three financing alternatives described above, as well as for combining the alternatives.

PAY-AS-YOU-GO

Advantages:

- Costs paid by users creating demand for the service.
- No financing costs for the City.
- Funds for capital construction on hand.
- Easy to administer.
- No sewer cost advantage of one geographic area over another area.
- User fee principle consistent with State Construction limitations.
- Easily understood by the public.

Disadvantages:

- Sufficient funds may not be available at the time needed.
- May cause acceptability problems if large amounts are on hand for capital construction and operating fees require increase.
- Does not take advantage of inflation reducing the purchasing value of money.
- Is not equitable to the extent costs of service vary by service area.

REVENUE BOND

Advantages:

- o No geographic area has a sewer cost advantage over another.

Disadvantages:

- o All users pay whether they contribute to the need for new facilities or not.
- o Interest is costly.
- o Inequitable to the extent costs of service vary by service area.

ASSESSMENT BONDS

Advantages:

- o No financing costs for City.
- o Closer relationship between demand for service and cost than under revenue bond policy.

Disadvantages:

- o Politically difficult to fairly allocate costs to benefits received.
- o City needs to monitor construction.

COMBINATION POLICY

Advantages:

- o Lower connection fees than pay-as-you-go.
- o Lower service charges than 100 percent revenue bond financing.
- o Closer relationship between demand for service and cost than with 100 percent revenue bond financing.
- o Easy to administer.
- o Closer relationship between accumulation of funds and time of expenditure than other policies.
- o More acceptable to large sewer users than pay-as-you-go policy.

- More flexibility in responding to changing economic conditions affecting development and need for capital facilities.

- Consistent with State Constitution limitations because revenues are user fees.

Disadvantages:

- Interest is costly.

- All users pay whether they contribute to the need for new facilities or not.

- Inequitable to the extent costs of service vary by service area.

EXISTING CONDITIONS

The current sewer system costs are recovered from user charges and property development fees. These changes and fees are discussed below.

USER CHARGES

The current rate schedule was recently revised, taking effect in March 1986. The existing program is a combination of flat rates and variable rates based on flow and strength characteristics. Selected rates are shown in Table 10-3.

INSTALLATION CHARGES

There are two installation charges in the City, for a 4-inch lateral and a 6-inch lateral. This installation charge includes the labor, material, and equipment costs for the physical hook-up only. The charge is $700.00 for a 4-inch lateral, and $800.00 for a 6-inch lateral.

DEVELOPMENT FEE (CONNECTION FEE)

Part of the overall development fee for the City is dedicated to the sanitary sewer. This sewer fee covers the cost of oversizing lines and sewage disposal expansion. The treatment and fees for sewer facilities is $1,370.00 per single family dwelling unit (SFDU), $960.00 per unit for multiple family dwellings, and corresponding fees for commercial facilities with residential strength wastes. Fees for commercial with more than residential strength waste and for industrial users are calculated on a case-by-case basis.

Table 10-3
City of Woodland
Wastewater Facilities Master Plan

SELECTED SEWER USER CHARGES
(EFFECTIVE MARCH 1986)

Category	(Monthly Rate)
Residential	
Single Family	$7.00/D.U.
Multi-Family (2-4 unit structures) and condominiums	$5.85/D.U.
Apartments, Mobile Home Spaces	$4.75/D.U.
Institutional	
Schools	$0.42/ADA
Churches	$7.00/Unit
Hospital, convalescent Homes,	
Base Charge	$4.75/connection
Use Rate	$0.83/100 C.F.
Fairgrounds (flat rate)	$30.00
Commercial	
Standard Strength	
Base Change	$4.75/connection
Use Rate	$0.70/100 C.F.
High Strength	
Base Change	$4.75/connection
Restaurants	$1.75/100 C.F.
Hotel/Motel	$0.90/100 C.F.
Industrial	
Standard Strength	
Base Change	$4.75/connection
Use Rate	$0.70/100 C.F.
High Strength	
Base Change	$4.75/connection
Use Rate	(see calculation below)
Monitoring Charge	$10.00/connection

Industrial Use Rate calculation:

$$\text{Monthly Charge} = \frac{\text{Daily Flow (gal.)}}{225\text{ gal.}} \times \left[.60 + \left[\frac{\text{BOD (mg/l)}}{175\text{ mg/l}} \times .30\right] + \left[\frac{\text{SS (mg/l)}}{175\text{ mg/l}} \times .10\right]\right] \times \$7.00$$

FINANCING SCENARIOS

Potential financing scenarios were developed based on the costs of the estimated improvements, the allocation of costs among new and existing users, and construction phasing. Financing scenarios were independently developed for four separate cost categories: (1) collection system upgrade costs for the existing user, (2) collection system expansion costs for the new user, (3) treatment and disposal upgrade costs for the existing users, and (4) treatment and disposal expansion costs for the new users. These costs and the recovery mechanism are described below. Tables 10-4 and 10-5 summarize the estimated unit costs, user charges, and development fees for these categories. A more detailed description of the calculations involved in developing these scenarios is provided in Appendix G, Tables G-1 through G-4.

COLLECTION SYSTEM UPGRADE FINANCING

Capital costs allocated to the collection system amount to $2.46 million. Total costs, including financing costs, amount to almost $5.8 million. These costs are scheduled to begin in 1986 and continue through 2005. However, revenue bonds or other long-term financing will be needed for the 1986 improvements. Revenue bonds were assumed to have issuance costs of 20 percent, an 11 percent interest rate, and a 20-year repayment period. These costs are allocated 100 percent to flow and to existing users based on their peak flows. Existing users include those entering the system after initial collection system upgrade work begins in 1986. This is because these users, once connected to the system, contribute to the cost of the existing system, which does not include expansion or added capacity costs. User charges are based on a 1986 unit cost of approximately $34,000 per mgd of peak capacity. Due to the influx of new users, this $34,000/mgd declines to less than $25,000 by year 2005.

