CROWS LANDING INDUSTRIAL BUSINESS PARK

SANITARY SEWER INFRASTRUCTURE AND FACILITIES STUDY

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1.0 INTRODUCTION

Section 1 states the study background and purposes, study area, and overall system planning assumptions.

1.1 STUDY BACKGROUND AND PURPOSES

The Crows Landing Industrial Business Park Project (Project) is an approximately 1,528-acre conceptually planned development that encompasses the reuse of the former Crows Landing Air Facility, which was decommissioned by NASA in the late 1990s, as shown in Figure 1.1.

This Sanitary Sewer Infrastructure and Facilities Study provides information required for the County to better assess the feasibility of the planned development by defining the sanitary sewer system infrastructure improvements necessary to accommodate planned development in the proposed industrial business park, herein referred to collectively as the "Project." The scope of this plan includes the following major tasks:

- Compute the projected sewer flows generated by the Project based on the projected land use.
- Determine the overall preliminary sewer system layout and sizing using the proposed land use and circulation plan for collection, conveyance, treatment, and disposal.

The findings of this study are based on available information and are subject to change once more detailed engineering analyses are performed as the Project progresses.

1.2 STUDY PURPOSE

The Project study area includes the Project site, the Western Hills Water District sewer conveyance facilities west of the Project site, and the City of Patterson Water Quality Control Facility (WQCF) north of the Project site.

The Project addresses the reuse of the former Crows Landing Air Facility, encompassing approximately 1,528 acres in the western portion of Stanislaus County west of State Route 33 and east of Interstate 5, southwest of Patterson, and approximately 1 mile west of the unincorporated community of Crows Landing (Figure 1.1). The Project is bounded on the east by Bell Road, on the south by Fink Road, on the west by Davis Road, and on the north by Marshall Road and State Route 33. The Delta-Mendota Canal traverses the southern portion of the Project in a northwest/southeast direction. Little Salado Creek enters the Project site along the western property boundary slightly northeast of the Delta-Mendota Canal and terminates near the intersection of Marshall Road and State Route 33. The Project site topography generally slopes down in a northeasterly direction with an elevation change of approximately 80 feet, with the lowest elevation near the intersection of State Route 33 and Marshall Road. The site includes vehicle and aviation improvements associated with the former air facility which are currently being leased for agricultural use.

1.3 OVERALL SYSTEM PLANNING ASSUMPTIONS

Stanislaus County Department of Public Works Standards and Specifications Section 6.5 states:

> The sewer system shall conform to the requirements of the sewer district in which the development is located. If the development is located outside of a sewer district, then the sewer system shall be designed and constructed in conformance with the City of Modesto sanitary sewer standards.

The proposed project is not located within a sewer district. Therefore, the overall system planning assumptions for the sewer system in this study are based on *City of Modesto Public Works Department Standard Specifications 2006* (COM Standards) and the *City of Modesto Wastewater Collection System Master Plan, March 2000* (COM Wastewater Master Plan). In the case where design guidelines and criteria are not provided by the COM Standards or the COM Wastewater Master Plan, assumptions are made based on a comparative analysis of sewer generation rates for local cities and agencies, including the City of Modesto, and typical values published in the *Wastewater Engineering Treatment and Reuse* (Metcalf and Eddy, Inc. 2003. New York: The McGraw-Hill Companies, Inc.).

2.0 BACKGROUND INVESTIGATION

Section 2 discusses topography and the existing sewer facilities at and around the Project.

2.1 TOPOGRAPHY

The Project site terrain is composed of gently sloping land. Terrain in the study area rises from approximately 120 feet above mean sea level in the northeastern corner of the Project site (near the Marshall Road / State Route 33 intersection) to approximately 200 feet above mean sea level at the southwestern corner of the Project site (immediately north of Fink Road).

2.2 EXISTING SEWER FACILITIES

An existing sewage storage and treatment system is located within the Project site north of the existing north-south runway. This existing sewer system is composed of approximately 5,400 feet of sewage piping, an Imhoff processing tank, a sludge drying bed, and three settling ponds. The existing sewer system is connected to a sink and toilet in Building 109 (Shaw Environmental, Inc. 2006).The County does not anticipate using the existing treatment system.

Existing sewer facilities outside the Project site, but within the broader Project study area, include an existing 18-inch-diameter Western Hills Water District sewer trunk line which is located approximately 1.2 miles west of the Project site. The trunk line conveys sanitary sewer flows from the Diablo Grande development, which is located approximately 8 miles west of the Project Site, to the City of Patterson Water Quality Control Facility located approximately 5 miles north of the Project (Figure 2.1). The trunk line crosses Interstate 5 and the California Aqueduct, continues west along Oak Flat Road, then north along Ward Ave.

The City of Modesto (COM) Jennings Road Secondary/Tertiary Wastewater Treatment Plant (Jennings Plant) is located approximately 7 miles north of the Project (Figure 2.1). The COM Jennings Plant receives primary treated effluent from the COM Sutter Avenue Primary Wastewater Treatment Plant located approximately 14 miles northeast of the Project site. Tertiary treated effluent produced by the COM Jennings Plant is disposed of by beneficial irrigation of City-owned lands, by storing treated effluent in reservoirs, and by discharging treated effluent into the San Joaquin River during the months of October through May. Discharges to the San Joaquin River are based on the river flow, and irrigation disposal is dictated by the agronomic conditions and farming operations.

The City of Patterson Water Quality Control Facility (WQCF) receives effluent from the City of Patterson and the community of Diablo Grande. The treatment plant has a design capacity of approximately 2.25 MGD. The average annual wastewater flows to the WQCF are approximately 1.4 MGD. Treatment is accomplished through three treatment processes at the facility including the South Activated Sludge Treatment System (SASTS), the North Activated Sludge Treatment System (NASTS), and the Advanced Integrated Pond System (AIPS). These treatment systems use a combination of aeration, circulation, nitrogen removal, clarifiers, aerobic digesters, percolation ponds, and dewatering beds. The treatment plant contains several percolation ponds for effluent disposal. Biosolids are spread over agricultural lands and also disposed of at a sanitary landfill (City of Patterson Wastewater Master Plan, 2010).

2.3 REGIONALIZATION

As the San Joaquin Valley continues to develop, a number of factors indicate that regional infrastructure planning could provide benefits for local agencies and residents alike. Increasing water demands; periods of drought and water supply shortages; environmental concerns, regulations, and adjudications; aquifer overdrafts and declining groundwater table elevations; shrinking deliveries of surface water entitlements; expanding threats to both groundwater and surface water quality; and increasing quality standards for potable water, non-potable water, storm water, and effluents have all impacted water resources and planning in the Central Valley. Regionalization is proving an effective solution to many of these concerns in larger metropolitan areas throughout the state.

While the economies of scale afforded by regional infrastructure solutions generally provide financial benefits to project stakeholders, community participation in the planning and utilization of such systems is an important factor in their successful implementation. The County is reaching out to local municipalities, unincorporated communities, water districts, community service districts, and a fire protection district to plan for regional infrastructure solutions that could provide benefits to multiple stakeholders. Conversations are ongoing regarding regional solutions for sanitary sewer treatment. Potential future opportunities for regionalization related to wastewater include wastewater conveyance, wastewater treatment, and recycled water supply for potential use in agricultural and/or landscape irrigation, community fire protection, non-potable industrial use, or non-potable use in commercial or residential buildings.

Options for managing regional services include agreements with local municipalities; agreements with existing community services districts and/or water districts; implementation of a joint powers agreement (JPA); or a new community service district or water district. The advantages of each potential agreement vary depending on the extent of regionalization and potential customer mix. The County recognizes that both surrounding communities and the Project can jointly benefit from such cooperation and is dedicated in continuing their efforts in the development of these services and management systems.

The preferred alternative for the Project is to connect to the Western Hills Water District sanitary sewer effluent conveyance system to transport Project effluent to and through the City of Patterson's wastewater conveyance system, and ultimately to the City of Patterson Water Quality Control Facility for treatment. The County intends to purchase capacity in the Ward Ave. trunk line from Western Hills Water District. This alternative could be accomplished through coordination with the City of Patterson to connect to the City's existing and future sewer trunk line services. Section 6 describes the proposed phasing for connections to the City's existing and proposed trunk lines to accommodate the Crows Landing Industrial Business Park buildout for Phases 1, 2, and 3.

3.0 PROPOSED LAND USE AND SEWER GENERATION PROJECTIONS FOR PROJECT SERVICE AREAS

Section 3 provides an overview of the proposed project land use, service areas, analysis methodology of calculating projected sewer generation rates, and provides the projected sewer generation rates for the Project.

3.1 PROPOSED LAND USE

The Project proposes to develop the 1,528-acre site from its current land use into a business park with primarily public facilities, logistics, industrial, and business park land uses with a small amount of aviation-related land use. This study assumes that 1,274 acres of the Project will be developable and 1,261 of those acres will require sanitary sewer services. Figure 1.1 shows the land use designations and acreages for the Project based on the Crows Landing Industrial Business Park Land Use Plan. The Project area designated in Figure 1.1 as Phase 1A (Fink Road Corridor) will be developed first.

3.2 SERVICE AREAS

Due to the Project's phasing, the Project is divided into two sewer collection service areas, designated as Service Area 1 and Service Area 2. Service Area 1 includes the existing airfield and all areas north of the existing airfield, including the portions associated with Phase 1B, Phase 2, and Phase 3. Service Area 2 includes all areas south of the existing airfield, including the portion associated with Phase 1B and the entirety of Phase 1A. The proposed Land Use Plan, the Conceptual Phasing Map, and the United States Geological Survey (USGS) Crows Landing 7.5-Minute Series Quadrangle Map were used together to determine sewer shed areas for the Project site. Figure 4.4 shows the service area boundaries for the Project. Sanitary sewer service is not proposed within the existing airport crash zone easements.

3.3 ANALYSIS METHODOLOGY

The City of Modesto's (COM) Standard Specification (Table 5.1) lists acreage flow estimates for sewer flow projections. The Project is predominantly public facilities, logistics, industrial, and business park land uses, and the COM standards only provide flow values for light industrial. As a result, assumptions are made for sewer generation rates in place of the COM Standards unit sewer generation rates as described in Section 1.3. For the purposes of this study, the sewer flow rate applied to public facilities, logistics, industrial, and business park land use is a conservative estimate considered to represent general industrial activities since sewer generation rates are highly variable for different industrial land uses, and particular land uses for industrial development are not defined for the Project.

Sewer generation projections developed for this study (Table 3.2) were based on the accepted industry standard loading factors described in Table 3.1 and input from the County of Stanislaus (County).

Table 3.1 – Sewer Loading Factors

Land Use	Loading Factor
Airport Users[1] - Dry Weather Loading Factor	4 gpc/day
General Land Uses - Dry Weather Loading Factor[2]	1,000 gpd/acre
Wet Weather Loading Factor[3]	100 gpd/acre
Peaking Factor	3

*gpc = gallons per capita, gpd = gallons per day

Average Dry Weather Flow (ADWF) projections for industrial and aviation-related land uses were developed by multiplying the unit sewer loading factors for each land use category by either the proposed acreage for general industrial land uses or the assumed airport daily usage of 100 people per day for aviation-related uses. Peak Dry Weather Flow (PDWF) was estimated by multiplying the ADWF by the peaking factor. Estimates for inflow and Infiltration (I/I) were determined by multiplying the proposed acreage for each land use by the wet-weather loading factor.

3.3.1 Design Flow, Peaking Factor, and Inflow and Infiltration

Sewer flow rates vary based on the time of day, week, season of the year, type of dischargers, etc. Design flow rates are determined based on the peak wet weather flow (PWWF) rates. PWWF are calculated by adding the peak dry weather flow (PDWF) rates plus system inflow and infiltration (I/I) rates, and are typically used to determine the required capacity of collection and conveyance infrastructure. As described in the previous section, the PDWF rate for the Project is calculated by multiplying the average dry weather flow (ADWF) rate by a peaking factor (PF) of 3. I/I flow rates account for additional non-sewer flows that infiltrate the system typically during and after wet weather events and were accounted for using the wet-weather loading factor. Groundwater infiltration/inflow is extraneous water that enters the sewer system through defective joints and cracks in sewer mains, manhole walls, and sewer laterals, as well as through direct surface drainage connections or manhole links. For the purposes of this study, I/I flow is generally represented as a constant flow rate since it does not vary significantly over the course of a typical day. I/I flow rates are estimated to be 100 gpd/acre per the Metcalf & Eddy Wastewater Engineering design reference manual.

3.4 DESIGN FLOW PROJECTIONS

Design flow projections are provided for the full build-out condition as well as for Phase 1A, Phase 1B, Phase 2, and Phase 3.

3.4.1 Buildout Design Flow Projections

The proposed sewer system must be capable of collecting and conveying the PDWF and an instantaneous peak wet weather design flow as presented in Table 3.2. The ADWF, PDWF, and PWWF rates estimated for the Project are 0.85 MGD, 2.54 MGD, and 2.66 MGD, respectively.

[1] Metcalf & Eddy, Wastewater Engineering, McGraw Hill, 4th Edition page 157 Table 3-2
[2] Metcalf & Eddy, Wastewater Engineering, McGraw Hill, 4th Edition page 162
[3] Metcalf & Eddy, Wastewater Engineering, McGraw Hill, 4th Edition page 165

Table 3.2 – Project Buildout Sanitary Sewer Generation Projections

Sewer Shed Phase ID	Land Use	Acreage	Average Dry Weather Flow Planning Value (gpc/day)	Average Dry Weather Flow Planning Value (gpd/ac)	Peaking Factor	Inflow & Infiltration (gpd/ac)	Average Dry Weather Flow (gpd)	Peak Dry Weather Flow (gpd)	Inflow & Infiltration (gpd)	Peak Wet Weather Flow (gpd)
1B*	General Aviation	370.0	4.0	-	3.00	100	400	1,200	37,000	38,200
1B	Public Facilities	15.0	-	1,000	3.00	100	15,000	45,000	1,500	46,500
1A	Logistics	52.0	-	1,000	3.00	100	52,000	156,000	5,200	161,200
1B	Logistics	138.0	-	1,000	3.00	100	138,000	414,000	13,800	427,800
1A	Industrial	41.0	-	1,000	3.00	100	41,000	123,000	4,100	127,100
1B	Industrial	110.0	-	1,000	3.00	100	110,000	330,000	11,000	341,000
1A	Business Park	10.0	-	1,000	3.00	100	10,000	30,000	1,000	31,000
1B	Business Park	28.0	-	1,000	3.00	100	28,000	84,000	2,800	86,800
2*	Aviation Related	46.0	4.0	-	3.00	100	400	1,200	4,600	5,800
2	Public Facilities	35.0	-	1,000	3.00	100	35,000	105,000	3,500	108,500
2	Logistics	57.0	-	1,000	3.00	100	57,000	171,000	5,700	176,700
2	Industrial	71.0	-	1,000	3.00	100	71,000	213,000	7,100	220,100
2	Business Park	14.0	-	1,000	3.00	100	14,000	42,000	1,400	43,400
3	Public Facilities	18.0	-	1,000	3.00	100	18,000	54,000	1,800	55,800
3	Logistics	102.0	-	1,000	3.00	100	102,000	306,000	10,200	316,200
3	Industrial	128.0	-	1,000	3.00	100	128,000	384,000	12,800	396,800
3	Business Park	26.0	-	1,000	3.00	100	26,000	78,000	2,600	80,600
		1,261	**-**				**845,800**	**2,537,400**	**126,100**	**2,663,500**

Notes
** Average Dry Weather Flow estimations for aviation usage based on 100 people per day.*
** Land use for 13 acres of multimodal transportation/green space corridor and 254 acres of internal project infrastructure is not included as part of the 1,528 total project acreage.*

3.4.2 Phase 1 Design Flow Projections for Phase 1A and Phase 1B Development

Phase 1 ADWF, PDWF, and PWWF rates estimated for the Project are 0.39 MGD, 1.18 MGD, and 1.26 MGD, respectively, as presented in Table 3.3.

Phase 1A ADWF, PDWF, and PWWF rates estimated for the Project are 0.10 MGD, 0.310 MGD, and 0.32 MGD, respectively, as presented in Table 3.3a.

Table 3.3 – Phase 1 (Total) Sanitary Sewer Generation Projections

Sewer Shed Phase ID	Land Use	Acreage	Average Dry Weather Flow Planning Value (gpc/day)	Average Dry Weather Flow Planning Value (gpd/ac)	Peaking Factor	Inflow & Infiltration (gpd/ac)	Average Dry Weather Flow (gpd)	Peak Dry Weather Flow (gpd)	Inflow & Infiltration (gpd)	Peak Wet Weather Flow (gpd)
1B*	General Aviation	370.0	4.0	-	3.00	100	400	1,200	37,000	38,200
1B	Public Facilities	15.0	-	1,000	3.00	100	15,000	45,000	1,500	46,500
1A	Logistics	52.0	-	1,000	3.00	100	52,000	156,000	5,200	161,200
B	Logistics	138.0	-	1,000	3.00	100	138,000	414,000	13,800	427,800
1A	Industrial	41.0	-	1,000	3.00	100	41,000	123,000	4,100	127,100
1B	Industrial	110.0	-	1,000	3.00	100	110,000	330,000	11,000	341,000
1A	Business Park	10.0	-	1,000	3.00	100	10,000	30,000	1,000	31,000
1B	Business Park	28.0	-	1,000	3.00	100	28,000	84,000	2,800	86,800
		764					394,400	1,183,200	76,400	1,259,600

Notes
** - Average Dry Weather Flow estimations for aviation usage based on 100 people per day*

Table 3.3a – Phase 1A Sanitary Sewer Generation Projections

Sewer Shed Phase ID	Land Use	Acreage	Average Dry Weather Flow Planning Value (gpc/day)	Average Dry Weather Flow Planning Value (gpd/ac)	Peaking Factor	Inflow & Infiltration (gpd/ac)	Average Dry Weather Flow (gpd)	Peak Dry Weather Flow (gpd)	Inflow & Infiltration (gpd)	Peak Wet Weather Flow (gpd)
1A	Logistics	52.0	-	1,000	3.00	100	52,000	156,000	5,200	161,200
1A	Industrial	41.0	-	1,000	3.00	100	41,000	123,000	4100	127,100
1A	Business Park	10.0	-	1,000	3.00	100	10,000	30,000	1,000	31,000
		103					**103,000**	**309,000**	**103,000**	**319,300**

Notes
** - Average Dry Weather Flow estimations for aviation usage based on 100 people per day*

3.4.3 Phase 2 Design Flow Projections

Phase 2 ADWF, PDWF, and PWWF rates estimated for the Project are 0.24 MGD, 0.67 MGD, and 0.69 MGD, respectively, as presented in Table 3.4.

3.4.4 Phase 3 Design Flow Projections

Phase 3 ADWF, PDWF, and PWWF rates estimated for the Project are 0.27 MGD, 0.82 MGD, and 0.85 MGD, respectively, as presented in Table 3.5.

Table 3.4 – Phase 2 Sanitary Sewer Generation Projections

Sewer Shed Phase ID	Land Use	Acreage	Average Dry Weather Flow Planning Value (gpc/day)	Average Dry Weather Flow Planning Value (gpd/ac)	Peaking Factor	Inflow & Infiltration (gpd/ac)	Average Dry Weather Flow (gpd)	Peak Dry Weather Flow (gpd)	Inflow & Infiltration (gpd)	Peak Wet Weather Flow (gpd)
2	Aviation Related	46.0		1,000	3.0	100	46,000	138,000	4,600	142,600
2	Public Facilities	35.0	-	1,000	3.0	100	35,000	105,000	3,500	108,500
2	Logistics	57.0	-	1,000	3.0	100	57,000	171,000	5,700	176,700
2	Industrial	71.0	-	1,000	3.0	100	71,000	213,000	7,100	220,100
2	Business Park	14.0	-	1,000	3.0	100	14,000	42,000	1,400	43,400
		223					**223,000**	**669,000**	**22,300**	**691,300**

Table 3.5 – Phase 3 Sanitary Sewer Generation Projections

Sewer Shed Phase ID	Land Use	Acreage	Average Dry Weather Flow Planning Value (gpc/day)	Average Dry Weather Flow Planning Value (gpd/ac)	Peaking Factor	Inflow & Infiltration (gpd/ac)	Average Dry Weather Flow (gpd)	Peak Dry Weather Flow (gpd)	Inflow & Infiltration (gpd)	Peak Wet Weather Flow (gpd)
3	Public Facilities	18	-	1,000	3.0	100	18,000	54,000	1,800	55,800
3	Logistics	102	-	1,000	3.0	100	102,000	306,000	10,200	316,200
3	Industrial	128	-	1,000	3.0	100	128,000	384,000	12,800	396,800
3	Business Park	26	-	1,000	3.0	100	26,000	78,000	2,600	80,600
		274					**274,000**	**822,000**	**27,400**	**849,400**

3.5 DESIGN LOADING PROJECTIONS

Wastewater constituent loading projections for were estimated for the aforementioned AWDF flow projections for purposes of wastewater treatment and disposal. These are provided for the full build-out condition as well as for Phase 1, Phase 2, and Phase 3.