These costs are most easily recovered by an increase in sewer user charges. Levelizing these costs results in an annual cost of approximately $272,000 in 1986-95 and $306,000 in 1996-2005. This would create an initial increase in sewer rates of $12 per year per typical dwelling unit, or $4.28 per capita per year. This charge will be reduced over time as additional users enter the system. In year 2005, this charge should be closer to $8 per year per dwelling unit, or $3.10 per capita.

COLLECTION SYSTEM EXPANSION FINANCING

Capital costs allocated to the collection system expansion amount to $3,360,000. Including financing costs, total cost are $7.7 million and are allocated to future users. Costs are assumed to be recovered through system development

Table 10-4
City of Woodland
Wastewater Treatment Facilities Master Plan

COLLECTION SYSTEM - RATE INCREASES AND SYSTEM DEVELOPMENT FEES

Collection System Upgrade	1986	1990	1995	2000	2005	1986-2005 Average
Unit Rate $/mgd	34,051	30,446	26,887	27,129	24,559	28,614
Annual Costs						
$/Capita, Residential	4.28	3.83	3.39	3.42	3.10	3.60
$/D.U., Residential	11.72	10.48	9.26	9.34	8.45	9.85
$/Acre, Comm/Indus.	116	104	91	92	84	97

Collection System Expansion	1986	1990	1995	2000	2005	1985-2005 Average
Unit Rate $/mgd	1,255,135	1,255,135	1,255,135	1,255,135	1,255,135	1,255,135
System Development Fees						
$/Capita, Residential	159.86	159.86	159.86	159.86	159.86	159.86
$/D.U., Residential	432	432	432	432	432	432
$/Acre, Comm/Indus.	4,267	4,267	4,267	4,267	4,267	4,267

Table 10-5
City of Woodland
Wastewater Treatment Facilities Master Plan

TREATMENT PLANT - RATE INCREASES AND SYSTEM DEVELOPMENT FEES

Treatment Plant Upgrade	1986	1990	1995	2000	2005	1986-2005 Average
Unit Rates: Per mgd	195,511	174,809	154,377	138,221	125,126	157,609
Per 1,000 lbs BOD	12,258	10,960	9,679	8,666	7,845	9,882
Per 1,000 Lbs SS	5,304	4,742	4,188	3,750	3,394	4,276
Annual Costs						
$/Capita, Residential	17.00	15.22	13.46	12.06	10.93	13.73
$/D.U., Residential	46.58	41.65	36.78	32.93	29.81	37.55
$/Acre, Comm/Indus.	460	411	363	325	294	371

Treatment Plant Expansion	1986	1990	1995	2000	2005	1986-2005 Average
Unit Rates:						
Per mgd	3,560,955	3,560,955	3,560,955	3,560,955	3,560,955	3,560,955
Per 1,000 Lbs BOD	795	795	795	795	795	795
Per 1,000 Lbs SS	35	35	35	35	35	35
System Development Fees						
$/Capita, Residential	509.68	509.68	509.68	509.68	509.68	509.68
$/D.U., Residential	1,376	1,376	1,376	1,376	1,376	1,376
$/Acre, Comm/Indus.	13,591	13,591	13,591	13,591	13,591	13,591

charges based on peak capacity required in the system, measured in $/MGD. A unit cost of $1.26 million per mgd of peak capacity was used, calculated by dividing total costs of $7.7 million by 6.14 mgd of new peak capacity.

System development charges would be approximately $160 per capita (residential), $432 per dwelling unit, and $4,267 per commercial/industrial acre. These development charges represent the proportional contribution of residential and commercial/industrial users to additional peak capacity.

TREATMENT AND DISPOSAL UPGRADE FINANCING

Capital costs for the treatment and disposal upgrade costs were estimated at $5.33 million. Since these costs occur in 1986, they would need to be financed with long-term debt (revenue bonds were assumed in the analysis). Financing costs would increase cash outlays to almost $21.6 million. These costs were allocated 85 percent to flow, 10 percent to BOD, and 5 percent to suspended solids based on a cost-weighted distribution of treatment and disposal improvements, as shown in Table 10-6. The unit rates developed from these allocations are applied to residential and commercial/industrial users based on their flow, BOD and TSS contributions to the plant. The annual debt service from the revenue bond would require user charges initially set at $17 per capita (residential), or $46.58 per dwelling unit, and $460 per commercial/industrial acre. However, these charges would decline over time as the number of existing users increases, thereby lowering these rates. By year 2005, charges are expected to be approximately $11 per capita (residential), $30 per dwelling unit, and $294 per commercial/industrial acre.

TREATMENT AND DISPOSAL EXPANSION FINANCING

The treatment and disposal expansion would occur in three phases: $3.17 million would be spent in 1986, $2.12 million in 1995, and $3.07 million in 2005. A combination of revenue bonds for 1986 costs and system development fees for 1995 and 2005 costs is recommended. Including financing costs, total expenditures amount to $19.8 million.

Costs were allocated to loading parameters in the following percentages: 52 percent to flow, 45 percent to BOD, and 2 percent to suspended solids. Development of these allocations is shown in Table 10-6 and resulted in unit rates of $3.56 million per MGD, $1,640 per 1,000 lbs BOD and $72 per 1,000 lbs suspended solids. These unit rates were then used to calculate system development charges based on the flow, BOD, and TSS generated by each user. This resulted in typical charges of $510 per capita (residential), $1,376 per dwelling unit, and $13,591 per commercial/industrial acre.

Table 10-6
City of Woodland
Wastewater Treatment Facilities

TREATMENT PLANT IMPROVEMENTS - COST ALLOCATION TO FLOW, BOD, AND SUSPENDED SOLIDS (SS)

Year(s)	Improvements	Cost ($M)	Allocation Ratio (%) Flow	BOD	SS	Cost Distribution Flow	BOD	SS
	Treatment Plant Upgrade							
1985	4.6 MGD Upgrade							
	Influent Pumping	1.15	100	0	0	1.150	0.000	0.000
	Pond Construct.	0.05	0	100	0	0.000	0.050	0.000
	Dar Polishing	0.78	33	33	33	0.260	0.260	0.260
	Aeration	0.23	0	10	0	0.000	0.230	0.000
	Disinfection, Effl. Pumping	0.63	100	0	0	0.630	0.000	0.000
	Irrigation System	2.49	100	0	0	2.490	0.000	0.000
	TOTAL	5.33				4.53	0.54	0.26
	Allocation (A)					85.0%	10.1%	4.9%
	Treatment Plant Expansion							
Phase I 1985-88	1.7 MGD Upgrade							
	Influent Pumping	0.45	100	0	0	0.450	0.000	0.000
	Pond Construct.	1.19	0	100	0	0.000	1.190	0.000
	Dar Polishing	0.29	33	33	33	0.097	0.097	0.097
	Aeration	0.09	0	100	0	0.000	0.090	0.000
	Disinfection, Effl. Pumping	0.23	100	0	0	0.230	0.000	0.000
	Irrigation System	0.92	100	0	0	0.920	0.000	0.000
	TOTAL	3.17				1.70	1.38	0.10
Phase II 1989-95	1.7 MGD Expansion							
	Influent Pumping	0.42	100	0	0	0.420	0.000	0.000
	Pond Construct.	0.90	0	100	0	0.000	0.900	0.000
	Dar Polishing	0.11	33	33	33	0.037	0.037	0.037
	Aeration	0.09	0	100	0	0.000	0.090	0.000
	Disinfection, Effl. Pumping	0.12	100	0	0	0.120	0.000	0.000
	Irrigation System	0.48	100	0	0	0.480	0.000	0.000
	TOTAL	2.12				1.06	1.03	0.04

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Table 10-6
City of Woodland
Wastewater Treatment Facilities
(Continued)

TREATMENT PLANT IMPROVEMENTS - COST ALLOCATION TO FLOW, BOD, AND SUSPENDED SOLIDS (SS)

			Allocation Ratio (%)			Cost Distribution		
Year(s)	Improvements	Cost ($M)	Flow	BOD	SS	Flow	BOD	SS
	Treatment Plant Upgrade							
Phase III 1996-2010	2.6 MGD Expansion							
	Influent Pumping	0.65	100	0	0	0.650	0.000	0.000
	Pond Construct.	1.20	0	100	0	0.000	1.200	0.000
	Dar Polishing	0.17	33	33	33	0.057	0.057	0.057
	Aeration	0.13	0	100	0	0.000	0.130	0.000
	Disinfection, Effl. Pumping	0.19	100	0	0	0.190	0.000	0.000
	Irrigation System	0.73	100	0	0	0.730	0.000	0.000
	TOTAL	3.07				1.63	1.39	0.06
	Allocation (Phases I-III) (A)					52.4%	45.3%	2.3%

(A) Allocation made on the basis of cost-weighted averages of improvements.

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RATE AND FEE IMPLICATIONS

The impacts of financing the upgrade and expansion work for the collection system are summarized in Table 10-4. The treatment and disposal impacts are summarized in Table 10-5. All upgrade costs have been allocated to existing users. This results in 1986 rate increases averaging $4.86 per month ([$11.72 + $46.58] divided by 12) for a typical dwelling unit. However, as additional users enter the system, these rates will decline. Assuming a constant influx of new users averaging 350 dwelling units per year, rates in year 2005 will be approximately $3.19 per month ([$8.45 + $29.81] divided by 12). However, the rate at which additional users enter the system will affect this decline.

All expansion costs (collection system and treatment and disposal) have been allocated to new users based on loading capacity. These costs will be recovered through system development charges that will average approximately $1,800 ($432 + $1,376) per dwelling unit as shown in Table 10-4 and Table 10-5. These costs (and therefore rates) could increase by 50 percent if complete land disposal is required.

Initial (1986) construction cost for all improvements except collection system expansion have been assumed to be financed by long-term debt. Financing costs increase total cash outlays considerably. Interest rates were assumed to be 11 percent with issuance costs of 20 percent and a 20-year repayment period.

It is important to examine the annual cash outlays required by treatment, disposal, and collection system improvements. Table 10-7 illustrates the cumulative cash outlays at years 1990 and 2000. This table shows outlays of almost $11 million through year 1990 and over $36.7 million through year 2000.

In contrast, the revenues generated by the rate increase and system development charges listed in Tables 10-4 and 10-5 would more than meet construction costs through year 2000. The positive net cash flow of $3.2 million in 1990 and $3.5 million in year 2000 represents the reserve necessary to fund remaining work. This reserve will decline dramatically by completion of construction.