Raw (untreated) wastewater constituent loadings were calculated using the following planning level concentrations. These are commonly used planning level numbers for domestic sewage used for new developments. They also conform to the average concentrations seen at the COP WQCF.

Table 3.6 – Raw Wastewater Constituent Concentrations

Raw Wastewater Constituent	Average Concentration
Biochemical Oxygen Demand (BOD_5):	300 mg/L
Total Suspended Solids (TSS):	300 mg/L
Total Kjeldahl Nitrogen (TKN):	50 mg/L

Constituent loadings are presented in pounds per day (lb./day) as:

- Average Load (at ADWF) and
- Peak Load (Average Load X 1.3)

A summary of the constituent loading projections for all phases is presented in Table 3.7. These include both average and peak loadings for the ADWF for each phase of development.

Table 3.7 – Raw Wastewater Constituent Load Projections

Parameter	Units	Phase 1 (A&B)	Phase 2	Phase 3	Buildout
ADWF	MGD	0.394	0.223	0.274	0.891
Average BOD5 Load	lb./day	986	558	686	2,229
Peak BOD5 Load	lb./day	1,282	725	891	2,898
Average TSS Load	lb./day	986	558	686	2,229
Peak TSS Load	lb./day	1,282	725	891	2,898
Average TKN Load	lb./day	164	93	114	372
Peak TKN Load	lb./day	214	121	149	484

4.0 PROPOSED SANITARY SEWER SYSTEM INFRASTRUCTURE

Section 4 presents an overview of the proposed sanitary sewer infrastructure for the Project. Bentley's SewerGEMS v8i software was used for this analysis. Information from the Crows Landing Industrial Business Park Sanitary Sewer Infrastructure and Facilities Study, conducted by VVH Consulting Engineers in January 2015, was used to construct the hydraulic model. Sewer loadings were allocated throughout the model using the Thiessen polygon method. This method assigns each manhole an area of influence, which is overlaid with the site land use map and wastewater loading factors to calculate loadings for each manhole. Wastewater collection systems are typically sized for peak flows; therefore, for the purposes of this study, the peak flow scenario was used for the analysis. The analysis was performed under steady-state conditions.

Additionally, the proposed sanitary system layout was developed for planning purposes and further design of the prosed system will need to be conducted for the final design of the system layout including pipe sizing, slopes, and costs.

4.1 PROPOSED SANITARY SEWER INFRASTRUCTURE

Sanitary sewer infrastructure required as part of Phase 1 improvements includes gravity trunk mains, a 2.70-MGD sanitary sewer lift station southwest of the Marshall Road and State Route 33 intersection, a 0.32-MGD sanitary lift station south of the airfield near the Delta Mendota Canal, and a force main within Marshall Road to convey effluent to the existing Western Hills Water District trunk main in Ward Ave. The gravity trunk mains and the lift station to be constructed in Phase 1A improvements are sized to accommodate ultimate expansion within the business park, and the force main constructed in Phase 1A is sized to accommodate effluent from Phases 1, 2, and 3. See Figure 4.1 for the Phase 1 Sanitary Sewer System Map.

Construction of the Phase 1A improvements include a gravity trunk main system with approximately 10,506 lineal feet of 18-inch-diameter pipe, 2,992 lineal feet of 12-inch-diameter pipe, 2,146 lineal feet of 8-inch-diameter pipe, approximately 56 manholes, construction of a 2.66-MGD sanitary sewer lift station, construction of a 0.32-MGD sanitary sewer lift station, construction of approximately 12,400 lineal feet of 12-inch sanitary sewer force main, a temporary connection to the existing Western Hills Water District's 18-inch sanitary sewer trunk line, and a crossing under the Delta Mendota Canal. Construction of the Phase 1B improvements include approximately 518 lineal feet of 15-inch-diameter pipe, 3,028 lineal feet of 12-inch-diameter pipe, 5,367 lineal feet of 10-inch-diameter pipe, 17,228 lineal feet of 8-inch-diameter pipe, and approximately 28 manholes. The estimated cost for the total Phase 1 development is approximately $12 million (Table 4.1).

Sanitary sewer infrastructure required as part of Phase 2 improvements include gravity trunk mains to connect to existing sanitary sewer infrastructure constructed with Phase 1. See Figure 4.2 for the Phase 2 Sanitary Sewer System Map. Construction of the Phase 2 gravity trunk main system, including approximately 1,318 lineal feet of 12-inch-diameter pipe, 971 lineal feet of 10-inch-diameter pipe, 7,661 lineal feet of 8-inch-diameter pipe, 20 manholes, removal of the temporary connection to the Western Hills Water District's sanitary sewer trunk line, and install approximately 7,870 LF of 12-inch-diameter force main paralleling the existing Western Hills Water District's sewer trunk line along Ward Avenue between Marshall Road and Bartch Avenue, is estimated to cost approximately $2.8 million (Table 4.2).

Development of Phase 3 proposes construction of backbone infrastructure to provide sanitary sewer service to the Phase 3 areas south of Marshall Road. Construction of the Phase 3 gravity trunk main system, including approximately 3,037 lineal feet of 10-inch-diameter pipe, 13,326 lineal feet of 8-inch-diameter pipe, and 33 manholes, is estimated to cost approximately $2.5 million (Table 4.3).

Table 4.1 – Phase 1 Infrastructure Probable Cost

Description		Quantity		Unit Cost ($)	Total Cost ($)
Phase 1A Infrastructure					
1.	18" Pipe	10,506	LF	$130	$1,366,000
2.	12" Pipe	2,992	LF	$100	$300,000
3.	8" Pipe	2,146	LF	$80	$172,000
4.	12" Force Main	12,400	LF	$120	$1,488,000
5.	Type "A" Case I Manhole	56	EA	$9,000	$504,000
6.	2.70-MGD Lift Station	1	LS	$1,750,000	$1,750,000
7.	0.32-MGD Lift Station	1	LS	200,000	$200,000
8.	Tunneled Crossing (Delta Mendota Canal South of Air Field)	300	LF	$250	$75,000
				Subtotal	5,855,000
				Engineering Costs (20%)	$1,171,000
				Contingencies (20%)	$1,406,000
				Subtotal Phase 1A Development Costs	**$8,432,000**
Phase 1B Infrastructure					
9.	15” Pipe	518	LF	$110	$57,000
10.	12” Pipe	3,028	LF	$100	$303,000
11.	10" Pipe	5,367	LF	$90	$484,000
12.	8” Pipe	17,228	LF	$80	$1,379,000
13.	Type “A” Case I Manhole	28	EA	$9,000	$252,000
				Subtotal	$2,475,000
				Engineering Costs (20%)	$495,000
				Contingencies (20%)	$594,000
				Subtotal Phase 1B Development Costs	**$3,564,000**
				Total Project Cost	**$12,000,000**

Table 4.2 – Phase 2 Infrastructure Probable Cost

	Description	Quantity		Unit Cost ($)	Total Cost ($)
1.	12" Pipe	1,318	LF	$100	$132,000
2.	10" Pipe	971	LF	$90	$88,000
3.	8" Pipe	7,661	LF	$80	$613,000
4.	12" Force Main	7,870	LF	$120	$945,000
5.	Type "A" Case I Manhole	20	EA	$9,000	$180,000
				Subtotal	$1,958,000
				Engineering Costs (20%)	$392,000
				Contingencies (20%)	$470,000
				Total Project Cost	**$2,820,0000**

Table 4.3 – Phase 3 Infrastructure Probable Cost

	Description	Quantity		Unit Cost ($)	Total Cost ($)
1.	10" Pipe	3,037	LF	$90	$274,000
2.	8" Pipe	13,326	LF	$80	$1,067,000
3.	Type "A" Case I Manhole	33	EA	$9,000	$297,000
				Subtotal	$1,638,000
				Engineering Costs (20%)	$328,000
				Contingencies (20%)	$394,000
				Total Project Cost	**$2,360,000**

Connection fees were also estimated for each planning phase based on proposed building area square footages and typical sewer connection fees for commercial and industrial connections. Commercial connection fees were assumed to be $2.11 per square-foot of building area and industrial connection fees were assumed to be $2.49 per square-foot of building area. Based the preliminary evaluation of the service connection fees, the total estimated buildout connection cost is approximately $30.6 million with connection costs for Phase 1A, Phase 1B, Phase 2, and Phase 3 being $3.6, $9.9, $6.5, and $10.7 million respectively (Table 4.4).

Table 4.4 – Estimated Sanitary Sewer Connection Fee

Description	Connection Fee ($/SF)	Phase 1A Connection Cost ($)	Phase 1B Connection Cost ($)	Phase 2 Connection Cost ($)	Phase 3 Connection Cost ($)
Commercial Connection	2.11	$2,000,000	$5,700,000	$3,400,000	$5,100,000
Industrial Connection	2.49	$1,600,000	$4,200,000	$3,100,000	$5,600,000
Total Connection Cost by Phase =		$3,600,000	$9,900,000	$6,500,000	$10,700,000
				Total Buildout Connection Cost	**$30,600,000**

Phase 1A Interim Sanitary Sewer Infrastructure

An interim solution prior to completion of the Phase 1A gravity trunk-line improvements is to construct and operate a temporary packaged wastewater treatment facility to treat and discharge waste from development in the Phase 1A area. Typical packaged plant systems can be designed for short term or long term use and utilize conventional wastewater treatment practices such as aeration, sedimentation, and filtration, to meet discharge standards. Additional cost-benefit analysis is needed to determine if a packaged treatment plant may be a suitable interim solution to complete buildout of the proposed Phase 1A improvements.

5.0 SYSTEM DESIGN CRITERIA

Section 5 discusses the system design criteria for the Project. Sewer service for the Project will consist of a gravity trunk main system as well as a lift station and force main facilities to convey flows to the existing Western Hills Water District 18-inch trunk line beneath Ward Ave west of the Project.

5.1 GRAVITY COLLECTION AND CONVEYANCE

Gravity collection and conveyance facilities will be sized for the design flow as defined and calculated in Section 3.

5.1.1 Manning's Coefficient

A Manning's coefficient of roughness (n) of 0.013 is used in determining the require pipe sizes for the system. This value is conservative for capacity determination and is typically used in the design of new facilities.

5.1.2 Flow Depth Criteria

Flow depth criteria is expressed as a maximum depth of flow to pipe diameter (d/D). Per the COM Wastewater Master Plan, new gravity sewer mains must be sized to convey design flows at 70 percent of pipe capacity.

5.1.3 Design Velocity and Minimum Slope

Design criteria for gravity collection and conveyance facilities are typically established to keep velocities equal to or greater than 2 feet per second (fps) at full flow. Lower velocities increase the possibility of buildup in the sewer system. Pipes were sized from a capacity standpoint, and pipe velocities will need to be further evaluated for final design. The minimum pipe slope criteria used in this analysis to maintain acceptable pipe velocities are consistent with COM Standards. Typical published values for minimum pipe slope are listed in Table 5.1.

Table 5.1 – Minimum Slope Criteria

Pipe Diameter (Inches)	Minimum Slope (FT/FT)
8	0.0035
10	0.0025
12	0.0020
15	0.0012
18	0.0010
24	0.0007

5.2 LIFT STATIONS AND FORCE MAINS

Two lift stations are to be constructed as part of Phase 1A improvements. The first lift station is southwest of the Marshall Road and State Route 33 intersection will be designed to provide 50 percent standby capacity with a minimum of 2 pumps. The lift stations will be sized to handle peak sewer flows generated from the respective service areas. All pumps will have equal capacity and will utilize variable speed drive motors to minimize the wet well size. The lift station will be equipped with, at minimum, telemetry equipment capable of transmitting alarm conditions, standby-power generating equipment, and flow monitoring equipment. Compliance will be required with all applicable agency permitting and regulations for the design and operation of the facility, including, but not limited to, the State Regional Water Quality Control Board.

The sanitary sewer lift station and a force main from the lift station to the existing Western Hills Water District sewer trunk main in Ward Ave will be constructed as part of the initial phase of development. The force main will have sufficient capacity to convey wastewater flows from all areas to be developed and were sized in conjunction with the pumping facility. Project force main sizing was determined in accordance with the Hazen-Williams Equation. Force main sizing also considers maximum velocities in the pipe, as high velocities can cause scouring in the pipe and increase headloss. Typically, force mains are sized for a velocity range between 3 and 7 feet per second (fps). The force main will cross the Delta-Mendota Canal approximately 0.5 miles east of the Ward Ave/Marshall Road intersection.

A second lift station will also be constructed as part of the Phase 1A improvements south of the airfield near the Delta Mendota canal. Due to the depth of the canal structure a lift station will be required to convey peak sewer flows generated from the respective upstream service area. No force main piping is required.

6.0 SEWER COLLECTION AND SYSTEM LAYOUT

Section 6 discusses the required sewer system layout and sewer facilities needed to collect and convey sewer flows generated by the Project to the existing Western Hills Water District 18-inch trunk line beneath Ward Ave west of the Project discussed in Section 5. Additionally, this section discusses the phasing and implementation of the proposed sanitary sewer system and the future connection to the proposed South Patterson trunk line.

6.1 GRAVITY TRUNK LINES

Gravity trunk mains are sized based on criteria discussed in Section 5. Sewer flows generated by each service area described in Section 3.1 and shown in Figure 4.4 will be collected via gravity sewer trunk mains ranging in size from 8 inches in diameter to 18 inches in diameter. Trunk mains installed as part of the initial phases will have adequate capacity to convey flows from future phases of the Project. Figures 4.1-4.3 show the preliminary layout of the gravity sewer trunk main system for Phases 1, 2, and 3.

6.2 LIFT STATIONS AND FORCE MAINS

The lift station near the northeast corner of the development will be required to pump sewer flows generated from all areas of the Project. Based on the projected design flows for all phases of development combined, as discussed in Section 3, the required capacity of the lift station is approximately 2.66 MGD. A single 12-inch-diameter force main provides adequate velocities for Phases 1, 2, and 3 with approximate velocities of 2.50 fps, 3.59 fps, and 5.26 fps, respectively.

The sanitary sewer lift station south of airfield near the Delta Mendota Canal will be required to develop the required hydraulic profile for the Phase 1A system. Based on the project design flows discussed in Section 3, the required capacity of the lift station is approximately 0.32 MGD.

6.3 INFASTRUCTURE IMPLEMENTATION PLAN SUMMARY

The City of Patterson's (COP) existing sanitary sewer infrastructure does not have sufficient capacity to meet the Crows Landing Industrial Business Park's (CLIBP) buildout sanitary sewer flows. Therefore, in order to successfully convey sewer flows from the CLIBP to the COP, AECOM and County staff developed an infrastructure implementation plan to convey sanitary sewer loads for each phase of the project to the COP's Wastewater Treatment Facility. A summary of the infrastructure plan is below.

Based on conversations with County staff, Western Hills Water District (WHWD), and City of Patterson, the available capacity in the existing Ward Ave trunk lines and the South Patterson trunk line were estimated and summarized in Table 6.1 below.

Table 6.1 – Existing Available Pipe Capacity

Existing Sewer Facility	Owner	Existing (Yes/No)	Available Capacity (MGD)
Ward Ave Trunk	WHWD	Yes	2.5 [1]
Ward Ave Trunk	COP	Yes	1.37
South Patterson Trunk Sewer (SPTS)	COP	No, expected in about 10 years	4.9[2]

[1] This is the estimated available capacity in the Ward Ave. trunk link for the buildout of Diablo Grande. Based on document provided by WHWD, the total estimated sewer flow is around 1 MGD for buildout as shown in Appendix A in Table entitle, "Full Flow Pipeline Capacity for 18" Line Along Ward Ave".
[2]Available capacity is for the worst case section of proposed SPTS based on COP buildout scenario loadings. Under buildout, the SPTS is designed for 0.50 d/D ratio. Available capacity shown brings d/D ratio to 0.8 which is considered full capacity, see Appendix A Table entitled, "South Patterson Trunk Sewer Capacity Analysis"

(Update: See the sewer capacity discussion in Section 7.0.)

Comparing the projected CLIBP sewer flows to the existing and anticipated available capacities of the COP trunk lines, the following infrastructure phasing plan for each phase of the CLIBP buildout is described as follows.

Phase 1

Phase 1A. The County proposes to convey the projected 0.32 MGD of PWWF CLIBP sewer flows from the Phase 1A development to the WHWD Ward trunk line down to the COP where it enters the COP Ward trunk line and flows to the COP wastewater treatment plant (WWTP).

Phase 1B. The County proposes to tie in to the Phase 1A Corridor sanitary sewer infrastructure to convey the projected 1.26 MGD of combined Phase 1Aand Phase 1B PWWF CLIBP sewer flows to the WHWD Ward trunk.

Phase 2

The County proposes to build a force main system parallel to the WHWD Ward Ave trunk to convey sewage from the CLIBP to the COP at this juncture in time. The force main system should be able to convey at least 2.66 MGD for the peak wet weather flow scenario from the CLIBP 100% buildout. The proposed parallel force main will connect to the proposed South Patterson Trunk Sewer (SPTS). This new trunk line will be utilized to convey CLIBP-generated sewage to the COP WWTP. The County will assist in paying for the necessary STPS construction and any necessary improvements to expand the COP WWTP to accommodate the additional CLIBP sewer flows. The COP WWTP expansion should be sized to handle buildout peak wet weather flows from the CLIBP.

Phase 3

This phase will utilize the newly constructed parallel force main system in Ward Ave. to convey CLIBP sewer flows to the COP. The SPTS will carry buildout flows from the CLIBP to the expanded COP WWTP.

Assumptions

The Project phasing assumes the following:

- WHWD will allow the CLIBP to utilize their portion of the available Ward Ave trunk line capacity. District Engineer Patrick Garvey has confirmed that WHWD has tentatively agreed to accommodate the CLIBP at this point. An agreement will be developed between the County and WHWD to capture costs associated with utilizing capacity in the Ward Ave. trunk line.
- The COP owns and operates the portion of the Ward Ave trunk line along Ward Ave from M Street to just south of Bartch Avenue extending to the limits of the Patterson Service Area as identified in the COP Master Plan. WHWD owns and operates the Ward Ave trunk line to the south of this limit to approximately Marshall Road.
- The available capacity of the Ward Ave. trunk owned by WHWD as calculated by WHWD is 3.6 MGD for a full pipe. Assuming a 0.8 d/D ratio, capacity is approximately 3.5 MGD.
- Diablo Grande will generate approximately 1 MGD of sewage flow at buildout. There are currently reports of little to no peaking flow in the trunk. It is uncertain if this lack of peaking flow will continue.
- The County will fund its fair share of the improvements needed in the COP sewer system due to impacts by the CLIBP through connection fees.
- The COP will build the improvements needed to accommodate the CLIBP.
- The COP will fix the known existing deficiency in the Ward trunk. The existing deficiency is at the intersection of Ward Ave and M Street. There is a pipe with reverse slope here that will need to be corrected.
- Inflow and infiltration should be very little for new sewer systems. While it is anticipated to be minimal for the CLIBP initially, it will still be present due to holes in manhole covers and leaking pipe joints, etc.
- The revised sewer loading factors and revised demands are confirmed and acceptable to the County.

7.0 SEWER TREATMENT, STORAGE, AND DISPOSAL

Section 7 discusses treatment and disposal of sewer flows generated by the Project. Information contained within the *City of Patterson Wastewater Master Plan, May 2010 Edition* was used to define treatment, storage, and disposal provided by the City of Patterson Water Quality Control Facility (WQCF).

Prior to the November 2017 update to this study, the COP completed an update to its Wastewater Master Plan (WWMP). That plan did not include wastewater contributions from CLIBP. The COP contracted with Blackwater Consulting Engineers, Inc. (Blackwater) to generate a Technical Memorandum (TM) as an update to their master plan, summarizing the potential impacts to Patterson's wastewater collection system and WQCF from CLIBP wastewater flows and loadings, including from Phase 1 to Buildout. This included a hydraulic model update of the City's sewer system and capacity analysis of the WQCF. A copy of this TM is included in Appendix C.

The County's preferred alternative is to construct sanitary sewer force mains in Marshall Road from the Project's lift station to a new connection on the existing Western Hills Water District sewer trunk line, which conveys sewer flows to the City of Patterson's sanitary sewer conveyance system for delivery to the City's WQCF. According to the City's current Wastewater Master Plan, the permitted capacity of 3.5 MGD does not account for development outside the City's 2004 sphere of influence. Additionally, the plant evaluation in Appendix C concluded that the WQCF's "reliable" capacity is less than the permitted capacity; therefore, a facility expansion would be required to handle Project wastewater flows. The timing of such expansion would need to be determined with the City of Patterson.

7.1 CITY OF PATTERSON WASTEWATER COLLECTION AND TREATMENT SYSTEMS

The COP WQCF receives wastewater from the trunk sewer system near the intersection of Walnut Ave and Poplar Ave. The wastewater enters an influent pumping station where it is screened and then pumped to several process units for treatment. The City is using three treatment processes including the South Activated Sludge Treatment System, the North Activated Sludge Treatment System, and the Advanced Integrated Pond System. These treatment systems use a combination of aeration, circulation, nitrogen removal, clarifiers, aerobic digesters, percolation ponds, and dewatering beds.

There are 15 percolation ponds for effluent disposal located in the WQCF plant site. The total area of these ponds is approximately 109 acres. Percolation capacity on an average annual basis is approximately 3.38 MGD.

7.1.1 City of Patterson Wastewater Collection System

The Blackwater TM (Appendix C) contains the following findings and conclusions regarding acceptance of CLIBP wastewater flows into the COP wastewater collection systems.

- The original approach for disposing of the projected CLIBP sewer flows from the Phase 1A and Phase 1B developments was to discharge by gravity to the WHWD Ward trunk line down to the COP where it enters the COP Ward trunk line and flows to the COP WQCF. This pipeline route is shown in Figure 2.1 at the end of this document.

- Hydraulic analysis of the Ward Avenue trunk sewer showed it does not have sufficient capacity to accommodate the known areas in Patterson for potential growth, and the addition of CLIBP Phase 1 flows. To accommodate the CLIBP flows, the existing 21-inch sections would need to be upsized to 24-inches.
- Further downstream on the proposed COP route, hydraulic analysis confirmed a portion of the M Street sewer has a reverse slope, and is recommended for replacement.
- For CLIBP Phase 2, the County proposes to build a force main parallel to Ward Road, connecting to the proposed new SPTS discharging to the WQCF. This route is also shown in Figure 2.1. The Blackwater analysis confirmed this proposed conveyance has the capacity to accommodate the CLIBP Buildout PWWF.
- Construction of the SPTS system was recommended before accepting CLIBP flows up to their buildout ADWF. System would be built to accommodate full buildout flows from Diablo Grande, CLIBP and South Patterson. Probable construction cost was estimated at $8.38M, equating to a cost-sharing unit cost of $3.40 per gpd ADWF.
- Cost share to the County for accommodating the CLIBP full buildout flow in the City's collection system was estimated at $3.03M.

7.1.2 City of Patterson WQCF Treatment Capacity

The current total "reliable" capacity of the COP WQCF is estimated to be 1.85 MGD. Completion of the Phase III and Phase IV expansion projects described in the City's latest WWMP are needed to accept the full buildout flows from the CLIBP.

- The report in Appendix C provides line item estimates for the Phase IV expansion. Probable construction cost was estimated at $8.38M, equating to a cost-sharing unit cost of $30 per gpd ADWF. Cost share to the County for accommodating the CLIBP full buildout flow in the City's collection system and the WQCF was estimated at $29.8M.

7.2 WASTEWATER TREATMENT AND DISPOSAL ALTERNATIVES

7.2.1 Individual On-Site Treatment and Disposal

If the City of Patterson cannot accommodate the projected wastewater flows from the Project, then the Stanislaus County's *Guidelines for Septic System Design* could be followed for development until the City can make provisions to accommodate additional sewer flows. This approach could be used for initial development of the Phase I areas, with new industrial facility owners or tenants responsible for the individual systems' design, construction and maintenance. The County could evaluate and approve individual systems on a case by case basis. Further studies would be required to determine the number and extent of individual systems that could be allowed until construction of Phase I sewer infrastructure should begin.

Such systems, referred to as Onsite Wastewater Treatment Systems (OWTS), are regulated under OWTS policy by the State Water Resources Control Board, as well as Stanislaus County. The range from traditional septic systems with leach fields to more advanced systems with biological filters to reduce BOD and TSS in the septic tank effluent. Some systems or components can also reduce nitrates. The state OWTS policy categorizes these treatment systems within several tiers, with ascending tiers associated with fewer environmental risks. Stanislaus County guidelines require a biological treatment component for new septic systems. A commonly used OWTS biological filter module used to provide additional treatment to septic tank effluent is shown in Figure 7.1.

Figure 7.1 – Septic Tank Effluent Biofilter (Orenco)

This is one of several National Sanitation Foundation (NSF) approved OWTS components that provide higher levels of treatment than standard septic systems with leach fields. Biofilters of this type should be able to produce effluent with less than 30 mg/L BOD and less than 30 mg/L TSS or better. Components and options include the following.

- Filter feed pumps recirculate the septic tank effluent through fabric biofilters to reduce dissolved organic constituents.
- Effluent dosing pumps convey the treated effluent to irrigation systems and/or shallow soil percolation fields. Under state regulations, irrigation distribution systems that distribute effluent below the soil surface and do not result in any surface ponding can operate without disinfection of the treated effluent.

- Each OWTS is subject to siting regulations and restrictions, including soil type, percolation rates, depth to groundwater, and other limitations. The County would evaluate each system on a site-specific basis to determine if it can be approved.

The use of OWTS will have a greater impact on groundwater and will require: 1) referral to RWQCB for review for any systems that treat industrial waste, 2) monitoring more closely than other systems, 3) more land area designated for the disposal of the effluent (initial dispersal field 100% future expansion dispersal field) for each system, and 4) engineered design as they are commercial and industrial systems.

7.2.2 Phased Wastewater On-Site Treatment and Disposal

Packaged or custom wastewater treatment systems, complying with California Title 22 recycled water regulations and State Water Board wastewater discharge regulations, can be constructed on the CLIBP property to manage its wastewater over time.[4] Modular treatment systems can be matched to the treatment capacity required for each phase and constructed as needed, not unlike the phased expansion projects that the COP is planning with its WQCF.

A primary consideration in selecting an on-site treatment system is the reuse or disposal method selected for the treated effluent. Three effluent reuse and disposal assumptions were considered.

- 100 percent of treated effluent is reused for landscape irrigation with storage during the non-irrigation wet season.
- Treated effluent is reused for landscape irrigation to the extent practicable during the irrigation season with limited storage and percolation to manage effluent generated during the wet season.

Treated effluent is disposed of by percolation in the multi-use storm water retention pond described in the CLIBP Drainage Study.

A number of combinations may also be employed. For example, treated effluent could be used for irrigation during the irrigation season and discharge to the storm water retention pond during the non-irrigation season.

Water quality requirements for effluent disposal assumptions are presented in Table 7.1.

Table 7.1 – Water Quality Requirements for Effluent Disposal Assumptions

Constituent	Assumed Effluent for Reuse	Assumed Effluent for Surface Discharge	California Title 22
BOD_5	< 10 mg/L	< 5 mg/L	
TSS	< 10 mg/L	< 5 mg/L	
Total Nitrogen	< 10 mg/L	< 2 mg/L	
Turbidity			< 2 NTU
Fecal Coliform			< 2.2 MPN/100 ml

[4] A package treatment system may also require submittal of Waste Discharge Requirements (WDR) to the RWQCB.

A 12-month water balance was calculated to determine irrigation demands and how much irrigated land and water storage would be required for the 100 percent effluent irrigation option. This balance was calculated only for the total buildout phase using the ADWF of 0.891 MGD to establish the feasibility of this assumption. The parameters used in the water balance, including evapotranspiration and precipitation data along with their sources, are summarized in Appendix D.

Figure 7.2 shows a graphical representation of the monthly irrigation demand overlaid by the full buildout ADWF effluent flow from the proposed on-site treatment plant that would be available for irrigation. Several balances were run with different sized land areas. The results shown in Figure 7.2 were derived from running a balance on about 250 irrigated acres.

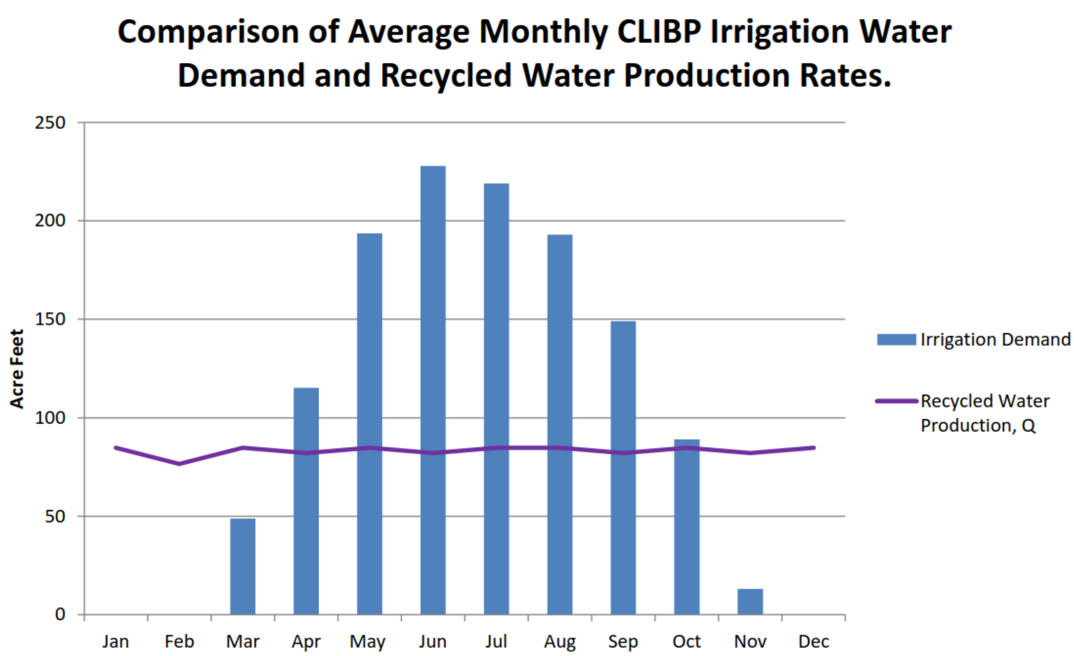

Figure 7.2 – Water Balance Graph for 250 Irrigated Acres

As can be seen in the figure, irrigation demand in the dry season from April through October significantly exceeds the recycled water that would be available at full buildout. During wet season months from November through March, recycled water generation exceeds irrigation demand which falls to zero in the months of December, January, and February. To achieve a 100 percent irrigation disposal scenario, the effluent would have to be stored in a reservoir through these non-irrigation periods and be available for the greater irrigation demand months in addition to the recycled water generated in those months. However, reservoir capacity needed for this storage would require setting aside more land than is likely to be available. Furthermore this reservoir would have to be set back from the airport runway as described in the CLIBP Drainage Study. Owing to these restrictions, the 100 percent irrigation disposal assumption is not being considered.

The other assumptions, irrigation as practicable with percolation, or call percolation discharging to the storm water retention pond, remain viable options for disposing of treated wastewater from the CLIBP.

To compare an on-site wastewater treatment system to the option of disposal at the Patterson WQCF, an assessment was made of treatment systems for the full buildout wastewater ADWF. Two types of modular, packaged treatment systems were considered. These are described below.

Sequencing Batch Reactor (SBR)

SBRs will have been successfully utilized for decades in the United States. The process consists generally of two or more activated sludge reactors/basins, which operate with alternate filling, reacting, settling, and decanting over a specified time. The alternating sequences of the activated sludge basins allow for continuous flow into an out of the treatment plant in spite of its “batch”operation. The SBR combines BOD reduction, nitrification and denitrification, and clarification into each reactor. Pretreatment includes screening and grit removal of the raw influent. Generally there is no primary settling. Nearly suspended solids and dissolved organics are treated in the activated sludge reactors which produce clarified effluent and waste activated sludge (WAS). The decanted clarified effluent is further treated by tertiary filters to achieve the turbidity requirements of California Title 22 recycled water regulations. The fecal coliform requirements are achieved with ultraviolet (UV) disinfection.

Waste products requiring off-site disposal would include the screenings and grit, both washed, mechanically dewatered and compacted, and the WAS. The WAS is stabilized in an aerobic digester reactor that is part of the packaged plant. Stabilized WAS his then mechanically dewatered, typically with a centrifuge or screw press. A contracted waste hauler will periodically remove these byproducts for off-site disposal at a permitted facility.

The amount of land needed for an SBR and its support infrastructure should be less than 10 acres. This would include a small emergency storage reservoir that can store from 1 to 3 days of effluent should it fall out of compliance with Title 22 or state discharge permit limitations. This is a regulatory requirement. A properly operated SBR with tertiary filtration and UV disinfection should be able to comfortably meet the effluent limitations presented in Table 7.1.

Membrane Bioreactor (MBR) Process

MBRs have become very popular for high effluent quality. They are similar to SBRs in that all biological processes happen in a common reactor basin. The MBR also combines microfiltration within the reactor or in a side chamber, eliminating the need for a settling/clarification step. MBRs can achieve non-detect results for BOD and TSS, and < 0.01 NTU turbidity. If nitrogen removal is included, total nitrogen in the effluent will be typically < 5 mg/L. The preliminary treatment processes, tertiary filtration and disinfection, and WAS digestion on dewatering processes would be the same as those described for the SBR. MBRs typically use more energy than comparable SBRs, but are reported to be somewhat easier to operate. Both MBRs and will SBRs are ideal for modular phased construction, adding capacity when it is needed.

The unit costs assumed for construction cost opinions for these processes range as follows.

- SBR: $25-$30 per gpd ADWF
- MBR: $27-$32 per gpd ADWF

Assuming full capacity build out facilities were constructed, the construction cost opinions would average $24.5M for the SBR process, and $26.3M for the MBR process. Building either process in phases to match the capacities needed for each development phase would cost more in current dollars, but less and life cycle or present worth dollars. Phased construction is the normal method in most projects of this type.

7.2.3 Permitting and Operations for On-Site Treatment and Disposal

Individual OWTS

For initial developments with OWTS for individual facilities, the County has permitting authority and mechanisms available to evaluate, approve and permit such systems. State criteria are mostly siting based and the County would remain the lead agency as long as treated effluent cannot percolate into groundwater or migrate into surface waters.

Irrigation and Percolation Assumption

Under this treatment and disposal assumption, highly treated effluent is discharged to land with no discharge to surface waters, but discharge will reach groundwater. Under this scenario, the treatment plant owner must obtain a waste discharge requirements (WDR) permit from the State Water Board. The Regional Water Board will be the lead agency, but the County will also be involved. The Regional Water Board will write WDRs that include effluent limitations designed to protect groundwater quality.

Discharge into Storm Water Pond with Percolation Assumption

Under this treatment and disposal assumption, highly treated effluent is discharged into the proposed multi-use storm water pond where the effluent will percolate into the upper unconfined groundwater aquifer. During storm events, effluent would blend with storm water in the pond, which will be designed with a specially engineered bottom to enhance percolation in the otherwise slow percolating soil in that area. This is explained in the CLIBP Drainage Study.

- The proposed storm water pond is to be designed to contain all storm water runoff up to a 2-year storm event. This 40 acre pond is shown on Figure 1.1.
- In the event that a storm event greater than the 2-year storm occurs, the pond could overflow at its north end with the overflow eventually making its way to the San Joaquin River. Although any of the treated effluent in the pond would be a small portion of this overflow, the state Regional Water Board would consider this a surface water discharge. The County would be required to get and NPDES discharge permit in addition to state WDRs. The NPDES permit would likely have seasonal flow limitations, allowing discharge from the Storm Water Pond only during the wet season.
- Permitting either of the above alternatives may have complications due to currently unknown site conditions. Limitations on dissolved mineral parameters such as total dissolved solids (TDS) and electro conductivity (EC) can be difficult to resolve for either land/groundwater or surface water discharges. If residuals from wellhead treatment are discharged to the sewer system, this could exacerbate the TDS or EC problems.

8.0OVERALL FINDINGS

The following conclusions are made based on the findings of this study.

- Wastewater flows generated by the Project and pumped into the existing trunk main within Ward Ave will require treatment, storage, and disposal.
- The Project area will be annexed into the Western Hills Water District for sanitary sewer conveyance and treatment. Eventually the Phase 2 and 3 buildout will require coordination with the City of Patterson to connect to the proposed South Patterson trunk line.
- The existing agreement between the City of Patterson and the Western Hills Water District to convey, treat, and dispose of wastewater will require amendment to accommodate Project flows.
- The City of Patterson Water Quality Control Facility will require improvements to accommodate the addition of Project flows. Additional studies are required to determine the improvements required at the facility to handle Project flows.
- The projected peak wet weather flows at build-out of the Project total approximately 2.66 MGD.
- The projected peak wet weather flows for Phase 1A development total approximately 0.32 MGD
- The projected peak wet weather flows for Phase 1 of the Project total approximately 1.26 MGD.
- The Project will consist of two sewer collection system service areas.
- The lift station located near Marshall Road is required to convey sewer flows from the Project to the existing Western Hills Water District 18-inch sanitary sewer trunk main beneath Ward Ave. The lift station is to be sized to convey the estimated peak sewer flows of 2.66 MGD for the anticipated buildout of the development. The lift station located south of the air field near the Delta Mendota Canal is required to maintain the hydraulic profile in the system after traveling under the 20- to 30-foot-deep canal structure. The lift station is to be sized for approximately 0.32 MGD, which will deliver approximately 4 feet of head to downstream invert.
- OWTS for individual sewer connections may be feasible, subject to percolation test data, in the initial development stages of Phase 1, transitioning to a community collection system at a point to be determined.
- Phased on-site community wastewater treatment and disposal facilities that discharge highly treated effluent to landscape irrigation and/or percolation are a feasible alternative to sending wastewater to the City of Patterson. On-site community wastewater treatment and disposal facilities will require engineered design, and percolation test data will be necessary to determine feasibility and the amount of land required for waste water discharge/disposal.

8.1 ALTERNATIVES

A stand-alone onsite wastewater treatment and disposal system facility is feasible, but the County prefers a regional solution with the City of Patterson to better serve the Project and its community stakeholders. An on-site treatment solution would require implementation of a local disposal or re-use solution for treated effluent in addition to a plan for solids removal or re-use. An advantage to the regional solution with the City of Patterson is that their collection and treatment system is already permitted.

Appendix A
Sewer Calculations

South Patterson Trunk Sewer Remaining Capacity Analysis

Crows Landing Industrial Business Park Sewer System (Sanitary Sewer) Infrastructure Study)

Stanislaus County

Label[1]	Diameter (in)[1]	Length (Unified) (ft)[1]	Slope (Calculated) (ft/ft)[1]	Flow (gal/day)[1]	d/D (%)[1]	Flow at 0.7 d/D[2]	Flow (MGD)	Remaining Capacity Assuming Max d/D of 0.7 (MGD)	Available Capacity (Y/N)
S1	24	1,280	0.0041	4,232,539	47.2	7.83	4.2	3.6	Yes
S2	24	1,353	0.0044	4,521,867	48.0	8.11	4.5	3.6	Yes
S3	30	1,927	0.0017	4,836,249	46.6	9.15	4.8	4.3	Yes
S4	30	2,076	0.0018	4,932,013	46.3	9.41	4.9	4.5	Yes
S5	30	353	0.0020	5,379,426	47.2	9.92	5.4	4.5	Yes
S6	30	1,627	0.0042	5,379,426	38.4	14.38	5.4	9.0	Yes
S7	33	2,653	0.0012	5,465,825	47.7	9.91	5.5	4.4	Yes
S8	33	3,947	0.0022	6,542,925	44.5	13.42	6.5	6.9	Yes
S9	36	2,586	0.0015	6,684,588	44.0	13.97	6.7	7.3	Yes
Buildout Peak Wet Weather Flow of CLIBP			2.66	MGD					

[1]Design data provided by NV5.