IMPLEMENTATION

To achieve a more equitable allocation of costs between new commercial/industrial users, the development fee should be based on the capacity required of the facilities instead of acreage. By assessing system development charges based on unit costs for loading parameters, charges are directly related to capacity required. This could be implemented with

Table 10-7
City of Woodland
Wastewater Treatment Facilities Master Plan

COMPARISON OF CASH OUTFLOW AND EXPECTED REVENUES[a]
(x $1,000)

	Through 1990	Through 2000
Cumulative Cash Outlays		
Collection System Upgrade	$ 1,358	$ 4,245
Collection System Expansion	989	3,833
Treatment and Disposal Upgrade	5,395	16,184
Treatment and Disposal Expansion	3,210	12,479
Total	$10,952	$36,741
Revenues Based on Rates from Tables 10-4 and 10-5 Rates		
Collection System Upgrade	$ 1,358	$ 4,245
Collection System Expansion	1,778	4,741
Treatment and Disposal Upgrade	5,395	16,184
Treatment and Disposal Expansion	5,663	15,100
Total	$14,194	$40,270
Net Cash Flow	$ 3,242	$ 3,529

[a]ENR 5100 (April 1985)

a set charge for a typical residence while larger developments should be based on a case-by-case basis. This fee should be collected before service becomes operational - typically when a building permit is issued. If after-hookup loadings differ substantially from loadings used in calculating the system development charge, an additional system development charge should be assessed.

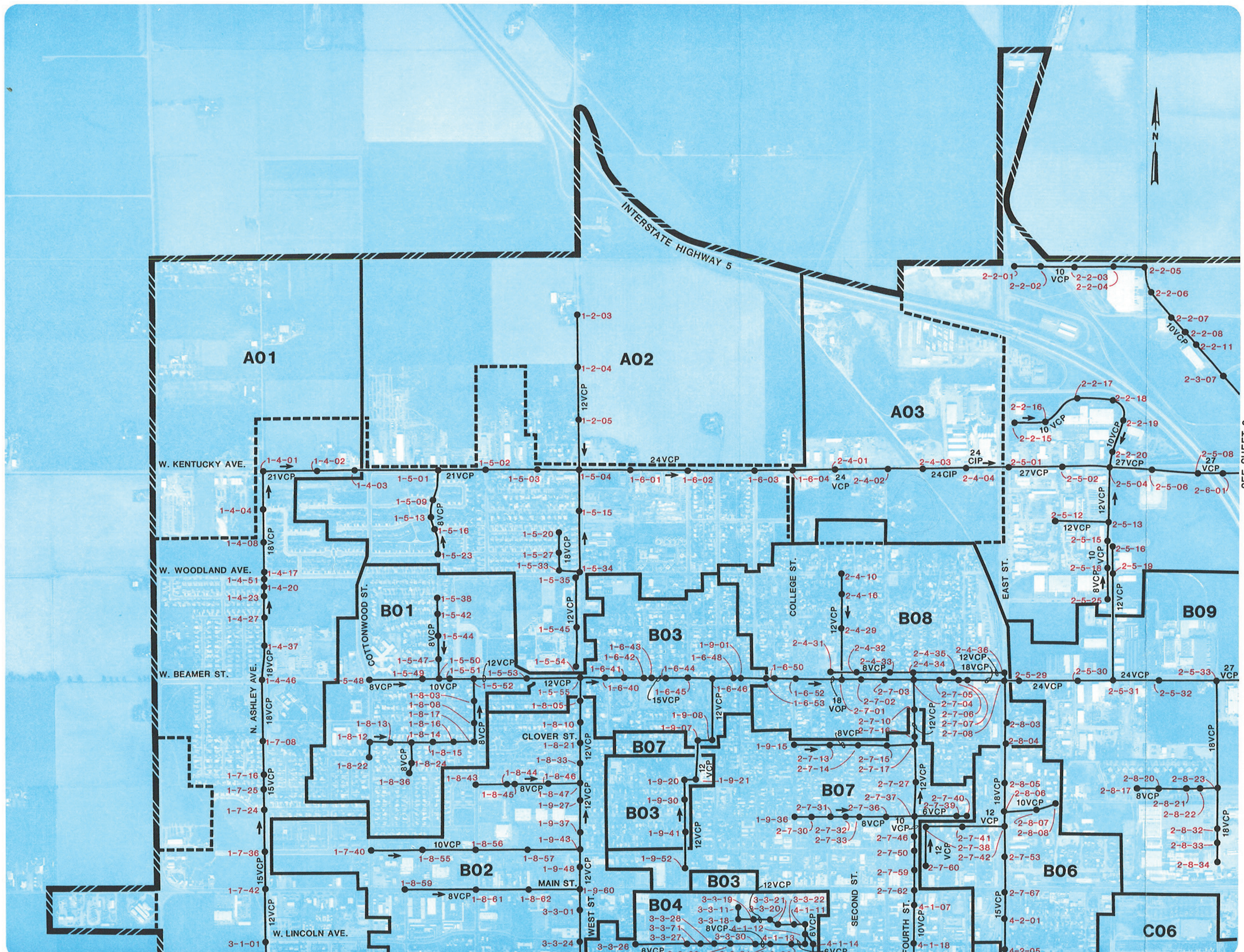
The system development charges shown are in 1985 dollars. These charges should be adjusted annually by the Engineering News Record (ENR) Construction Cost Index to follow inflation. Excess revenues from any given year should be invested to keep up with inflation.

The practice of having an oversizing cost in the development fee will be unnecessary if the capacity allocation methodology is followed and if any improvements by others meets master plan requirements.

SFR18/105

CH2M HILL

APPENDIX A



LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- **A01** BASIN IDENTIFICATION
- MAIN SEWER LINE
- 8VCP PIPE SIZE (IN.) AND TYPE
- ● MANHOLE
- 2-2-01 MANHOLE NUMBER
- → DIRECTION OF FLOW

VERIFY SCALES

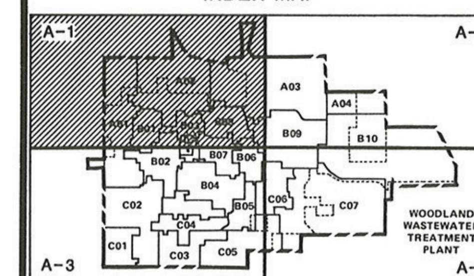
BAR IS ONE INCH ON ORIGINAL DRAWING.