[2]Assumes manning's n of 0.013. Calculation was performed using http://hawsedc.com/engcalcs/Manning-Pipe-Flow.php accessed 2/11/16

Full Flow Pipeline Capacity for 18" Line along Ward Ave
Crows Landing Industrial Business Park Sewer System (Sanitary Sewer) Infrastructure Study)
Stanislaus County

Mannings Equation $Q = \left(\frac{1.49}{n}\right) AR^{2/3}\sqrt{S}$

Source:
http://www.jmeagle.com/pdfs/2008%20Brochures/Gravity%20Sewer_web.pdf

n = 0.011
S = 0.002
d = 18 in
1.5 ft
A = 1.77 ft2
R = 0.375

From WHWD
Q = 5.564 cfs
3,595,857 gpd
3.60 MGD

Capacity

Diablo Grande	
Units (#)	Usage (gpd)
450	45,000
1000	100,000
2300	230,000
Full Permited Flow	1,000,000
*Usage Ratio	100

Crows Landing		
	Dry (gpd)	Wet (gpd)
Phase 1	1,184,000	1,265,000
Phase 2	531,000	549,000
Phase 3	822,000	849,400
Phase 1+2	1,715,000	1,814,000
Phase 1+2+3	2,537,000	2,663,400

Scenario Analysis

Total Capacity Analysis										
		Crows Landing Buildout Scenarios (Ward Ave Pipe Capacity 3.5 MGD assumes max d/D is 0.8)								
		Phase 1			Phase 1+2			Phase 1+2+3		
		Dry (gpd)	Wet (gpd)	Capacity (Y/N)	Dry (gpd)	Wet (gpd)	Capacity (Y/N)	Dry (gpd)	Wet (gpd)	Capacity (Y/N)
Diablo Bildout Scenarios	w/ Current Units	1,229,000	1,310,000	Y	1,760,000	1,859,000	Y	2,582,000	2,708,400	Y
	w/ 1000 Units	1,284,000	1,365,000	Y	1,815,000	1,914,000	Y	2,637,000	2,763,400	Y
	w/ 2300 Units	1,414,000	1,495,000	Y	1,945,000	2,044,000	Y	2,767,000	2,893,400	Y
	Full Permitted Flow	2,184,000	2,265,000	Y	2,715,000	2,814,000	Y	3,537,000	3,663,400	N

Appendix B
Model Output

Scenario: Phase 1 - Peak
Current Time Step: 0.000Hr
FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Manning's n	Diameter (in)	Length (ft)	Slope (ft/ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (Minimum) (ft/s)	Velocity (Maximum) (ft/s)	Velocity (Average) (ft/s)	Depth (Normal) / Rise (%)
CO-13	MH-08	118.92	MH-11	111.50	0.013	18.0	3,711.0	0.0020	1.99	4.70	2.00	15.00	2.55	45.5
CO-18	MH-07A	119.70	MH-08	118.92	0.013	15.0	518.0	0.0015	0.41	2.51	2.00	15.00	1.51	27.4
CO-20	MH-42	140.70	MH-45	128.00	0.013	8.0	3,195.0	0.0040	(N/A)	0.76	2.00	15.00	(N/A)	(N/A)
CO-22	MH-21	157.34	MH-41	151.85	0.013	8.0	1,569.0	0.0035	0.04	0.71	2.00	15.00	1.10	15.9
CO-23	MH-41	151.85	MH-40	147.01	0.013	8.0	1,384.0	0.0035	0.29	0.71	2.00	15.00	1.95	44.6
CO-25	MH-03	125.72	MH-7B	124.42	0.013	8.0	864.0	0.0015	0.13	0.47	2.00	15.00	1.14	35.8
CO-26	MH-7B	124.42	MH-07A	119.70	0.013	10.0	3,151.0	0.0015	0.38	0.85	2.00	15.00	1.51	47.0
CO-27	MH-002	131.36	MH-001	130.06	0.013	8.0	371.0	0.0035	0.17	0.72	2.00	15.00	1.67	32.8
CO-28	MH-001	130.06	MH-7B	124.42	0.013	8.0	1,611.0	0.0035	0.24	0.71	2.00	15.00	1.85	40.3
CO-29	MH-37	165.03	MH-41	153.23	0.013	8.0	1,902.0	0.0062	0.04	0.95	2.00	15.00	1.35	13.9
CO-30	MH-30	169.93	MH-29	166.79	0.013	8.0	897.0	0.0035	0.03	0.71	2.00	15.00	0.97	13.1
CO-31	MH-29	163.39	MH-36	158.78	0.013	8.0	1,316.0	0.0035	0.10	0.72	2.00	15.00	1.45	25.5
CO-32	MH-36	155.68	MH-40	153.53	0.013	8.0	716.0	0.0030	0.20	0.66	2.00	15.00	1.66	37.4
CO-34	MH-17	165.50	MH-35	162.43	0.013	8.0	1,025.0	0.0030	0.18	0.66	2.00	15.00	1.61	35.6
CO-35	MH-40	147.01	MH-35	142.61	0.013	10.0	2,201.0	0.0020	0.70	0.98	2.00	15.00	1.95	62.3
CO-36	MH-31	169.43	MH-17	167.14	0.013	8.0	654.0	0.0035	0.03	0.72	2.00	15.00	1.00	13.6
CO-37	MH-38	169.60	MH-33	164.69	0.013	8.0	1,403.0	0.0035	0.04	0.71	2.00	15.00	1.14	17.0
CO-38	MH-33	164.69	MH-34B	159.65	0.013	8.0	1,677.0	0.0030	0.19	0.66	2.00	15.00	1.65	37.2
CO-41	MH-39	169.21	MH-32	163.68	0.013	8.0	1,581.0	0.0035	0.04	0.71	2.00	15.00	1.14	16.9
CO-42	MH-32	163.68	MH-26	154.44	0.013	12.0	674.0	0.0137	0.07	4.17	2.00	15.00	2.02	9.2
CO-43	MH-34B	157.88	MH-26	154.44	0.013	8.0	981.0	0.0035	0.26	0.72	2.00	15.00	1.90	42.1
CO-45	MH-16	170.00	MH-48	164.50	0.013	8.0	154.0	0.0357	0.07	2.28	2.00	15.00	2.93	11.9
CO-47	MH-48	164.50	MH-49	162.30	0.013	8.0	529.0	0.0042	0.07	0.78	2.00	15.00	1.37	20.0
CO-49	MH-49	162.30	W-1	162.30	0.013	8.0	2.0	0.0000	0.07	0.00	2.00	15.00	0.20	(N/A)
CO-51	MH-34A	136.63	MH-08	118.92	0.013	18.0	6,795.0	0.0026	1.58	5.36	2.00	15.00	2.64	37.2
CO-52	MH-26	154.44	MH-34A	136.63	0.013	12.0	2,353.0	0.0076	0.36	3.10	2.00	15.00	2.63	22.9
CO-54	T-2	167.58	MH-17	165.83	0.013	8.0	738.0	0.0024	0.10	0.59	2.00	15.00	1.27	28.5
CO-55	MH-35	142.61	MH-51	138.48	0.013	12.0	2,066.4	0.0020	1.09	1.59	2.00	15.00	2.18	60.8
CO-56	MH-51	138.48	MH-34A	136.63	0.013	12.0	925.8	0.0020	1.09	1.59	2.00	15.00	2.18	60.8

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Scenario: Phase 1 - Peak
Current Time Step: 0.000Hr
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss (ft)	Is Active?	Sanitary Loads	Sanitary Loads <Count>
MH-40	156.86	147.01	0.70	147.53	147.53	0.00	True	<Collection: 1 item>	1
MH-08	129.00	118.92	1.99	119.60	119.60	0.00	True	<Collection: 0 items>	0
MH-002	134.53	131.36	0.17	131.58	131.58	0.00	True	<Collection: 1 item>	1
MH-001	133.23	130.06	0.24	130.33	130.33	0.00	True	<Collection: 1 item>	1
MH-03	145.00	125.72	0.13	125.96	125.96	0.00	True	<Collection: 1 item>	1
MH-21	162.00	157.34	0.04	157.45	157.45	0.00	True	<Collection: 1 item>	1
MH-37	168.20	165.03	0.04	165.12	165.12	0.00	True	<Collection: 1 item>	1
MH-51	161.32	138.48	1.09	139.09	139.09	0.00	True	<Collection: 0 items>	0
MH-36	161.95	155.68	0.20	155.93	155.93	0.00	True	<Collection: 1 item>	1
MH-29	169.96	166.79	0.10	163.56	163.56	0.00	True	<Collection: 1 item>	1
MH-30	173.10	169.93	0.03	170.02	170.02	0.00	True	<Collection: 1 item>	1
MH-31	172.60	169.43	0.03	169.52	169.52	0.00	True	<Collection: 1 item>	1
MH-17	171.00	165.83	0.18	165.74	165.74	0.00	True	<Collection: 1 item>	1
MH-16	182.00	170.00	0.07	170.12	170.12	0.00	True	<Collection: 1 item>	1
MH-07A	130.00	119.70	0.41	120.04	120.04	0.00	True	<Collection: 1 item>	1
MH-49	175.00	162.30	0.07	163.80	163.80	0.00	True	<Collection: 0 items>	0
MH-41	155.02	151.85	0.29	152.15	152.15	0.00	True	<Collection: 1 item>	1
MH-35	165.00	142.61	1.09	143.22	143.22	0.00	True	<Collection: 1 item>	1
MH-48	178.00	164.50	0.07	164.63	164.63	0.00	True	<Collection: 0 items>	0
MH-7B	143.00	124.42	0.38	124.81	124.81	0.00	True	<Collection: 1 item>	1
MH-26	165.00	154.44	0.36	154.69	154.69	0.00	True	<Collection: 1 item>	1
MH-32	166.85	163.68	0.07	163.79	163.79	0.00	True	<Collection: 1 item>	1
MH-39	172.38	169.21	0.04	169.32	169.32	0.00	True	<Collection: 1 item>	1
MH-34A	159.67	136.63	1.58	137.19	137.19	0.00	True	<Collection: 1 item>	1
MH-34B	161.05	157.88	0.26	158.16	158.16	0.00	True	<Collection: 1 item>	1
MH-33	167.86	164.69	0.19	164.94	164.94	0.00	True	<Collection: 1 item>	1
MH-38	172.77	169.60	0.04	169.71	169.71	0.00	True	<Collection: 1 item>	1
MH-11	118.00	110.06	1.99	110.59	110.59	0.00	True	<Collection: 0 items>	0

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Scenario: Phase 1,2 - Peak
Current Time Step: 0.000Hr
FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Manning's n	Diameter (in)	Length (ft)	Slope (ft/ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (Minimum) (ft/s)	Velocity (Maximum) (ft/s)	Velocity (Average) (ft/s)	Depth (Normal) / Rise (%)
CO-4	MH-13	117.22	MH-12	114.32	0.013	8.0	966.0	0.0030	0.01	0.66	2.00	15.00	0.72	9.1
CO-6	MH-14	121.93	MH-13	120.08	0.013	8.0	527.0	0.0035	0.00	0.72	2.00	15.00	0.52	4.9
CO-13	MH-08	118.92	MH-11	111.50	0.013	18.0	3,711.0	0.0020	2.73	4.70	2.00	15.00	2.76	54.8
CO-14	MH-12	112.70	MH-11	110.06	0.013	12.0	1,318.0	0.0020	0.05	1.59	2.00	15.00	0.90	11.7
CO-15	MH-43	140.50	MH-44	131.71	0.013	8.0	1,953.0	0.0045	0.28	0.81	2.00	15.00	2.10	40.4
CO-16	MH-44	131.71	MH-45	128.65	0.013	8.0	1,020.0	0.0030	0.44	0.66	2.00	15.00	2.03	59.8
CO-17	MH-45	128.65	MH-07A	124.77	0.013	10.0	971.0	0.0040	0.73	1.38	2.00	15.00	2.57	51.4
CO-18	MH-07A	119.70	MH-08	118.92	0.013	15.0	518.0	0.0015	1.29	2.51	2.00	15.00	2.06	50.9
CO-20	MH-42	140.70	MH-45	128.00	0.013	8.0	3,195.0	0.0040	0.20	0.76	2.00	15.00	1.84	35.1
CO-22	MH-21	157.34	MH-41	151.85	0.013	8.0	1,569.0	0.0035	0.13	0.71	2.00	15.00	1.56	28.8
CO-23	MH-41	151.85	MH-40	147.01	0.013	8.0	1,384.0	0.0035	0.35	0.71	2.00	15.00	2.03	49.1
CO-25	MH-03	125.72	MH-7B	124.42	0.013	8.0	864.0	0.0015	0.12	0.47	2.00	15.00	1.13	34.8
CO-26	MH-7B	124.42	MH-07A	119.70	0.013	10.0	3,151.0	0.0015	0.42	0.85	2.00	15.00	1.56	50.0
CO-27	MH-002	131.36	MH-001	130.06	0.013	8.0	371.0	0.0035	0.16	0.72	2.00	15.00	1.64	31.9
CO-28	MH-001	130.06	MH-7B	124.42	0.013	8.0	1,611.0	0.0035	0.25	0.71	2.00	15.00	1.86	40.4
CO-29	MH-37	165.03	MH-41	153.23	0.013	8.0	1,902.0	0.0062	0.03	0.95	2.00	15.00	1.26	12.4
CO-30	MH-30	169.93	MH-29	166.79	0.013	8.0	897.0	0.0035	0.03	0.71	2.00	15.00	0.97	12.9
CO-31	MH-29	163.39	MH-36	158.78	0.013	8.0	1,316.0	0.0035	0.08	0.72	2.00	15.00	1.38	23.2
CO-32	MH-36	155.68	MH-40	153.53	0.013	8.0	716.0	0.0030	0.16	0.66	2.00	15.00	1.56	33.4
CO-34	MH-17	165.50	MH-35	162.43	0.013	8.0	1,025.0	0.0030	0.17	0.66	2.00	15.00	1.59	34.9
CO-35	MH-40	147.01	MH-35	142.61	0.013	10.0	2,201.0	0.0020	0.66	0.98	2.00	15.00	1.93	60.2
CO-36	MH-31	169.43	MH-17	167.14	0.013	8.0	654.0	0.0035	0.03	0.72	2.00	15.00	1.03	14.4
CO-37	MH-38	169.60	MH-33	164.69	0.013	8.0	1,403.0	0.0035	0.03	0.71	2.00	15.00	1.06	15.0
CO-38	MH-33	164.69	MH-34B	159.65	0.013	8.0	1,677.0	0.0030	0.15	0.66	2.00	15.00	1.54	32.6
CO-41	MH-39	169.21	MH-32	163.68	0.013	8.0	1,581.0	0.0035	0.05	0.71	2.00	15.00	1.18	18.0
CO-42	MH-32	163.68	MH-26	154.44	0.013	12.0	674.0	0.0137	0.08	4.17	2.00	15.00	2.04	9.4
CO-43	MH-34B	157.88	MH-26	154.44	0.013	8.0	981.0	0.0035	0.21	0.72	2.00	15.00	1.77	36.8
CO-45	MH-16	170.00	MH-48	164.50	0.013	8.0	154.0	0.0357	0.09	2.28	2.00	15.00	3.14	13.3
CO-47	MH-48	164.50	MH-49	162.30	0.013	8.0	529.0	0.0042	0.09	0.78	2.00	15.00	1.47	22.6
CO-49	MH-49	162.30	W-1	162.30	0.013	8.0	2.0	0.0000	0.09	0.00	2.00	15.00	0.25	(N/A)
CO-51	MH-34A	136.63	MH-08	118.92	0.013	18.0	6,795.0	0.0026	1.41	5.36	2.00	15.00	2.56	35.0
CO-52	MH-26	154.44	MH-34A	136.63	0.013	12.0	2,353.0	0.0076	0.30	3.10	2.00	15.00	2.50	21.0
CO-54	T-2	167.58	MH-17	165.83	0.013	8.0	738.0	0.0024	0.10	0.59	2.00	15.00	1.27	28.5
CO-55	MH-35	142.61	MH-51	138.48	0.013	12.0	2,066.4	0.0020	1.00	1.59	2.00	15.00	2.14	57.5
CO-56	MH-51	138.48	MH-34A	136.63	0.013	12.0	925.8	0.0020	1.00	1.59	2.00	15.00	2.14	57.5

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Scenario: Phase 1,2 - Peak
Current Time Step: 0.000Hr
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss (ft)	Is Active?	Sanitary Loads	Sanitary Loads <Count>
MH-42	143.87	140.70	0.20	140.93	140.93	0.00	True	<Collection: 1 item>	1
MH-29	169.96	166.79	0.08	163.54	163.54	0.00	True	<Collection: 1 item>	1
MH-36	161.95	155.68	0.16	155.90	155.90	0.00	True	<Collection: 1 item>	1
MH-51	161.32	138.48	1.00	139.06	139.06	0.00	True	<Collection: 0 items>	0
MH-37	168.20	165.03	0.03	165.11	165.11	0.00	True	<Collection: 1 item>	1
MH-21	162.00	157.34	0.13	157.53	157.53	0.00	True	<Collection: 1 item>	1
MH-03	145.00	125.72	0.12	125.95	125.95	0.00	True	<Collection: 1 item>	1
MH-30	173.10	169.93	0.03	170.02	170.02	0.00	True	<Collection: 1 item>	1
MH-002	134.53	131.36	0.16	131.57	131.57	0.00	True	<Collection: 1 item>	1
MH-40	156.86	147.01	0.66	147.51	147.51	0.00	True	<Collection: 1 item>	1
MH-43	143.67	140.50	0.28	140.77	140.77	0.00	True	<Collection: 1 item>	1
MH-45	131.17	128.00	0.73	129.08	129.08	0.00	True	<Collection: 1 item>	1
MH-44	134.88	131.71	0.44	132.11	132.11	0.00	True	<Collection: 1 item>	1
MH-08	129.00	118.92	2.73	119.74	119.74	0.00	True	<Collection: 1 item>	1
MH-14	128.00	121.93	0.00	121.96	121.96	0.00	True	<Collection: 1 item>	1
MH-12	121.00	112.70	0.05	112.82	112.82	0.00	True	<Collection: 1 item>	1
MH-13	128.00	117.22	0.01	117.28	117.28	0.00	True	<Collection: 1 item>	1
MH-001	133.23	130.06	0.25	130.33	130.33	0.00	True	<Collection: 1 item>	1
MH-07A	130.00	119.70	1.29	120.34	120.34	0.00	True	<Collection: 1 item>	1
MH-49	175.00	162.30	0.09	163.80	163.80	0.00	True	<Collection: 0 items>	0
MH-48	178.00	164.50	0.09	164.65	164.65	0.00	True	<Collection: 0 items>	0
MH-11	118.00	110.06	2.82	110.70	110.70	0.00	True	<Collection: 1 item>	1
MH-41	155.02	151.85	0.35	152.18	152.18	0.00	True	<Collection: 1 item>	1
MH-7B	143.00	124.42	0.42	124.84	124.84	0.00	True	<Collection: 1 item>	1
MH-31	172.60	169.43	0.03	169.53	169.53	0.00	True	<Collection: 1 item>	1
MH-26	165.00	154.44	0.30	154.67	154.67	0.00	True	<Collection: 1 item>	1
MH-32	166.85	163.68	0.08	163.79	163.79	0.00	True	<Collection: 1 item>	1
MH-34A	159.67	136.63	1.41	137.15	137.15	0.00	True	<Collection: 1 item>	1
MH-34B	161.05	157.88	0.21	158.13	158.13	0.00	True	<Collection: 1 item>	1
MH-33	167.86	164.69	0.15	164.91	164.91	0.00	True	<Collection: 1 item>	1
MH-38	172.77	169.60	0.03	169.70	169.70	0.00	True	<Collection: 1 item>	1
MH-17	171.00	165.83	0.17	165.73	165.73	0.00	True	<Collection: 1 item>	1
MH-39	172.38	169.21	0.05	169.33	169.33	0.00	True	<Collection: 1 item>	1
MH-16	182.00	170.00	0.09	170.13	170.13	0.00	True	<Collection: 1 item>	1
MH-35	165.00	142.61	1.00	143.18	143.18	0.00	True	<Collection: 1 item>	1

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Scenario: Phase 1,2,3 - Peak
Current Time Step: 0.000Hr
FlexTable: Conduit Table