0 1"

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1" = 600'

INDEX MAP

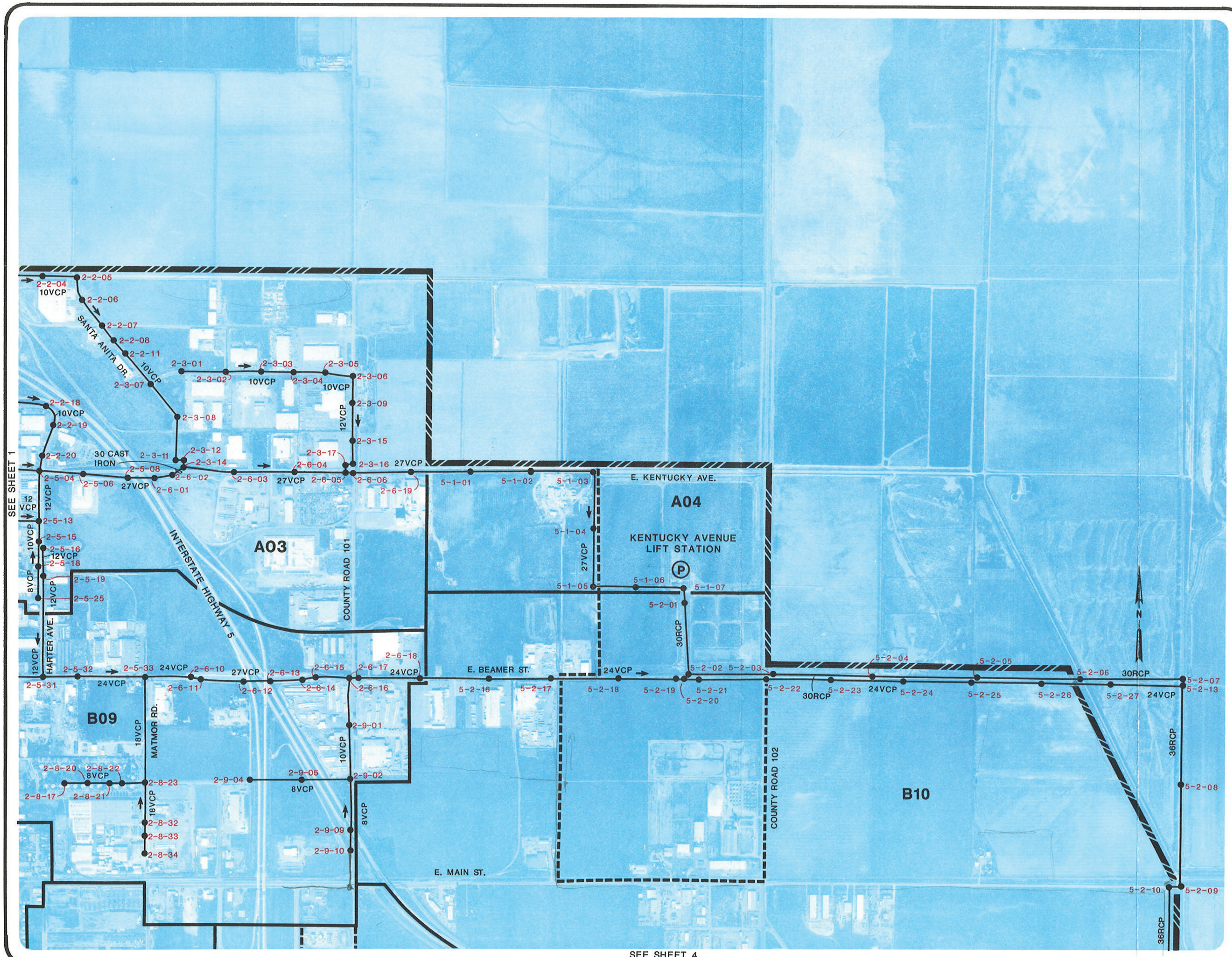


APPENDIX A-1

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

CH2M HILL



LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- A03 BASIN IDENTIFICATION
- MAIN SEWER LINE
- 8VCP PIPE SIZE (IN.) AND TYPE
- ● MANHOLE
- 2-2-04 MANHOLE NUMBER
- → DIRECTION OF FLOW
- (P) PUMP STATION

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APPROXIMATE SCALE: 1" = 600'

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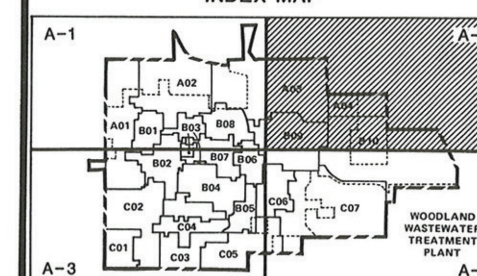
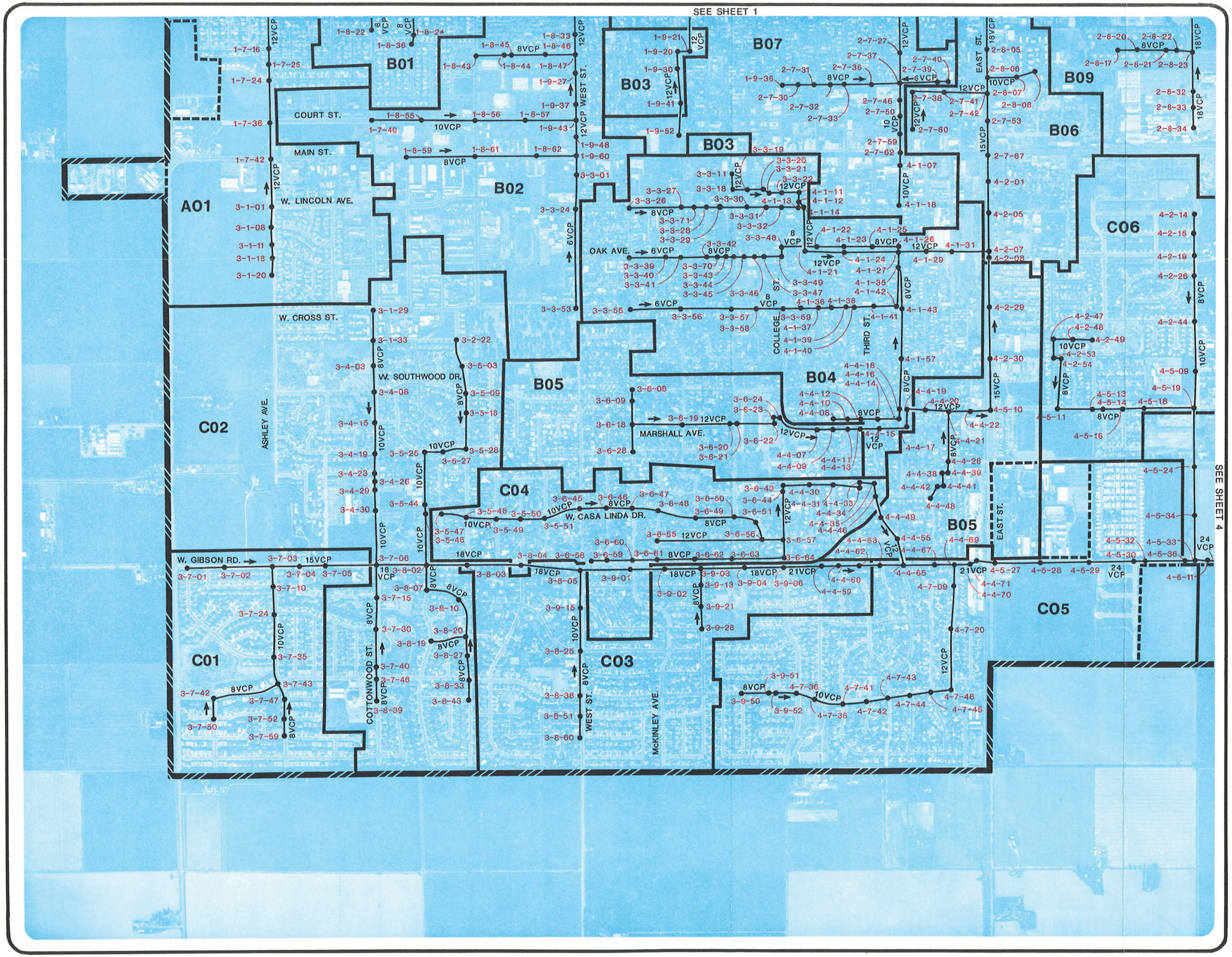


APPENDIX A-2

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

CH2M HILL



LEGEND :

URBAN LIMIT LINE

CITY BOUNDARY

BASIN BOUNDARY

B04 BASIN IDENTIFICATION

MAIN SEWER LINE

8VCP PIPE SIZE (IN.) AND TYPE

MANHOLE

4-2-07 MANHOLE NUMBER

DIRECTION OF FLOW

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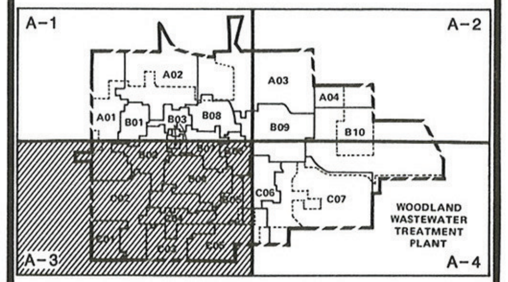
APPROXIMATE SCALE: 1" = 600'