Label	Start Node	Invert (Start) (ft)	Stop Node	Invert (Stop) (ft)	Manning's n	Diameter (in)	Length (ft)	Slope (ft/ft)	Flow (cfs)	Capacity (Full Flow) (cfs)	Velocity (Minimum) (ft/s)	Velocity (Maximum) (ft/s)	Velocity (Average) (ft/s)	Depth (Normal) / Rise (%)
CO-2	MH-52A	131.13	MH-52B	124.03	0.013	8.0	2,027.2	0.0035	0.04	0.72	2.00	15.00	1.13	16.7
CO-3	MH-52B	124.03	MH-13	119.96	0.013	8.0	1,161.9	0.0035	0.09	0.72	2.00	15.00	1.40	24.1
CO-4	MH-13	117.22	MH-12	114.32	0.013	8.0	966.0	0.0030	0.27	0.66	2.00	15.00	1.81	44.7
CO-5	MH-53	124.63	MH-13	117.22	0.013	8.0	2,117.0	0.0035	0.08	0.71	2.00	15.00	1.36	22.9
CO-6	MH-14	121.93	MH-13	120.08	0.013	8.0	527.0	0.0035	0.01	0.72	2.00	15.00	0.71	7.9
CO-7	MH-49	131.71	MH-46	122.51	0.013	8.0	2,626.0	0.0035	0.05	0.72	2.00	15.00	1.19	18.1
CO-8	MH-46	122.51	MH-47	119.15	0.013	8.0	960.0	0.0035	0.10	0.71	2.00	15.00	1.46	25.6
CO-9	MH-47	119.15	MH-48	117.30	0.013	10.0	739.0	0.0025	0.25	1.10	2.00	15.00	1.63	32.4
CO-10	MH-48	117.30	MH-12	112.70	0.013	10.0	2,298.0	0.0020	0.59	0.98	2.00	15.00	1.88	55.8
CO-11	MH-50	129.80	MH-47	121.02	0.013	8.0	2,509.0	0.0035	0.07	0.71	2.00	15.00	1.33	21.8
CO-12	MH-51	124.43	MH-48	117.69	0.013	8.0	1,925.0	0.0035	0.14	0.72	2.00	15.00	1.59	30.0
CO-13	MH-08	118.92	MH-11	111.50	0.013	18.0	3,711.0	0.0020	3.05	4.70	2.00	15.00	2.83	58.7
CO-14	MH-12	112.70	MH-11	110.06	0.013	12.0	1,318.0	0.0020	0.96	1.59	2.00	15.00	2.12	55.9
CO-15	MH-43	140.50	MH-44	131.71	0.013	8.0	1,953.0	0.0045	0.31	0.81	2.00	15.00	2.16	42.7
CO-16	MH-44	131.71	MH-45	128.65	0.013	8.0	1,020.0	0.0030	0.51	0.66	2.00	15.00	2.09	65.8
CO-17	MH-45	128.65	MH-07A	124.77	0.013	10.0	971.0	0.0040	0.75	1.38	2.00	15.00	2.59	52.3
CO-18	MH-07A	119.70	MH-08	118.92	0.013	15.0	518.0	0.0015	1.44	2.51	2.00	15.00	2.11	54.3
CO-20	MH-42	140.70	MH-45	128.00	0.013	8.0	3,195.0	0.0040	0.15	0.76	2.00	15.00	1.71	30.5
CO-22	MH-21	157.34	MH-41	151.85	0.013	8.0	1,569.0	0.0035	0.16	0.71	2.00	15.00	1.64	31.9
CO-23	MH-41	151.85	MH-40	147.01	0.013	8.0	1,384.0	0.0035	0.40	0.71	2.00	15.00	2.11	53.8
CO-25	MH-03	125.72	MH-7B	124.42	0.013	8.0	864.0	0.0015	0.10	0.47	2.00	15.00	1.06	31.0
CO-26	MH-7B	124.42	MH-07A	119.70	0.013	10.0	3,151.0	0.0015	0.54	0.85	2.00	15.00	1.65	58.1
CO-27	MH-002	131.36	MH-001	130.06	0.013	8.0	371.0	0.0035	0.18	0.72	2.00	15.00	1.70	34.1
CO-28	MH-001	130.06	MH-7B	124.42	0.013	8.0	1,611.0	0.0035	0.27	0.71	2.00	15.00	1.91	42.6
CO-29	MH-37	165.03	MH-41	153.23	0.013	8.0	1,902.0	0.0062	0.04	0.95	2.00	15.00	1.32	13.4
CO-30	MH-30	169.93	MH-29	166.79	0.013	8.0	897.0	0.0035	0.03	0.71	2.00	15.00	1.00	13.8
CO-31	MH-29	163.39	MH-36	158.78	0.013	8.0	1,316.0	0.0035	0.10	0.72	2.00	15.00	1.43	24.8
CO-32	MH-36	155.68	MH-40	153.53	0.013	8.0	716.0	0.0030	0.18	0.66	2.00	15.00	1.61	35.7
CO-34	MH-17	165.50	MH-35	162.43	0.013	8.0	1,025.0	0.0030	0.18	0.66	2.00	15.00	1.61	35.8
CO-35	MH-40	147.01	MH-35	142.61	0.013	10.0	2,201.0	0.0020	0.76	0.98	2.00	15.00	1.98	66.1
CO-36	MH-31	169.43	MH-17	167.14	0.013	8.0	654.0	0.0035	0.04	0.72	2.00	15.00	1.07	15.3
CO-37	MH-38	169.60	MH-33	164.69	0.013	8.0	1,403.0	0.0035	0.04	0.71	2.00	15.00	1.09	15.8
CO-38	MH-33	164.69	MH-34B	159.65	0.013	8.0	1,677.0	0.0030	0.17	0.66	2.00	15.00	1.59	34.6
CO-41	MH-39	169.21	MH-32	163.68	0.013	8.0	1,581.0	0.0035	0.06	0.71	2.00	15.00	1.23	19.0
CO-42	MH-32	163.68	MH-26	154.44	0.013	12.0	674.0	0.0137	0.09	4.17	2.00	15.00	2.12	9.9
CO-43	MH-34B	157.88	MH-26	154.44	0.013	8.0	981.0	0.0035	0.23	0.72	2.00	15.00	1.83	39.1
CO-45	MH-16	170.00	MH-48	164.50	0.013	8.0	154.0	0.0357	0.10	2.28	2.00	15.00	3.29	14.3
CO-47	MH-48	164.50	MH-49	162.30	0.013	8.0	529.0	0.0042	0.10	0.78	2.00	15.00	1.53	24.3
CO-49	MH-49	162.30	W-1	162.30	0.013	8.0	2.0	0.0000	0.10	0.00	2.00	15.00	0.29	(N/A)
CO-51	MH-34A	136.63	MH-08	118.92	0.013	18.0	6,795.0	0.0026	1.58	5.36	2.00	15.00	2.64	37.2
CO-52	MH-26	154.44	MH-34A	136.63	0.013	12.0	2,353.0	0.0076	0.34	3.10	2.00	15.00	2.58	22.2
CO-54	T-2	167.58	MH-17	165.83	0.013	8.0	738.0	0.0024	0.10	0.59	2.00	15.00	1.27	28.5
CO-55	MH-35	142.61	MH-51	138.48	0.013	12.0	2,066.4	0.0020	1.13	1.59	2.00	15.00	2.20	62.1
CO-56	MH-51	138.48	MH-34A	136.63	0.013	12.0	925.8	0.0020	1.13	1.59	2.00	15.00	2.20	62.1

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Scenario: Phase 1,2,3 - Peak
Current Time Step: 0.000Hr
FlexTable: Manhole Table

Label	Elevation (Rim) (ft)	Elevation (Invert) (ft)	Flow (Total Out) (cfs)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss (ft)	Is Active?	Sanitary Loads	Sanitary Loads <Count>
MH-51	127.60	124.43	0.14	124.63	124.63	0.00	True	<Collection: 1 item>	1
MH-52A	134.30	131.13	0.04	131.24	131.24	0.00	True	<Collection: 1 item>	1
MH-21	162.00	157.34	0.16	157.55	157.55	0.00	True	<Collection: 1 item>	1
MH-03	145.00	125.72	0.10	125.93	125.93	0.00	True	<Collection: 1 item>	1
MH-001	133.23	130.06	0.27	130.34	130.34	0.00	True	<Collection: 1 item>	1
MH-002	134.53	131.36	0.18	131.59	131.59	0.00	True	<Collection: 1 item>	1
MH-42	143.87	140.70	0.15	140.90	140.90	0.00	True	<Collection: 1 item>	1
MH-43	143.67	140.50	0.31	140.78	140.78	0.00	True	<Collection: 1 item>	1
MH-45	131.17	128.00	0.75	129.09	129.09	0.00	True	<Collection: 1 item>	1
MH-37	168.20	165.03	0.04	165.12	165.12	0.00	True	<Collection: 1 item>	1
MH-08	129.00	118.92	3.05	119.80	119.80	0.00	True	<Collection: 1 item>	1
MH-40	156.86	147.01	0.76	147.56	147.56	0.00	True	<Collection: 1 item>	1
MH-50	132.97	129.80	0.07	129.95	129.95	0.00	True	<Collection: 1 item>	1
MH-46	125.68	122.51	0.10	122.68	122.68	0.00	True	<Collection: 1 item>	1
MH-49	134.88	131.71	0.05	131.83	131.83	0.00	True	<Collection: 1 item>	1
MH-14	128.00	121.93	0.01	121.98	121.98	0.00	True	<Collection: 1 item>	1
MH-48	120.47	117.30	0.59	117.76	117.76	0.00	True	<Collection: 1 item>	1
MH-12	121.00	112.70	0.96	113.26	113.26	0.00	True	<Collection: 1 item>	1
MH-53	127.80	124.63	0.08	124.78	124.78	0.00	True	<Collection: 1 item>	1
MH-13	128.00	117.22	0.27	117.52	117.52	0.00	True	<Collection: 1 item>	1
MH-52B	127.20	124.03	0.09	124.19	124.19	0.00	True	<Collection: 1 item>	1
MH-44	134.88	131.71	0.51	132.15	132.15	0.00	True	<Collection: 1 item>	1
MH-34B	161.05	157.88	0.23	158.14	158.14	0.00	True	<Collection: 1 item>	1
MH-49	175.00	162.30	0.10	163.80	163.80	0.00	True	<Collection: 0 items>	0
MH-48	178.00	164.50	0.10	164.66	164.66	0.00	True	<Collection: 0 items>	0
MH-11	118.00	110.06	4.13	110.84	110.84	0.00	True	<Collection: 1 item>	1
MH-7B	143.00	124.42	0.54	124.90	124.90	0.00	True	<Collection: 1 item>	1
MH-07A	130.00	119.70	1.44	120.38	120.38	0.00	True	<Collection: 1 item>	1
MH-47	122.32	119.15	0.25	119.42	119.42	0.00	True	<Collection: 1 item>	1
MH-26	165.00	154.44	0.34	154.68	154.68	0.00	True	<Collection: 1 item>	1
MH-32	166.85	163.68	0.09	163.80	163.80	0.00	True	<Collection: 1 item>	1
MH-41	155.02	151.85	0.40	152.21	152.21	0.00	True	<Collection: 1 item>	1
MH-34A	159.67	136.63	1.58	137.19	137.19	0.00	True	<Collection: 1 item>	1
MH-51	161.32	138.48	1.13	139.10	139.10	0.00	True	<Collection: 0 items>	0
MH-33	167.86	164.69	0.17	164.92	164.92	0.00	True	<Collection: 1 item>	1
MH-38	172.77	169.60	0.04	169.71	169.71	0.00	True	<Collection: 1 item>	1
MH-35	165.00	142.61	1.13	143.23	143.23	0.00	True	<Collection: 1 item>	1
MH-16	182.00	170.00	0.10	170.14	170.14	0.00	True	<Collection: 1 item>	1
MH-17	171.00	165.83	0.18	165.74	165.74	0.00	True	<Collection: 1 item>	1
MH-31	172.60	169.43	0.04	169.53	169.53	0.00	True	<Collection: 1 item>	1
MH-30	173.10	169.93	0.03	170.02	170.02	0.00	True	<Collection: 1 item>	1
MH-29	169.96	166.79	0.10	163.56	163.56	0.00	True	<Collection: 1 item>	1
MH-36	161.95	155.68	0.18	155.92	155.92	0.00	True	<Collection: 1 item>	1
MH-39	172.38	169.21	0.06	169.34	169.34	0.00	True	<Collection: 1 item>	1

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Appendix C
Potential Impacts to Patterson Wastewater Facilities from CLIBP (TM)

BLACKWATER CONSULTING ENGINEERS, INC.

To: Ken Irwin, City Manager; Michael H. Willett, Director of Public Works
From: Alison Furuya, P.E.; Jeff Black, P.E.

Subject: Potential Impacts to Patterson Wastewater Facilities from Crows Landing Industrial Business Park

Date: August 25, 2017

INTRODUCTION

Stanislaus County (County) is proposing to reuse the former Crows Landing Air Facility property and develop the Crows Landing Industrial Business Park (CLIBP). The CLIBP is a planned 1,528 acre business park consisting of public facilities, logistics, industrial, business park, and general aviation land uses. The County is seeking permission to convey the wastewater from the CLIBP to City of Patterson (City) facilities for conveyance, treatment and disposal. This technical memorandum (TM) evaluates the potential impacts of the CLIBP project to the City wastewater collection system and Water Quality Control Facility (WQCF). The evaluation included:

1. A review of the City's Wastewater Master Plan WWMP) [1] and other recently completed documents related to the City's wastewater facilities.

2. A review of the Wastewater Flow and Load assumptions for the future Crows Landing Industrial Business Park development phases memorandum (CLIBP Wastewater Memo) [2], as well as previous documents relating to wastewater infrastructure for the CLIBP.

BACKGROUND

<u>Crows Landing Industrial Business Park Project</u>

The following is a brief summary of the wastewater information provided in the CLIBP Wastewater Memo. Wastewater flow and loading projections for the CLIBP were developed using the assumptions presented in Table 1.

Table 1 – CLIBP Wastewater Flow and Loading Assumptions

Parameter	Value
Airport Users - Dry Weather Loading Factor	4 gpc/day
General Land Users - Dry Weather Loading Factor	1,000 gpd/acre
Wet Weather Loading Factor, Infiltration/Inflow (I/I)	100 gpd/acre
Dry Weather Peaking Factor	3
Raw Wastewater Constituents	
Biochemical Oxygen Demand (BOD_5)	300 mg/L
Total Suspended Solids (TSS)	300 mg/L
Total Kjeldahl Nitrogen (TKN)	50 mg/L

The CLIBP plan area infrastructure and land use development is anticipated to occur over three ten-year phases. Table 2 summarizes the projected flows and loads associated with each phase and buildout of the CLIBP.

Table 2 – CLIBP Wastewater Flow and Load Projections

Parameter	Units	Phase 1 2018-2028	Phase 2 2029-2039	Phase 3 2049-2050	Total (Buildout)
Flow					
Average Dry Weather Flow (ADWF)	mgd	0.394	0.223	0.274	0.891
Peak Dry Weather Flow (PDWF)	mgd	1.182	0.669	0.822	2.673
Peak Wet Weather Flow (PWWF)	mgd	1.259	0.691	0.849	2.799
Loads					
Average BOD_5 Load	lbs/day	986	558	686	2,229
Peak BOD_5 Load	lbs/day	1,282	725	891	2,898
Average TSS Load	lbs/day	986	558	686	2,229
Peak TSS Load	lbs/day	1,282	725	891	2,898
Average TKN Load	lbs/day	164	93	114	372
Peak TKN Load	lbs/day	214	121	149	484

City of Patterson Historical Wastewater Flows and Loads

Wastewater flow and influent data for the past five years were reviewed and are summarized in Tables 3 and 4. Several influent BOD and TSS results were unusually high in 2015 and 2016. These results are not included in the data summarized in Table 5.

Table 3 – WQCF Average Dry Weather Flow Summary

Month	WQCF Influent Flow (mgd)				
	2012	2013	2014	2015	2016
June	1.55	1.41	1.45	1.42	1.41
July	1.38	1.41	1.48	1.49	1.39
August	1.43	1.45	1.48	1.41	1.43
Average	**1.45**	**1.42**	**1.47**	**1.44**	**1.41**
5-yr Average = 1.44 mgd					

Table 4 – WQCF Influent BOD and TSS Summary

Parameter	Units	2012	2013	2014	2015	2016	Average
BOD_5							
Average	mg/L	280	259	287	366	245	**287**
Minimum	mg/L	180	140	120	160	120	**144**
Maximum	mg/L	660	520	710	900	970	**752**
BOD_5 Load							
Average	lbs/d	3,331	3,121	3,500	4,315	2,876	**3,429**
Minimum	lbs/d	2,106	1,708	1,477	1,829	1,380	**1,700**
Maximum	lbs/d	7,211	6,462	8,379	9,833	10,792	**8,535**
TSS							
Average	mg/L	225	235	295	319	208	**256**
Minimum	mg/L	20	44	110	44	72	**58**
Maximum	mg/L	810	610	1,000	820	720	**792**
TSS Load							
Average	lbs/d	2,662	2,834	3,577	3,781	2,436	**3,058**
Minimum	lbs/d	228	522	1,336	540	862	**698**
Maximum	lbs/d	8,850	7,336	11,819	9,708	8,010	**9,145**

City of Patterson Projected Growth

For this evaluation, wastewater flow was estimated to increase at the same rate as projected population growth rates. The City 2015-2023 Housing Element Updated, adopted February 2016 [3] presented population projections and average annual growth rates for the City and Stanislaus County. These population projections are summarized in Table 5.

Table 5 – Patterson and Stanislaus County Population Projections

Year	Patterson		Stanislaus County	
	Population	Average Annual Growth Rate	Population	Average Annual Growth Rate
2010	20,413		514,453	
2015	25,065	4.20%	551,668	1.40%
2020	30,375	3.90%	594,146	1.50%
2025	35,685	3.30%	636,625	1.40%
2030	40,995	2.80%	679,403	1.30%
2035	43,559	1.20%	721,582	1.20%
2040	46,124	1.20%	764,060	1.20%
Change/Average	25,711	2.8%	249,607	1.3%

Source: City of Patterson 2015-2023 Housing Element Updated, adopted February 2, 2016 [3]

Projected wastewater flows for the WQCF based on the growth rates presented in Table 5 for the City, with the addition of contributions from Diablo Grande and the CLIBP, are summarized in Table 6. A total ADWF of 1.47 mgd, the maximum ADWF measured for the past 5 years, was used as the starting condition. Average annual growth rates from year 2040-2050 were assumed to be consistent with the growth rate of 1.2% for 2036-2040. The projected buildout flow for the City is also included in the table, and is from the WWMP.

Table 6 – WQCF ADWF Flow Projections

Year/Condition	Average Annual Growth Rate [a]	Projected City ADWF (mgd)	Projected Diablo Grande ADWF (mgd)	Projected Total ADWF w/o CLIBP (mgd)	Projected CLIBP ADWF (mgd)	Projected Total ADWF with CLIBP (mgd)
Existing (2016)		1.40	0.04	1.44	-	1.44
2018	3.9%	1.51	0.05	1.56	0.39	1.96
2029	2.8 - 3.3%	2.15	0.11	2.25	0.62	2.87
2040	1.2 - 2.8%	2.49	0.16	2.65	0.89	3.54
2050	1.2%	2.80	0.22	3.02	0.89	3.91
Buildout	-	5.54	0.75	6.29	0.89	7.18

[a] Average annual growth rate assumptions are based on the average annual growth rates for Patterson presented in Table 6.
[b] Assumes an ADWF of 0.032 mgd for Diablo Grande in 2009-2010, with annual increases of 5,250 gpd per year.

The City receives wastewater from the Diablo Grande development, located west of the City limits. The WWMP reported an ADWF for Diablo Grande of 0.032 mgd, based on flow data from 2009-2010. This flow was used as a baseline and was increased by 5,250 gpd per year, based on the assumption that 30 housing units have been and will be added per year, with an average flow of 175 gallons per day (gpd) per unit. This growth assumption for Diablo Grande resulted in an estimated ADWF of 0.04 mgd for

Diablo Grande in 2016. The City is in the process of collecting flow data for Diablo Grande. The most recently collected data indicates that Diablo Grande is discharging average flows in the range of 350,000 to 420,000 gpd, which is significantly higher than the estimate shown in Table 6.

POTENTIAL IMPACTS TO COLLECTION SYSTEM

The CLIBP Wastewater Memo describes the installation of a temporary connection to the existing Western Hills Water District (WHWD) 18-inch sewer trunk line at the intersection of Ward Avenue and Marshall Road to convey CLIBP Phase 1 flows to the City collection system. This temporary connection will be replaced with a permanent connection to the proposed South Patterson Trunk Sewer (SPTS) at the intersection of Bartch Avenue and Ward Avenue, as part of CLIBP Phase 2.

The hydraulic model, developed as part of the WWMP, was evaluated for the existing trunk sewers on Ward Avenue, M Street and Ward Avenue (referred to as the Central Trunk Sewer (CTS) in this TM), and the proposed SPTS. The following two scenarios were executed to determine if the proposed CLIBP wastewater connections could be accommodated by the existing and proposed City collection system.

Scenario 1: CLIBP Phase 1 flows added to southern end of Ward Avenue Trunk Sewer. Diablo Grande ADWF of 0.10 mgd. Complete development of known potential developments in the City, as shown in Figure 1. The developments include: Villages of Patterson, Patterson Gardens, Keystone Business Park, West Ridge Business Park, Villa del Lago, Arambel Business Park, and other small developments.

Scenario 2: CLIBP Buildout flows added to the proposed SPTS. Diablo Grande buildout flows added to the proposed SPTS. Complete development of City General Plan areas.

The City wastewater loads assigned to the manholes were calculated using the method presented in the WWMP, which includes the use of a variable diurnal peaking factor (DPF) to calculate PDWF and an I/I factor based on area served to calculate PWWF. Consistent with the WWMP, Diablo Grande flows were assigned a constant peaking factor of 3.1 and an I/I factor of 300 gpd/ac over an area of 5,070 acres.

Detailed information regarding the hydraulic model, including a listing of the manhole IDs, wastewater loads, and capacity in the trunk sewers on Ward Avenue, Walnut Avenue, M Street, and the SPTS is provided in Appendix A. An overview of the hydraulic model results is provided below.

- As detailed in the WWMP, the hydraulic limitations of pipe segment E5-6:E5:5 on M Street due to a reverse slope were confirmed, and this pipe segment is recommended for replacement.
- The Ward Avenue trunk sewer does not have sufficient capacity to accommodate the known areas in Patterson for potential growth, shown in Figure 1, and the addition of CLIBP Phase 1 flows. To accommodate the CLIBP flows, the existing 21-inch sections would need to be upsized to 24-inches.
- PWWF from Diablo Grande and potential developments in the City are critical to determining the remaining available capacity in the Ward Avenue Trunk Sewer for the CLIBP.
- The SPTS, as proposed in the WWMP, has sufficient capacity to accommodate the projected CLIBP buildout flows. Projected d/D values in the SPTS range from 0.42-0.60.

POTENTIAL IMPACTS TO WASTEWATER QUALITY CONTROL FACILITY

The existing reliable capacity and projected capacity following the completion of future expansion phases for the WQCF are summarized in Table 8. This information originated from the WWMP, with slight adjustments to provide more detail on capacity impacts associated with decommissioning existing facilities as they become antiquated. Additionally, the existing reliable capacity for the WQCF differs from the permitted capacity. The WQCF is currently regulated under Regional Water Quality Control Board (Regional Board) Waste Discharge Requirements Order R5-2007-0147 (WDRs). The WDRs include effluent nitrogen limits which have been challenging for the older treatment facilities at the WQCF to meet. Therefore, the City considers the reliable capacity of the WQCF to be less than the permitted capacity to ensure compliance with the WDRs. Based on the information presented in Table 7, the addition of the CLIBP flows would require and additional expansion project after Phase V.

Table 7 – WQCF Existing and Anticipated Capacity

Condition		Reliable Capacity (mgd)	Total Reliable Capacity (mgd)
Existing			1.85
North Activated Sludge Treatment System		0.6	
Advanced Integrated Pond System		0	
South Activated Sludge Treatment System			
	Treatment Train 1	1.25	
Completion of Phase III Expansion			3.1
North Activated Sludge Treatment System		0.6	
Advanced Integrated Pond System		0	
South Activated Sludge Treatment System			
	Treatment Train 1	1.25	
	Treatment Train 2	1.25	
Phase IV Expansion			4.25
North Activated Sludge Treatment System		0	
Advanced Integrated Pond System		0	
South Activated Sludge Treatment System			
	Treatment Train 1	1.25	
	Treatment Train 2	1.25	
	Treatment Train 3	1.75	
Phase V Expansion			6.5
North Activated Sludge Treatment System		0	
Advanced Integrated Pond System		0	
South Activated Sludge Treatment System			
	Treatment Train 1	1.25	
	Treatment Train 2	1.25	
	Treatment Train 3	2	
	Treatment Train 4	2	

Expansion phases are recommended to begin design and permitting seven years prior to reaching the reliable capacity of the facility and construction five years prior to reaching the reliable capacity of the facility. Table 8 presents estimates for the recommended construction completion time for Phase III and IV expansions. The flows to the WQCF are projected to exceed the existing reliable capacity of 1.85 mgd ADWF within the next five years and acceptance of wastewater from the CLIBP is not recommended until construction of Phase III has started. WQCF flows and development projections should be regularly updated to refine the timing for implementation of expansion projects.

Table 8 – Estimated Timing for WQCF Expansion Projects

Expansion Phase	Total Reliable Capacity after Expansion Phase Completed (mgd)	Recommended Year to Complete Construction	
		w/out CLIBP	w/ CLIBP
Existing	1.85	-	-
Phase III	3.1	2018	2017
Phase IV	4.25	2045	2028

Projected BOD, TSS, and TKN strength for the CLIBP are similar to historical WQCF influent concentrations and are not anticipated to be an issue.

DEVELOPER IMPACT FEES AND COST SHARING

Collection System

The WWMP provided cost estimates for construction of the SPTS. These costs are summarized in Table 9. Table 10 provides a summary of the wastewater loads which the SPTS is planned to accept.

Table 9 – Costs for South Patterson Trunk Sewer Components

Project Components	Base Cost
Junction Structure[a]	495,000
South Patterson Trunk Sewer	3,897,000
South Patterson Pump Station	640,000
South Patterson Force Main	635,000
Base Construction Cost	5,700,000
Probable Construction Cost [b]	8,379,000

[a] Base cost listed is half of the total cost because the junction structure will be for the North Patterson Trunk Sewer as well.

[b] Probable construction cost includes applying contingencies for planning and design (10%), construction management (10%), and construction (20%), to the Base Construction Cost to obtain a subtotal cost. An additional 5% contingency for program administration is applied to the subtotal cost to obtain the Probable Construction Cost.

Table 10 – South Patterson Trunk Sewer Design Wastewater Loads

Development Area	ADWF (gpd)
Diablo Grande	750,000
Crows Landing Industrial Business Park	891,000
Development in south Patterson	823,060
Projected ADWF Capacity Increase	2,464,060

Based on this information, incremental capacity is being provided at an approximate cost of $3.40/gpd ADWF. This unit cost can be used as an initial guide for developing impact fees for the collection system.

Wastewater Quality Control Facility

A conceptual list of components for the Phase IV expansion project is provided in Table 11. Budgetary costs are included with the list. The costs provided are based on cost estimates for the Phase III expansion project. The cost estimate indicates that expansion of treatment and disposal capacity is approximately $30/gpd ADWF.

Table 11 – Budgetary Phase IV Expansion Project Costs

Project Components	**Probable Construction Cost (in $1,000,000)**
Influent Pump Station	5.00
South Activated Sludge Treatment System, Unit 3	6.00
Solids Handling Facilities	5.50
Effluent Pumping Facilities	2.50
Plant Water System Improvements	0.50
Stormwater/Site Drainage Improvements	1.00
Electrical and Controls	4.00
Demolition of NASTS facilities	1.00
Site Piping	1.00
Site Grading and Surfacing Improvements	1.00
Tertiary Filters	3.00
Disinfection Facilities	2.00
Odor Control	1.00
Percolation Pond Expansion	2.00
Base Construction Cost	35.50
10% Planning and design contingency	*3.55*
10% Construction management contingency	*3.55*
20% Construction contingency	*7.10*
Subtotal	49.70
5% Program Administration contingency	2.49
Total Project Cost	52.19
WQCF Capacity Increase	1.75 mgd
Cost per gallon capacity	$30

[a] Percolation Pond Expansion cost includes land acquisition.

CLIBP Wastewater Cost Share Estimate

Table 12 presents an estimated cost share for the CLIBP for expanding the wastewater collection and WQCF facilities to accommodate the projected flows from the project. The total estimated CLIBP cost share is $29.8 million. The cost share does not include improvements to the existing City wastewater facilities that may be needed to accommodate CLIBP flows on a temporary basis.

Table 12 – Estimated CLIBP Cost Share for Expanding City Wastewater Facilities

Description	Value
Collection System Expansion Unit Cost	$3.40/gpd ADWF
WQCF Phase IV Expansion Project Unit Cost	$30/gpd ADWF
CLIBP Buildout ADWF	0.891 mgd
CLIBP Buildout Cost Share	$29.8M

SUMMARY

The findings from this evaluation are summarized below.

1. The existing collection system does not have sufficient capacity to accept the CLIBP Phase 1 flows and known potential developments in the City.
2. Recommended improvements to the collection system can be implemented to increase capacity in the existing system to accept CLIBP Phase 1 flows. These improvements include:
    a. Replacement of pipe segment E5-6:E5:5 on M Street, as previously identified in the WWMP.
    b. Upsizing of approximately 1,300 feet of 21-inch pipe in Ward Avenue.
3. The WQCF Phase III Expansion Project should be completed prior to accepting flow from the CLIBP. Accepting the CLIBP flows would be dependent on priority developments within the City.
4. The WQCF Phase IV Expansion Project should be planned for completion in the year 2028, if CLIBP wastewater is treated by the City.
5. The estimated CLIBP cost share for expanding the City wastewater facilities is $29.8 million.
6. The estimates presented in this TM are based on growth and flow assumptions. These assumptions should be reviewed regularly.

REFERENCES

[1] City of Patterson Wastewater Master Plan, prepared by Black Water Consulting Engineers, Inc. and NV5, April 2016

[2] Wastewater Flow and Load assumptions for the future Crows Landing Industrial Business Park development phases memorandum, prepared by AECOM, July 6, 2017

[3] City of Patterson 2015-2023 Housing Element Update, adopted February 2, 2016

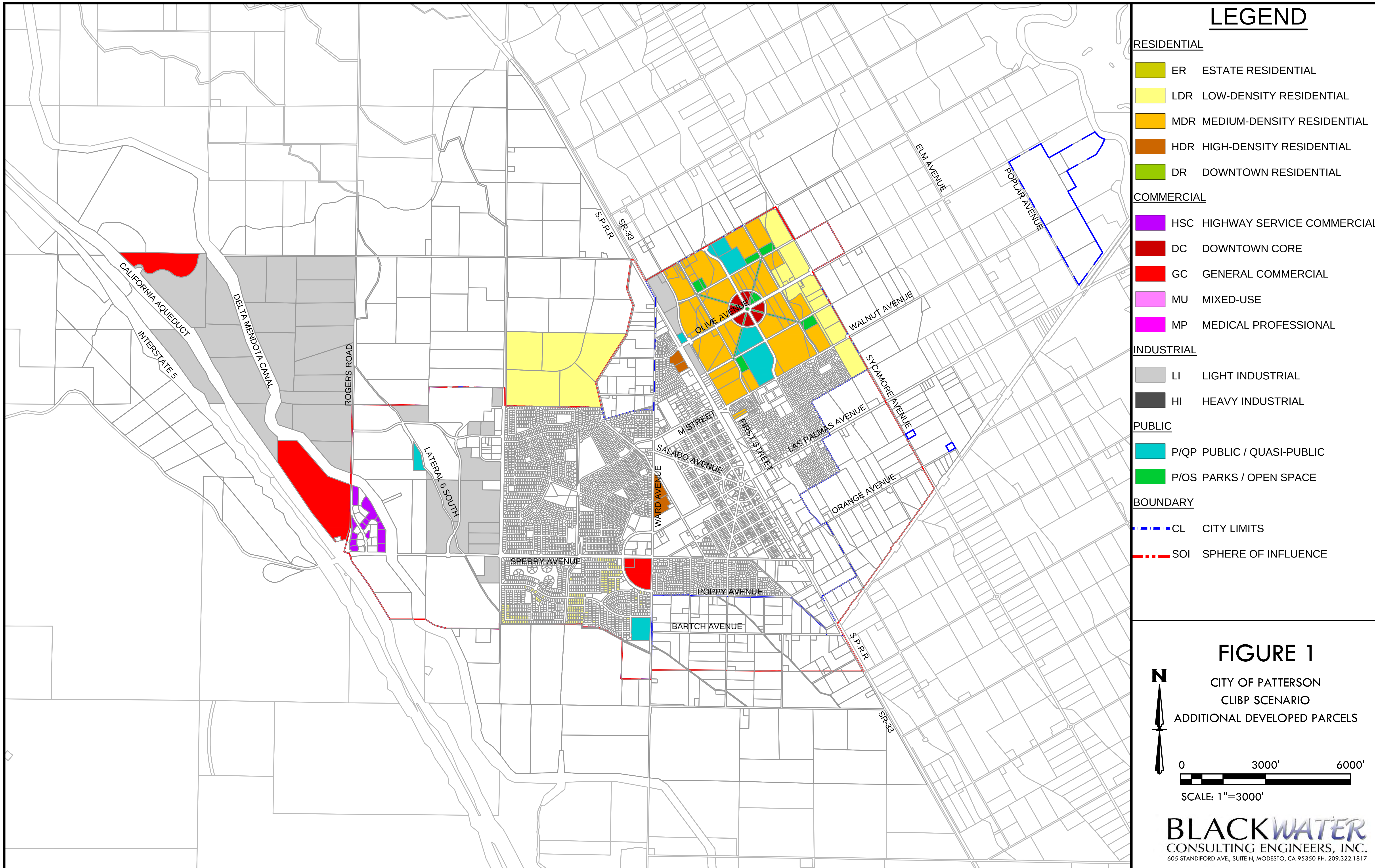

FIGURE 1

CITY OF PATTERSON
CLIBP SCENARIO
ADDITIONAL DEVELOPED PARCELS

BLACKWATER CONSULTING ENGINEERS, INC.
605 STANDIFORD AVE., SUITE N, MODESTO, CA 95350 PH. 209.322.1817

I:\J16125 CITY OF PATTERSON\TASKS\125-17B CLIBP EVALUATION\CAD\EXHIBITS\FIGURES\125_FIGURE 2.DWG PLOT: 8/8/2017 4:38:47 PM BY KEVIN WILLIAMS

APPENDIX A
HYDRAULIC MODEL RESULTS

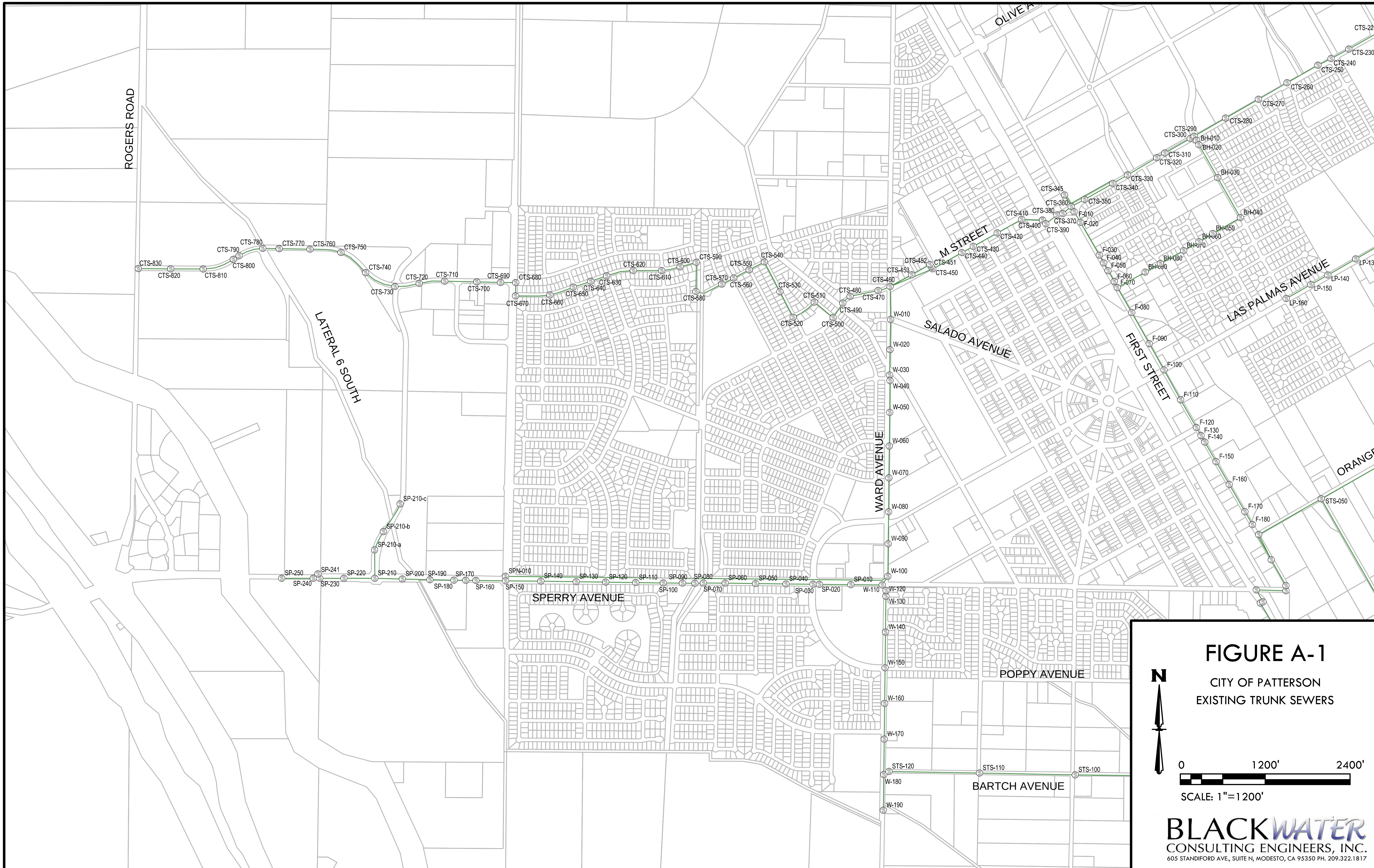

FIGURE A-1

CITY OF PATTERSON

EXISTING TRUNK SEWERS

I:\16125 CITY OF PATTERSON\TASKS\125-17B CLIBP EVALUATION\CAD\EXHIBITS\FIGURES\125_FIGURE 3.DWG PLOT: 8/8/2017 4:24:58 PM BY KEVIN WILLIAMS

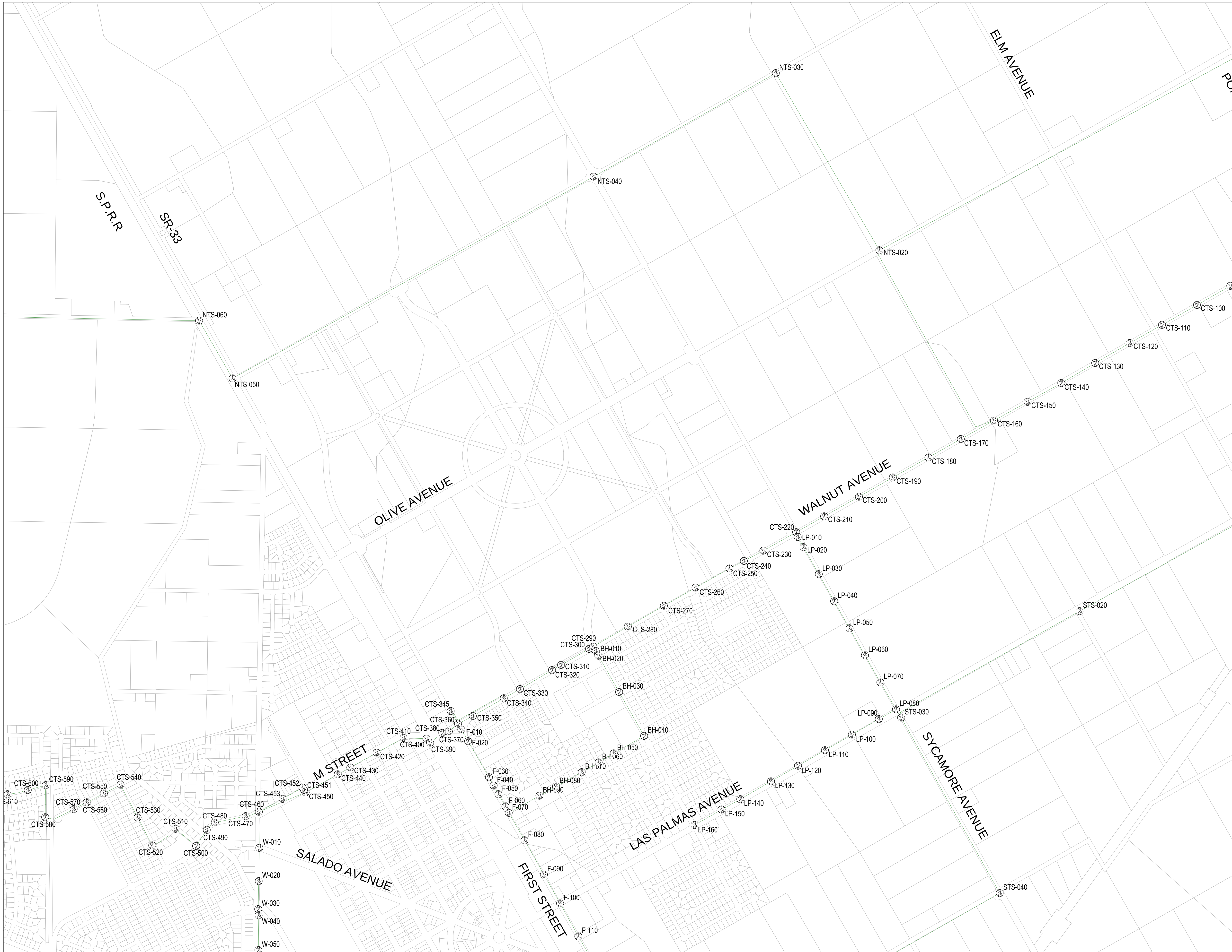

FIGURE A-2

CITY OF PATTERSON
EXISTING TRUNK SEWERS

N

0 1200' 2400'