INDEX MAP



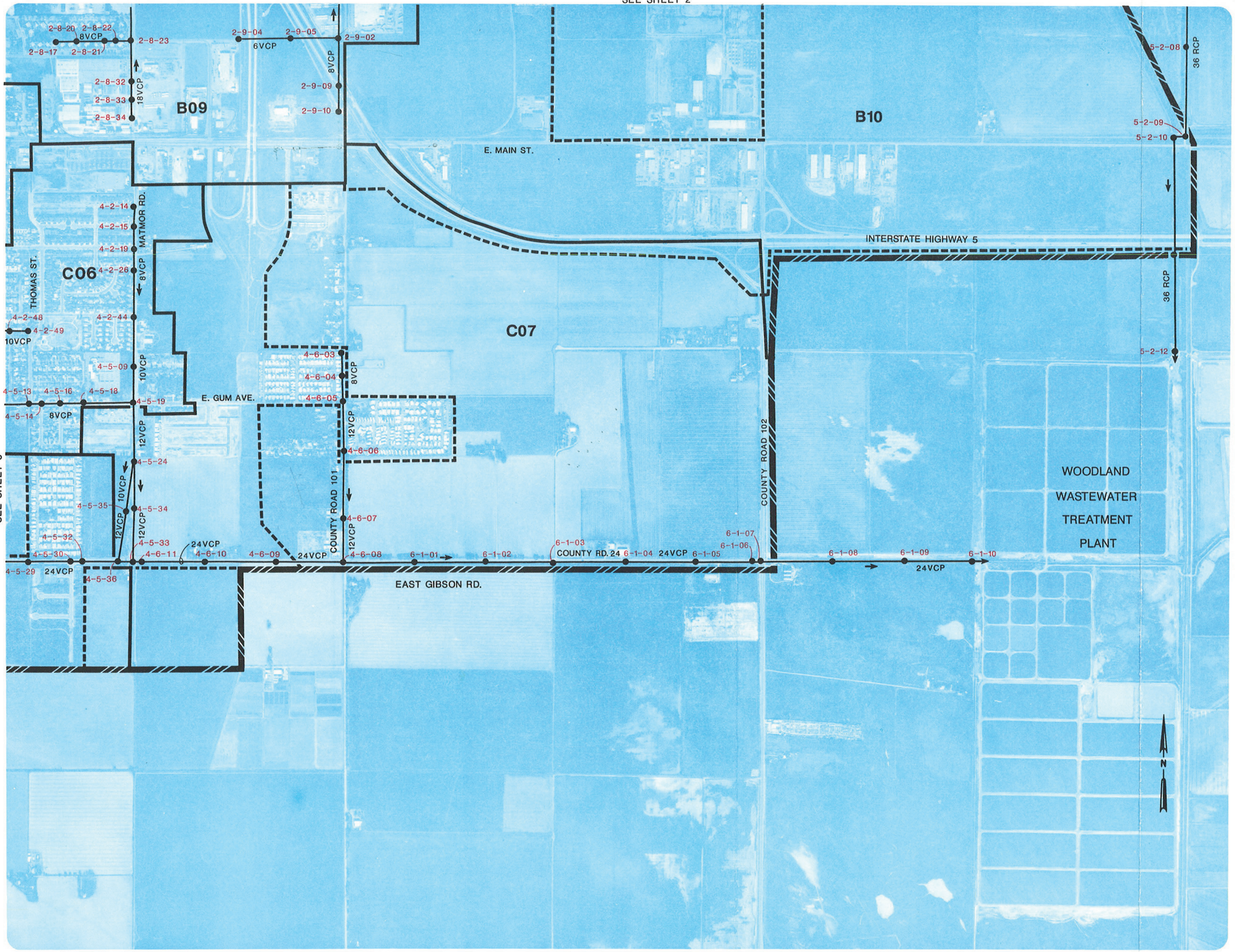
APPENDIX A-3

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

SEE SHEET 2



LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- **B10** BASIN IDENTIFICATION
- MAIN SEWER LINE
- 8VCP PIPE SIZE (IN.) AND TYPE
- ● MANHOLE
- 4-5-36 MANHOLE NUMBER
- → DIRECTION OF FLOW

VERIFY SCALES
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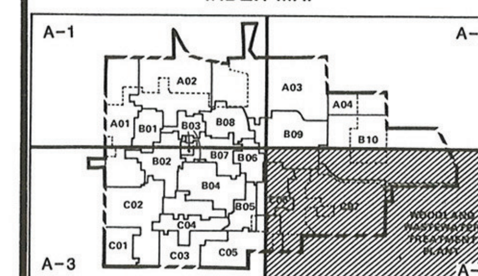
APPROXIMATE SCALE: 1" = 600'

INDEX MAP



APPENDIX A-4

CITY OF WOODLAND

WASTEWATER FACILITIES MASTER PLAN

CH2M HILL

APPENDIX B

Appendix B
INFILTRATION/INFLOW REDUCTION

The City of Woodland wastewater collection system is subjected to large flow increases resulting from periods of wet weather. Infiltration/Inflow (I/I) is stormwater runoff which enters the system through direct or indirect means. Sources which allow direct entry of stormwater (inflow) include connected downspouts, area and yard drains, manhole covers, and catch basins. Indirect sources (infiltration) include defective pipe, open joints, and deteriorated manhole walls.

As a result of the large flows observed during flow monitoring, a program to reduce I/I flows by rehabilitation was considered. Possible cost savings after I/I flow reduction appeared to be significant enough for additional evaluation using the master plan model. SAM was run assuming rehabilitation work in all basins could reduce peak I/I flows up to a maximum of 50 percent. The existing system deficiencies under this reduced flow condition are presented in Table B-1 and illustrated in Figure B-1.

Using the same analysis procedure described in Chapters 7 and 10, a plan for proposed system improvements was developed at a total cost of $2,152,700. Compared with the total cost of $5,815,300 for improvements without I/I reduction, the resulting savings of $3,662,600 could be available for I/I source detection and rehabilitation work.

A source detection program would include smoke testing, physical inspection of manholes, flow isolation, and closed circuit television inspection of the pipelines. Rehabilitation work, as a result of source detection, would include a comprehensive program of grout sealing, lining, or replacement of main sewers, plus all or a portion of service laterals. The type of rehabilitation would be selected based on the pipeline structural condition. Manhole rehabilitation would include sealing, patching, lining, rebuilding, or total replacement as necessary.

SFR18/093

Table B-1
City of Woodland
Wastewater Facilities Master Plan

SUMMARY OF SYSTEM CAPACITY DEFICIENCIES[a]

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PWWF Year 2020	Percent Capacity PWWF
B04	Fourth Street	4-1-35/ 4-1-27	8	0.13	0.35	274
B07	Fourth Street	2-7-37/ 2-7-27	12	0.52	0.57	111
	Fourth Street	2-7-27/ 2-7-17	12	0.51	0.65	128
	Fourth Street	2-7-16/ 2-7-10	12	0.74	0.97	131
B10	County Road 21	2-6-18/ 5-2-16	24	5.42	6.03	111
	County Road 21	5-2-16/ 5-2-17	24	5.42	6.16	114
	County Road 21	5-2-17/ 5-2-18	24	5.42	6.29	116
	County Road 21	5-2-18/ 5-2-19	24	5.42	6.41	118
	County Road 21	5-2-19/ 5-2-20	24	4.62	6.41	139
	County Road 21	5-2-20/ 5-2-21	24	5.12	6.45	126