SCALE: 1"=1200'

BLACKWATER
CONSULTING ENGINEERS, INC.
605 STANDIFORD AVE., SUITE N, MODESTO, CA 95350 PH. 209.322.1817

I:\16125 CITY OF PATTERSON\TASKS\125-17B CLIBP EVALUATION\CAD\EXHIBITS\FIGURES\125_FIGURE 3.DWG PLOT: 8/8/2017 4:25:28 PM BY KEVIN WILLIAMS

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Manhole Loading Calculations

ID	Additional ADWF @ MH (gpd)	Additional I/I @ MH (gpd)	Total ADWF @ MH (gpd)	Diurnal Peaking Factor	Total PWWF @ MH (gpd)	Total I/I @ MH (gpd)	Total PWWF @ MH (gpd)	Model MH Load (gpd)
BH-010	0	0	55,074	3.33	183,278	88,973	272,251	0
BH-020	0	0	55,074	3.33	183,278	88,973	272,251	0
BH-030	0	0	55,074	3.33	183,278	88,973	272,251	0
BH-040	698	4,398	55,074	3.33	183,278	88,973	272,251	6,670
BH-050	13,128	19,888	54,376	3.33	181,006	84,575	265,582	62,878
BH-060	2,915	3,774	41,249	3.35	138,017	64,687	202,704	13,382
BH-070	15,525	20,100	38,333	3.35	128,409	60,913	189,321	71,643
BH-080	22,808	40,813	22,808	3.37	76,866	40,813	117,678	117,678
BH-090	0	0	0	3.40	0	0	0	0
CTS-010	0	0	2,546,651	1.58	3,553,569	5,627,556	9,181,125	0
CTS-020	72,176	255,258	2,546,651	1.58	3,553,569	5,627,556	9,181,125	369,296
CTS-030	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-040	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-050	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-060	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-070	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-080	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-090	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-100	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-110	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-120	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-130	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-140	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-150	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-160	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-170	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-180	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-190	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-200	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-210	0	0	2,474,475	1.58	3,439,531	5,372,298	8,811,829	0
CTS-220	268,839	405,388	2,474,475	1.58	3,439,531	5,372,298	8,811,829	1,052,774
CTS-230	0	0	2,120,677	1.58	2,880,530	4,878,524	7,759,054	0
CTS-240	15,334	22,693	2,120,677	1.58	2,880,530	4,878,524	7,759,054	46,921
CTS-250	0	0	2,105,343	1.58	2,856,302	4,855,831	7,712,133	0
CTS-260	0	0	2,105,343	1.58	2,856,302	4,855,831	7,712,133	0
CTS-270	33,022	42,752	2,105,343	1.58	2,856,302	4,855,831	7,712,133	94,928
CTS-280	0	0	2,072,321	1.58	2,804,127	4,813,079	7,617,206	0
CTS-290	0	0	2,072,321	1.58	2,804,127	4,813,079	7,617,206	175,990
CTS-300	7,581	9,903	2,017,247	1.58	2,717,110	4,724,105	7,441,215	21,882
CTS-310	0	0	2,009,666	1.58	2,705,132	4,714,202	7,419,334	0
CTS-320	9,080	11,861	2,009,666	1.58	2,705,132	4,714,202	7,419,334	26,207
CTS-330	3,811	5,364	2,000,586	1.58	2,690,786	4,702,341	7,393,127	11,384
CTS-340	5,539	17,119	1,996,775	1.58	2,684,765	4,696,978	7,381,743	25,871
CTS-350	0	0	1,991,236	1.58	2,676,013	4,679,858	7,355,872	0
CTS-360	13	106	1,991,236	1.58	2,676,013	4,679,858	7,355,872	1,115,324
CTS-370	0	0	1,660,602	1.58	2,153,612	4,086,936	6,240,548	0
CTS-380	0	0	1,660,602	1.58	2,153,612	4,086,936	6,240,548	0
CTS-390	0	0	1,660,602	1.58	2,153,612	4,086,936	6,240,548	0
CTS-400	0	0	1,660,602	1.58	2,153,612	4,086,936	6,240,548	0
CTS-410	17,054	27,290	1,660,602	1.58	2,153,612	4,086,936	6,240,548	54,236
CTS-420	8,107	11,090	1,643,548	1.58	2,126,666	4,059,646	6,186,312	23,899
CTS-430	110,773	128,317	1,635,441	1.58	2,113,857	4,048,556	6,162,413	303,338
CTS-440	0	0	1,524,668	1.58	1,938,835	3,920,239	5,859,074	0
CTS-450	6,952	23,748	1,524,668	1.58	1,938,835	3,920,239	5,859,074	34,733

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Manhole Loading Calculations

ID	Additional ADWF @ MH (gpd)	Additional I/I @ MH (gpd)	Total ADWF @ MH (gpd)	Diurnal Peaking Factor	Total PWWF @ MH (gpd)	Total I/I @ MH (gpd)	Total PWWF @ MH (gpd)	Model MH Load (gpd)
CTS-451	0	0	1,517,715	1.58	1,927,850	3,896,491	5,824,341	0
CTS-452	0	0	1,517,715	1.58	1,927,850	3,896,491	5,824,341	0
CTS-453	7,580	11,388	1,517,715	1.58	1,927,850	3,896,491	5,824,341	23,364
CTS-460	247,797	363,619	1,510,136	1.58	1,915,874	3,885,103	5,800,977	4,366,322
CTS-470	0	0	247,406	3.08	760,995	673,660	1,434,655	0
CTS-480	0	0	247,406	3.08	760,995	673,660	1,434,655	0
CTS-490	0	0	247,406	3.08	760,995	673,660	1,434,655	0
CTS-500	162	210	247,406	3.08	760,995	673,660	1,434,655	657
CTS-510	4,108	7,710	247,244	3.08	760,548	673,449	1,433,998	19,037
CTS-520	1,805	2,337	243,136	3.08	749,221	665,739	1,414,960	7,328
CTS-530	2,116	2,740	241,331	3.08	744,230	663,402	1,407,632	8,602
CTS-540	12,489	16,804	239,215	3.09	738,367	660,663	1,399,030	51,643
CTS-550	4,838	6,264	226,726	3.10	703,528	643,859	1,347,387	19,870
CTS-560	12,121	35,406	221,888	3.11	689,921	637,595	1,327,516	69,762
CTS-570	5,442	7,045	209,767	3.13	655,564	602,190	1,257,754	22,594
CTS-580	26,546	41,483	204,325	3.13	640,015	595,145	1,235,160	118,451
CTS-590	427	677	177,779	3.17	563,047	553,662	1,116,709	1,930
CTS-600	1,134	1,468	177,353	3.17	561,795	552,984	1,114,779	4,797
CTS-610	18,010	27,690	176,219	3.17	558,465	551,517	1,109,982	81,033
CTS-620	2,066	2,674	158,209	3.19	505,123	523,827	1,028,949	8,846
CTS-630	44,436	65,087	156,144	3.20	498,950	521,153	1,020,103	200,577
CTS-640	0	0	111,708	3.25	363,461	456,065	819,526	0
CTS-650	48,084	64,927	111,708	3.25	363,461	456,065	819,526	217,368
CTS-660	1,784	2,310	63,624	3.32	211,020	391,138	602,158	8,082
CTS-670	3,756	14,737	61,841	3.32	205,248	388,829	594,077	26,916
CTS-680	4,378	16,008	58,085	3.32	193,068	374,092	567,160	30,253
CTS-690	775	4,568	53,707	3.33	178,824	358,084	536,908	7,095
CTS-700	1,808	10,704	52,932	3.33	176,297	353,516	529,813	16,603
CTS-710	1,640	9,567	51,124	3.33	170,397	342,812	513,209	14,926
CTS-720	1,982	7,009	49,484	3.34	165,039	333,245	498,284	13,496
CTS-730	16,305	111,614	47,502	3.34	158,552	326,236	484,787	165,370
CTS-740	439	3,535	31,197	3.36	104,795	214,622	319,417	4,991
CTS-750	11,904	84,068	30,758	3.36	103,339	211,087	314,426	123,768
CTS-760	2,619	10,623	18,854	3.38	63,639	127,019	190,658	19,409
CTS-770	0	0	16,235	3.38	54,853	116,396	171,250	0
CTS-780	0	0	16,235	3.38	54,853	116,396	171,250	0
CTS-790	0	0	16,235	3.38	54,853	116,396	171,250	0
CTS-800	10,890	73,344	16,235	3.38	54,853	116,396	171,250	110,063
CTS-810	0	0	5,344	3.39	18,134	43,053	61,186	0
CTS-820	5,344	43,053	5,344	3.39	18,134	43,053	61,186	61,186
CTS-830	0	0	0	3.40	0	0	0	0
F-010	0	0	330,621	2.97	980,914	592,816	1,573,731	0
F-020	1,562	8,713	330,621	2.97	980,914	592,816	1,573,731	12,674
F-030	5,580	8,866	329,058	2.97	976,953	584,104	1,561,056	23,069
F-040	0	0	323,478	2.98	962,749	575,237	1,537,987	0
F-050	1,410	1,825	323,478	2.98	962,749	575,237	1,537,987	5,427
F-060	232,069	328,155	322,068	2.98	959,148	573,412	1,532,560	991,919
F-070	2,706	3,503	89,999	3.28	295,385	245,257	540,642	12,074
F-080	973	3,648	87,293	3.29	286,814	241,754	528,568	6,736
F-090	3,300	18,402	86,320	3.29	283,726	238,106	521,832	28,889
F-100	0	0	83,020	3.29	273,239	219,704	492,943	0
F-110	0	0	83,020	3.29	273,239	219,704	492,943	0
F-120	0	0	83,020	3.29	273,239	219,704	492,943	0
F-130	0	0	83,020	3.29	273,239	219,704	492,943	0

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Manhole Loading Calculations

ID	Additional ADWF @ MH (gpd)	Additional I/I @ MH (gpd)	Total ADWF @ MH (gpd)	Diurnal Peaking Factor	Total PWWF @ MH (gpd)	Total I/I @ MH (gpd)	Total PWWF @ MH (gpd)	Model MH Load (gpd)
F-140	0	0	83,020	3.29	273,239	219,704	492,943	0
F-150	0	0	83,020	3.29	273,239	219,704	492,943	0
F-160	0	0	83,020	3.29	273,239	219,704	492,943	0
F-170	14,154	78,936	83,020	3.29	273,239	219,704	492,943	124,243
F-180	68,866	140,768	68,866	3.31	227,931	140,768	368,700	368,700
LP-010	0	0	84,958	3.29	279,403	88,387	367,790	0
LP-020	0	0	84,958	3.29	279,403	88,387	367,790	0
LP-030	0	0	84,958	3.29	279,403	88,387	367,790	0
LP-040	13,115	13,677	84,958	3.29	279,403	88,387	367,790	55,574
LP-050	0	0	71,843	3.31	237,506	74,710	312,216	0
LP-060	0	0	71,843	3.31	237,506	74,710	312,216	0
LP-070	0	0	71,843	3.31	237,506	74,710	312,216	0
LP-080	1,130	3,996	71,843	3.31	237,506	74,710	312,216	7,626
LP-090	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-100	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-110	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-120	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-130	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-140	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-150	0	0	70,714	3.31	233,876	70,714	304,589	0
LP-160	54,461	70,714	70,714	3.31	233,876	70,714	304,589	304,589
SP-010	4,031	14,988	492,065	2.76	1,355,833	1,302,841	2,658,674	23,519
SP-020	0	0	488,034	2.76	1,347,303	1,287,853	2,635,156	0
SP-030	124,749	225,240	488,034	2.76	1,347,303	1,287,853	2,635,156	510,264
SP-040	0	0	363,285	2.92	1,062,279	1,062,612	2,124,892	0
SP-050	0	0	363,285	2.92	1,062,279	1,062,612	2,124,892	0
SP-060	0	0	363,285	2.92	1,062,279	1,062,612	2,124,892	0
SP-070	8,805	13,423	363,285	2.92	1,062,279	1,062,612	2,124,892	35,081
SP-080	0	0	354,479	2.94	1,040,621	1,049,190	2,089,811	0
SP-090	0	0	354,479	2.94	1,040,621	1,049,190	2,089,811	0
SP-100	91,804	143,909	354,479	2.94	1,040,621	1,049,190	2,089,811	381,822
SP-110	0	0	262,675	3.06	802,708	905,281	1,707,989	0
SP-120	0	0	262,675	3.06	802,708	905,281	1,707,989	0
SP-130	0	0	262,675	3.06	802,708	905,281	1,707,989	0
SP-140	0	0	262,675	3.06	802,708	905,281	1,707,989	0
SP-150	4,709	17,819	262,675	3.06	802,708	905,281	1,707,989	30,617
SP-160	0	0	257,966	3.06	789,910	887,462	1,677,372	0
SP-170	0	0	257,966	3.06	789,910	887,462	1,677,372	0
SP-180	0	0	257,966	3.06	789,910	887,462	1,677,372	0
SP-190	3,140	11,347	257,966	3.06	789,910	887,462	1,677,372	19,914
SP-200	0	0	254,826	3.07	781,343	876,114	1,657,458	0
SP-210	579	2,349	254,826	3.07	781,343	876,114	1,657,458	3,932
SP-210-a	0	0	254,247	3.07	779,760	873,765	1,653,525	0
SP-210-b	0	0	254,247	3.07	779,760	873,765	1,653,525	0
SP-210-c	24,768	100,447	254,247	3.07	779,760	873,765	1,653,525	168,963
SP-220	0	0	229,479	3.10	711,244	773,318	1,484,562	0
SP-230	195,536	677,861	229,479	3.10	711,244	773,318	1,484,562	1,275,206
SP-240	0	0	33,944	3.36	113,899	95,457	209,356	0
SP-241	33,944	95,457	33,944	3.36	113,899	95,457	209,356	209,356
SP-250	0	0	0	3.40	0	0	0	0
W-010	17,123	60,555	1,014,932	2.20	2,324,692	2,847,824	5,172,516	78,122
W-020	0	0	997,810	2.22	2,307,125	2,787,269	5,094,394	0
W-030	0	0	997,810	2.22	2,307,125	2,787,269	5,094,394	0
W-040	0	0	997,810	2.22	2,307,125	2,787,269	5,094,394	0

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Manhole Loading Calculations

ID	Additional ADWF @ MH (gpd)	Additional I/I @ MH (gpd)	Total ADWF @ MH (gpd)	Diurnal Peaking Factor	Total PWWF @ MH (gpd)	Total I/I @ MH (gpd)	Total PWWF @ MH (gpd)	Model MH Load (gpd)
W-050	5,468	4,485	997,810	2.22	2,307,125	2,787,269	5,094,394	10,257
W-060	0	0	992,342	2.23	2,301,353	2,782,784	5,084,137	0
W-070	6,027	4,943	992,342	2.23	2,301,353	2,782,784	5,084,137	11,395
W-080	0	0	986,315	2.24	2,294,900	2,777,841	5,072,741	0
W-090	0	0	986,315	2.24	2,294,900	2,777,841	5,072,741	0
W-100	0	0	986,315	2.24	2,294,900	2,777,841	5,072,741	0
W-110	0	0	986,315	2.24	2,294,900	2,777,841	5,072,741	2,150,725
W-120	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-130	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-140	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-150	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-160	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-170	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-180	0	0	494,250	2.88	1,447,016	1,475,000	2,922,016	0
W-190	494,250	1,475,000	494,250	2.88	1,447,016	1,475,000	2,922,016	2,922,016

2,036,148	City ADWF MH Load total
86,788	NPTS and SPTS flows from developed land (not included in this scenario)
2,122,937	Total City ADWF
100,250	Diablo Grande ADWF, assumed for Year 2028
394,000	Plus CLIBP Phase 1 flow
2,617,187	TOTAL ADWF

Other Assumptions

3.1	Diablo Grande separate Diurnal Peaking Factor (constant)
310,775	Diablo Grande Peak Dry Weather Flow (assumed constant throughout the system)
1,398,000	Diablo Grande I/I flow assumed
77,000	Plus CLIBP Phase 1 I/I flow

For sewers with flow from Diablo Grande (W trunk sewers and sewers downstream of CTS-460):
Diurnal Peaking Factor (DPF) = 3.4 - 1.31*(Total ADWF [mgd] - Diablo Grande ADWF [mgd]), with a minimum value of 1.58
Total PDWF = (Total ADWF- Diablo Grande Buildout ADWF)*DPF + Diablo Grande Buildout ADWF*Diablo Grande separate Diurnal Peaking Factor
Total PWWF = Total PDWF + Total I/I
Model MH Load = Total PWWF @ MH - Total PWWF @ upstream manhole

For sewers with no flow from Diablo Grande:
Diurnal Peaking Factor (DPF) = 3.4 - 1.31*Total ADWF [mgd], with a minimum value of 1.58
Total PDWF = Total ADWF*DPF
Total PWWF = Total PDWF + Total I/I
Model MH Load = Total PWWF @ MH - Total PWWF @ upstream manhole

Appendix A
Scenario 2: Buildout
Manhole Loading Calculations
South Patterson Trunk Sewer

ID	Additional ADWF @ MH (gpd)	Additional I/I @ MH (gpd)	Total ADWF @ MH (gpd)	Diurnal Peaking Factor	Total PDWF @ MH (gpd)	Total I/I @ MH (gpd)	Total PWWF @ MH (gpd)	Model MH Load (gpd)
STS-030	101,862	116,873	2,464,060	1.58	5,033,214	2,788,936	7,822,150	277,814
STS-040	54,010	56,324	2,362,198	1.58	4,872,273	2,672,063	7,544,336	141,660
STS-050	115,529	182,544	2,308,188	1.58	4,786,937	2,615,739	7,402,676	365,080
STS-060	19,195	56,070	2,192,659	1.58	4,604,402	2,433,195	7,037,597	86,398
STS-080	136,858	233,103	2,173,465	1.58	4,574,074	2,377,125	6,951,199	276,232
STS-090	35,242	43,440	2,036,607	1.71	4,530,945	2,144,021	6,674,967	46,092
STS-100	105,148	148,250	2,001,365	1.76	4,528,293	2,100,582	6,628,875	175,501
STS-110	92,471	143,225	1,896,217	1.90	4,501,042	1,952,332	6,453,374	191,130
STS-120	1,803,746	1,809,106	1,803,746	2.02	4,453,138	1,809,106	6,262,244	6,262,244

Assumptions

750,000	Diablo Grande Buildout ADWF
891,000	CLIBP Buildout flow
3.1	Diablo Grande separate Diurnal Peaking Factor (constant)
2,325,000	Diablo Grande Peak Dry Weather Flow (assumed constant throughout the system)
1,398,000	Diablo Grande I/I flow assumed
126,000	CLIBP Buildout I/I flow

Diurnal Peaking Factor (DPF) = 3.4 - 1.31*(Total ADWF [mgd] - Diablo Grande ADWF [mgd]), with a minimum value of 1.58
Total PDWF = (Total ADWF- Diablo Grande Buildout ADWF)*DPF + Diablo Grande Buildout ADWF*Diablo Grande separate Diurnal Peaking Factor
Total PWWF = Total PDWF + Total I/I
Model MH Load = Total PWWF @ MH - Total PWWF @ upstream manhole