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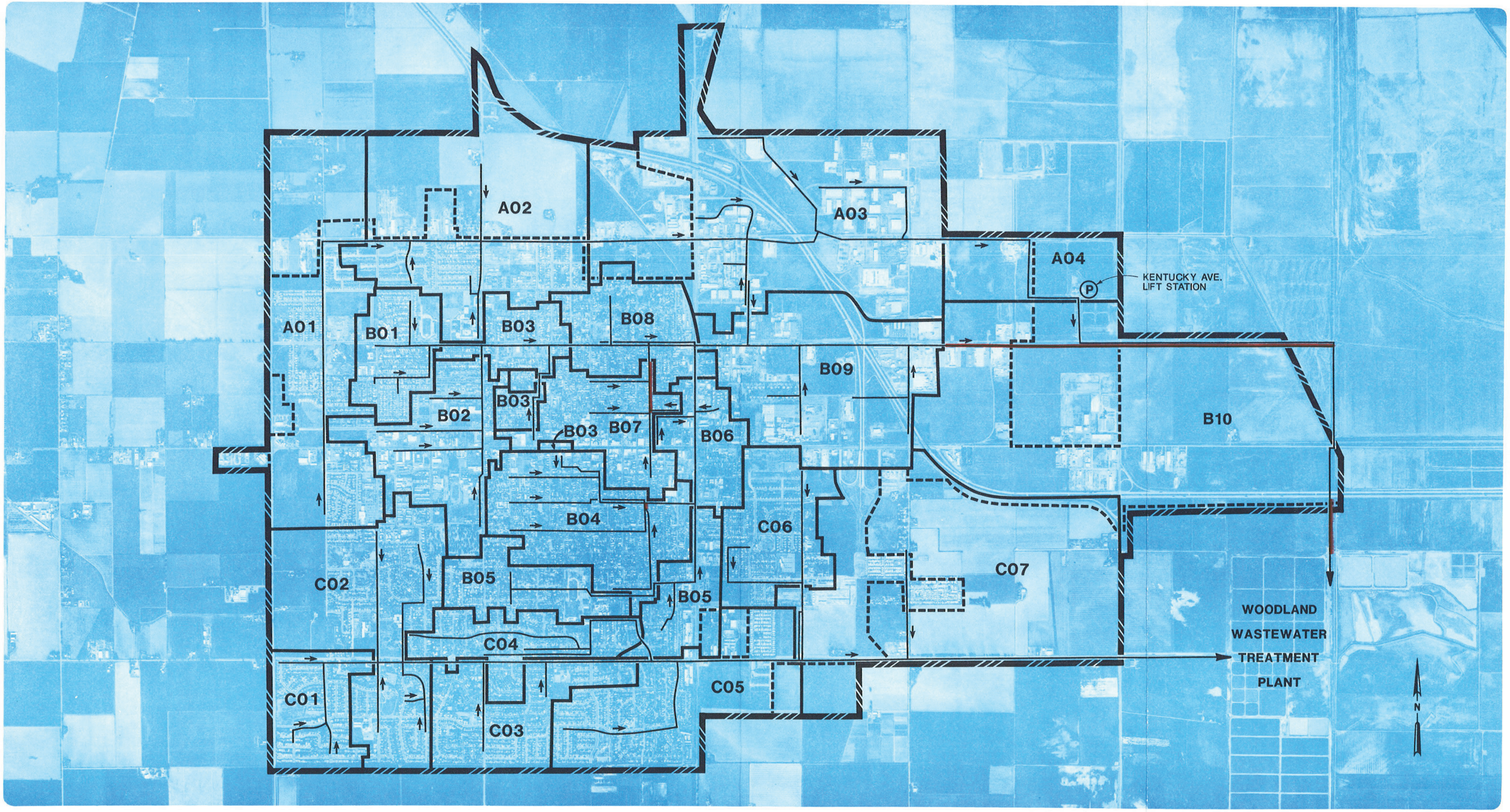
Table B-1
(continued)

Basin	Location	Upstream/ Downstream Manhole	Existing Diameter (in)	Existing Capacity (mgd)	PWWF Year 2020	Percent Capacity PWWF
	County Road 21	5-2-21/ 5-2-22	24	5.13	6.59	129
	County Road 21	5-2-22/ 5-2-23	24	5.40	6.73	125
	County Road 21	5-2-23/ 5-2-24	24	5.10	6.86	135
	County Road 21	5-2-24/ 5-2-25	24	5.68	7.00	123
	County Road 21	5-2-25/ 5-2-26	24	3.64	7.14	196
B10	County Road 21	5-2-26/ 5-2-27	24	3.91	7.28	186
	County Road 21	5-2-27/ 5-2-13	24	3.48	7.42	213
	County Road 103 line	5-2-11/ 5-2-12	36	12.54	14.06	112

[a]The summary of capacity deficiencies is presented for future conditions (2020) including 50% reduction in peak I/I.



LEGEND :

- URBAN LIMIT LINE
- CITY BOUNDARY
- BASIN BOUNDARY
- A01 BASIN IDENTIFICATION
- MAIN SEWER LINE
- DIRECTION OF FLOW
- (P) PUMP STATION
- SYSTEM CAPACITY DEFICIENCIES FOR FUTURE PWWF INCLUDING I/I REDUCTION (2- YEAR DESIGN STORM)

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

APPROXIMATE SCALE: 1"=1200'

CAPACITY DEFICIENCIES AFTER I/I REDUCTION

FIGURE B-1
CITY OF WOODLAND
WASTEWATER FACILITIES MASTER PLAN

CH2M HILL