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Ward Avenue Trunk Sewer
Manhole Results

ID	Rim Elevation (ft)	Total Flow (gpd)	Grade (ft)	Status	Hydraulic Jump	Surcharge Depth (ft)	Unfilled Depth (ft)
W-010	103	78,121.59	93.84	Not Full	No	0.14	9.16
W-020	104.6	0	94.88	Not Full	No	0.38	9.72
W-030	106.9	0	95.92	Not Full	No	0.71	10.98
W-040	106.9	0	95.96	Not Full	No	0.59	10.94
W-050	108.8	10,256.95	96.75	Not Full	No	-0.58	12.05
W-060	110.7	0	98.68	Not Full	No	-0.61	12.02
W-070	112.6	11,394.94	100.49	Not Full	No	-0.56	12.11
W-080	113.9	0	102.32	Not Full	No	-0.59	11.58
W-090	115.7	0	104.18	Not Full	No	-0.59	11.52
W-100	117.8	0	106.04	Not Full	No	-0.59	11.76
W-110	119.6	2,150,713.82	106.92	Not Full	Yes	-0.50	12.68
W-120	119.05	0	108.29	Not Full	No	-0.93	10.76
W-130	119.8	0	112.18	Not Full	No	-0.83	7.62
W-140	122.6	0	117.12	Not Full	No	-0.81	5.48
W-150	125.59	0	120.24	Not Full	No	-0.69	5.35
W-160	128.6	0	123.20	Not Full	No	-0.69	5.40
W-170	131.99	0	124.67	Not Full	No	-0.32	7.32
W-180	135.66	0	125.77	Not Full	Yes	-0.32	9.89
W-190	139.02	2,922,000.81	133.56	Not Full	No	-0.79	5.46

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Ward Avenue Trunk Sewer
Pipe Results

ID	Diameter (in)	Length (ft)	Slope	Total Flow (gpd)	Flow Type	Velocity (ft/s)	d/D	q/Q	Water Depth (ft)	Critical Depth (ft)	Froude Number	Full Flow (gpd)	Coverage Count	Backwater Adjustment	Adjusted Depth (ft)	Adjusted Velocity (ft/s)
W-010:CTS-460	21	421	0.002	5,172,488.11	Pressurized	3.33	1.00	1.07	1.75	1.02	0.44	4,851,952.10	0	No	1.75	3.33
W-020:W-010	21	421	0.002	5,094,366.52	Pressurized	3.28	1.00	1.14	1.75	0.97	0.44	4,476,077.23	0	Yes	1.75	3.28
W-030:W-020	21	421	0.002	5,094,366.52	Pressurized	3.28	1.00	1.21	1.75	0.94	0.44	4,216,787.86	0	Yes	1.75	3.28
W-040:W-030	21	14	0.004	5,094,366.52	Pressurized	4.76	0.65	0.76	1.14	1.04	0.84	6,722,104.09	0	Yes	1.75	3.28
W-050:W-040	21	465	0.004	5,094,366.52	Free Surface	4.63	0.67	0.78	1.17	1.04	0.80	6,494,169.53	0	Yes	1.70	3.30
W-060:W-050	21	465	0.004	5,084,109.57	Free Surface	4.72	0.65	0.76	1.14	1.04	0.83	6,666,458.58	0	Yes	1.16	4.67
W-070:W-060	21	465	0.004	5,084,109.57	Free Surface	4.52	0.68	0.81	1.19	1.04	0.77	6,317,183.37	0	No	1.19	4.52
W-080:W-070	21	465	0.004	5,072,714.63	Free Surface	4.62	0.67	0.78	1.16	1.04	0.80	6,494,169.53	0	Yes	1.18	4.56
W-090:W-080	21	465	0.004	5,072,714.63	Free Surface	4.62	0.67	0.78	1.16	1.04	0.80	6,494,169.53	0	No	1.16	4.62
W-100:W-090	21	465	0.004	5,072,714.63	Free Surface	4.62	0.67	0.78	1.16	1.04	0.80	6,494,169.53	0	No	1.16	4.62
W-110:W-100	21	172	0.003	5,072,714.63	Free Surface	4.28	0.71	0.86	1.25	1.04	0.70	5,911,079.91	0	No	1.25	4.28
W-120:W-110	18	95	0.02	2,922,000.81	Free Surface	7.38	0.38	0.30	0.57	0.82	2.00	9,601,425.61	0	Yes	0.83	4.52
W-130:W-120	18	85	0.011	2,922,000.81	Free Surface	5.93	0.45	0.41	0.67	0.82	1.46	7,120,305.60	0	No	0.67	5.93
W-140:W-130	18	500	0.01	2,922,000.81	Free Surface	5.66	0.46	0.44	0.69	0.82	1.36	6,683,518.26	0	No	0.69	5.66
W-150:W-140	18	500	0.006	2,922,000.81	Free Surface	4.68	0.54	0.56	0.81	0.82	1.03	5,184,186.52	0	No	0.81	4.68
W-160:W-150	18	500	0.006	2,922,000.81	Free Surface	4.65	0.54	0.57	0.81	0.82	1.02	5,148,309.37	0	No	0.81	4.65
W-170:W-160	18	500	0.002	2,922,000.81	Free Surface	3.04	0.79	0.96	1.18	0.82	0.49	3,044,259.15	0	No	1.18	3.04
W-180:W-170	18	500	0.002	2,922,000.81	Free Surface	3.04	0.79	0.96	1.18	0.82	0.49	3,044,259.15	0	No	1.18	3.04
W-190:W-180	18	500	0.009	2,922,000.81	Free Surface	5.46	0.48	0.46	0.71	0.82	1.29	6,371,162.40	0	No	0.71	5.46

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Central Trunk Sewer
Manhole Results

ID	Rim Elevation (ft)	Total Flow (gpd)	Grade (ft)	Status	Hydraulic Jump	Surcharge Depth (ft)	Unfilled Depth (ft)
CTS-010	55	0	46.26	Not Full	No	0.01	8.74
CTS-020	55	369,294.08	46.29	Not Full	No	0.04	8.71
CTS-030	55	0	46.45	Not Full	No	-0.11	8.56
CTS-040	54.5	0	46.55	Not Full	No	-0.20	7.95
CTS-050	55	0	46.81	Not Full	No	-0.45	8.19
CTS-060	56	0	47.05	Not Full	Yes	-0.68	8.96
CTS-070	56	0	51.92	Not Full	No	-0.98	4.08
CTS-080	56.56	0	53.39	Not Full	No	-1.51	3.17
CTS-090	57.97	0	54.60	Not Full	No	-1.21	3.38
CTS-100	59.36	0	55.48	Not Full	No	-1.21	3.88
CTS-110	60.81	0	56.42	Not Full	No	-1.21	4.39
CTS-120	62.15	0	57.29	Not Full	No	-1.21	4.86
CTS-130	63.59	0	58.22	Not Full	No	-1.21	5.38
CTS-140	65.02	0	59.13	Not Full	No	-1.21	5.89
CTS-150	66.41	0	60.03	Not Full	No	-1.21	6.38
CTS-160	67.8	0	60.92	Not Full	No	-1.21	6.88
CTS-170	70	0	61.80	Not Full	No	-1.21	8.20
CTS-180	70.51	0	62.66	Not Full	No	-1.21	7.85
CTS-190	71.99	0	63.61	Not Full	No	-1.21	8.38
CTS-200	73.39	0	64.52	Not Full	No	-1.21	8.88
CTS-210	74.84	0	65.44	Not Full	No	-1.21	9.40
CTS-220	76	1,052,768.53	66.19	Not Full	No	-1.21	9.81
CTS-230	77.3	0	67.28	Not Full	No	-1.16	10.02
CTS-240	78.11	46,920.76	68.07	Not Full	No	-1.13	10.04
CTS-250	78.63	0	68.57	Not Full	No	-1.18	10.06
CTS-260	79.95	0	69.85	Not Full	No	-1.13	10.10
CTS-270	81.23	94,927.51	70.97	Not Full	No	-1.08	10.26
CTS-280	82.64	0	72.21	Not Full	No	-1.14	10.43
CTS-290	84	175,989.09	73.53	Not Full	Yes	-1.17	10.47
CTS-300	84	21,881.89	73.57	Not Full	No	-1.36	10.43
CTS-310	86	0	74.77	Not Full	No	-1.10	11.23
CTS-320	86	26,206.86	75.04	Not Full	No	-1.33	10.96
CTS-330	88	11,383.94	76.19	Not Full	Yes	-1.00	11.81
CTS-340	89	25,870.87	77.10	Not Full	No	-1.13	11.90
CTS-350	90	0	78.65	Not Full	Yes	-1.04	11.35
CTS-360	90	1,115,318.20	80.31	Not Full	No	-1.09	9.69
CTS-370	90	0	80.92	Not Full	No	-1.17	9.08
CTS-380	90	0	81.13	Not Full	No	-1.17	8.87

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Central Trunk Sewer
Manhole Results

ID	Rim Elevation (ft)	Total Flow (gpd)	Grade (ft)	Status	Hydraulic Jump	Surcharge Depth (ft)	Unfilled Depth (ft)
CTS-390	91	0	82.19	Not Full	Yes	-1.17	8.81
CTS-400	91.5	0	82.79	Not Full	No	-1.37	8.71
CTS-410	92.5	54,235.72	84.11	Not Full	Yes	-1.16	8.39
CTS-420	94	23,898.88	86.26	Not Full	No	-1.25	7.74
CTS-430	96	303,336.42	88.15	Not Full	No	-1.18	7.85
CTS-440	97	0	88.92	Not Full	Yes	-1.12	8.08
CTS-450	99	34,732.82	90.96	Not Full	No	-1.24	8.04
CTS-451	99	0	91.60	Not Full	No	-0.63	7.41
CTS-452	99	0	92.23	Not Full	No	0.03	6.78
CTS-453	100.5	23,363.88	92.51	Not Full	No	0.03	7.99
CTS-460	102.3	4,366,299.30	92.74	Not Full	No	0.06	9.56
CTS-470	103.2	0	92.80	Not Full	No	-0.12	10.40
CTS-480	103.9	0	92.85	Not Full	No	-0.13	11.05
CTS-490	104.3	0	92.88	Not Full	No	-0.14	11.42
CTS-500	103.9	656.997	92.93	Not Full	No	-0.58	10.97
CTS-510	105	19,036.90	93.01	Not Full	No	-0.84	11.99
CTS-520	106.3	7,327.96	93.36	Not Full	No	-0.86	12.95
CTS-530	105.4	8,601.96	93.76	Not Full	No	-0.86	11.64
CTS-540	104.5	51,642.73	94.07	Not Full	No	-0.86	10.43
CTS-550	105.2	19,869.90	94.32	Not Full	No	-0.88	10.88
CTS-560	105.8	69,761.64	94.49	Not Full	No	-0.89	11.31
CTS-570	105.9	22,593.88	94.60	Not Full	No	-0.91	11.30
CTS-580	110	118,450.38	94.90	Not Full	No	-0.92	15.10
CTS-590	108.65	1,929.99	95.31	Not Full	No	-1.02	13.34
CTS-600	109.07	4,796.98	96.48	Not Full	No	-1.02	12.59
CTS-610	108.7	81,032.58	96.71	Not Full	No	-1.03	11.99
CTS-620	109.94	8,845.95	98.61	Not Full	No	-0.71	11.33
CTS-630	112.4	200,575.96	100.17	Not Full	No	-0.71	12.23
CTS-640	114.09	0	100.93	Not Full	No	-0.73	13.16
CTS-650	116.51	217,365.87	101.98	Not Full	Yes	-0.79	14.53
CTS-660	118.42	8,081.96	104.71	Not Full	No	-0.61	13.71
CTS-670	121.22	26,915.86	107.26	Not Full	No	-0.60	13.96
CTS-680	121.6	30,252.84	109.11	Not Full	No	-0.61	12.49
CTS-690	122.6	7,094.96	109.95	Not Full	No	-0.61	12.66
CTS-700	124.05	16,602.91	111.60	Not Full	Yes	-0.61	12.45
CTS-710	126.5	14,925.92	113.83	Not Full	No	-0.64	12.68
CTS-720	128.5	13,495.93	115.64	Not Full	No	-0.62	12.86
CTS-730	130.5	165,369.14	117.42	Not Full	No	-0.63	13.08

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Central Trunk Sewer
Manhole Results

ID	Rim Elevation (ft)	Total Flow (gpd)	Grade (ft)	Status	Hydraulic Jump	Surcharge Depth (ft)	Unfilled Depth (ft)
CTS-740	132.9	4,990.97	119.60	Not Full	No	-0.70	13.30
CTS-750	135.4	123,767.36	121.85	Not Full	No	-0.70	13.55
CTS-760	139	19,408.90	124.03	Not Full	No	-0.77	14.97
CTS-770	142.7	0	126.27	Not Full	No	-0.78	16.43
CTS-780	145.1	0	127.61	Not Full	Yes	-0.79	17.49
CTS-790	147.8	0	133.41	Not Full	No	-0.83	14.40
CTS-800	148.7	110,062.43	134.18	Not Full	No	-0.81	14.53
CTS-810	153	0	137.69	Not Full	No	-0.88	15.31
CTS-820	155.8	61,185.68	141.34	Not Full	No	-0.88	14.46
CTS-830	160	0	144.87	Not Full	No	-1.00	15.13

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Central Trunk Sewer
Pipe Results

ID	Diameter (in)	Length (ft)	Slope	Total Flow (gpd)	Flow Type	Velocity (ft/s)	d/D	q/Q	Water Depth (ft)	Critical Depth (ft)	Froude Number	Full Flow (gpd)	Backwater Adjustment	Adjusted Depth (ft)	Adjusted Velocity (ft/s)
CTS-020:CTS-010	33	38	0.001	9,181,073.27	Pressurized	3.54	0.64	0.74	1.76	1.23	0.51	12,432,136.22	Yes	2.75	2.39
CTS-030:CTS-020	33	230	0.001	8,811,779.19	Free Surface	3.50	0.62	0.71	1.72	1.21	0.51	12,377,965.43	Yes	2.72	2.30
CTS-040:CTS-030	33	154	0.001	8,811,779.19	Free Surface	3.50	0.62	0.71	1.72	1.21	0.51	12,351,144.24	Yes	2.60	2.35
CTS-050:CTS-040	33	392	0.001	8,811,779.19	Free Surface	3.50	0.62	0.71	1.72	1.21	0.51	12,362,167.13	Yes	2.42	2.46
CTS-060:CTS-050	33	354	0.001	8,811,779.19	Free Surface	3.50	0.62	0.71	1.72	1.21	0.51	12,354,632.77	Yes	2.19	2.69
CTS-070:CTS-060	18	25	0.257	8,811,779.19	Free Surface	25.27	0.35	0.26	0.52	1.37	7.24	34,522,489.34	Yes	1.30	8.40
CTS-080:CTS-070	33	200	0.004	8,811,779.19	Free Surface	5.23	0.45	0.42	1.24	1.21	0.94	20,987,861.52	No	1.24	5.23
CTS-090:CTS-080	33	500	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.55	1.21	0.62	14,540,817.00	No	1.55	3.97
CTS-100:CTS-090	33	494	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.54	1.21	0.62	14,547,356.61	Yes	1.55	3.97
CTS-110:CTS-100	33	517	0.002	8,811,779.19	Free Surface	3.98	0.56	0.60	1.54	1.21	0.63	14,614,070.95	Yes	1.54	3.98
CTS-120:CTS-110	33	478	0.002	8,811,779.19	Free Surface	3.99	0.56	0.60	1.54	1.21	0.63	14,621,712.29	Yes	1.54	3.98
CTS-130:CTS-120	33	511	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.55	1.21	0.62	14,542,397.78	No	1.55	3.97
CTS-140:CTS-130	33	507	0.002	8,811,779.19	Free Surface	3.98	0.56	0.60	1.54	1.21	0.63	14,599,651.54	Yes	1.54	3.98
CTS-150:CTS-140	33	496	0.002	8,811,779.19	Free Surface	3.98	0.56	0.60	1.54	1.21	0.63	14,599,331.59	No	1.54	3.98
CTS-160:CTS-150	33	494	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.54	1.21	0.62	14,547,356.61	No	1.54	3.97
CTS-170:CTS-160	33	488	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.54	1.21	0.62	14,554,053.98	Yes	1.54	3.97
CTS-180:CTS-170	33	477	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.54	1.21	0.62	14,552,667.02	No	1.54	3.97
CTS-190:CTS-180	33	525	0.002	8,811,779.19	Free Surface	3.98	0.56	0.60	1.54	1.21	0.63	14,579,234.02	Yes	1.54	3.97
CTS-200:CTS-190	33	500	0.002	8,811,779.19	Free Surface	3.97	0.56	0.61	1.55	1.21	0.62	14,540,817.00	No	1.55	3.97
CTS-210:CTS-200	33	513	0.002	8,811,779.19	Free Surface	3.98	0.56	0.60	1.54	1.21	0.63	14,592,689.71	Yes	1.54	3.97
CTS-220:CTS-210	33	414	0.002	8,811,779.19	Free Surface	3.98	0.56	0.60	1.54	1.21	0.63	14,587,572.16	No	1.54	3.98
CTS-230:CTS-220	30	481	0.003	7,759,010.66	Free Surface	4.47	0.54	0.56	1.34	1.16	0.76	13,765,531.98	Yes	1.44	4.09
CTS-240:CTS-230	30	304	0.003	7,759,010.66	Free Surface	4.35	0.55	0.58	1.37	1.16	0.73	13,290,480.64	No	1.37	4.35
CTS-250:CTS-240	30	195	0.003	7,712,089.91	Free Surface	4.55	0.53	0.55	1.32	1.16	0.78	14,116,749.94	Yes	1.35	4.43
CTS-260:CTS-250	30	493	0.002	7,712,089.91	Free Surface	4.34	0.55	0.58	1.37	1.16	0.73	13,276,994.60	No	1.37	4.34
CTS-270:CTS-260	30	480	0.002	7,712,089.91	Free Surface	4.16	0.57	0.62	1.42	1.16	0.68	12,549,948.77	No	1.42	4.16
CTS-280:CTS-270	30	527	0.002	7,617,162.40	Free Surface	4.31	0.55	0.58	1.36	1.15	0.73	13,201,918.62	Yes	1.39	4.21
CTS-290:CTS-280	30	510	0.003	7,617,162.40	Free Surface	4.43	0.53	0.56	1.33	1.15	0.76	13,675,791.75	Yes	1.35	4.37
CTS-300:CTS-290	30	42	0.005	7,441,173.32	Free Surface	5.77	0.43	0.38	1.07	1.14	1.13	19,670,253.44	Yes	1.24	4.76
CTS-310:CTS-300	30	442	0.002	7,419,291.43	Free Surface	4.05	0.56	0.61	1.40	1.14	0.67	12,258,108.89	No	1.40	4.05
CTS-320:CTS-310	30	127	0.004	7,419,291.43	Free Surface	5.10	0.47	0.45	1.17	1.14	0.95	16,678,378.46	Yes	1.29	4.51
CTS-330:CTS-320	30	475	0.002	7,393,084.57	Free Surface	3.73	0.60	0.67	1.50	1.13	0.59	11,044,112.05	No	1.50	3.73
CTS-340:CTS-330	27	233	0.006	7,381,700.63	Free Surface	5.79	0.50	0.49	1.12	1.17	1.09	14,933,653.74	Yes	1.31	4.77
CTS-350:CTS-340	27	349	0.004	7,355,829.76	Free Surface	5.21	0.54	0.57	1.21	1.17	0.93	12,981,141.89	No	1.21	5.21
CTS-360:CTS-350	27	351	0.005	7,355,829.76	Free Surface	5.52	0.52	0.53	1.16	1.17	1.02	14,008,565.97	Yes	1.19	5.36
CTS-370:CTS-360	27	154	0.004	6,240,511.56	Free Surface	5.13	0.48	0.47	1.08	1.07	0.99	13,434,248.20	Yes	1.12	4.90
CTS-380:CTS-370	27	47	0.004	6,240,511.56	Free Surface	5.13	0.48	0.47	1.08	1.07	0.99	13,415,593.83	No	1.08	5.13
CTS-390:CTS-380	27	235	0.005	6,240,511.56	Free Surface	5.15	0.48	0.46	1.08	1.07	0.99	13,479,326.22	Yes	1.08	5.14
CTS-400:CTS-390	27	64	0.009	6,240,511.56	Free Surface	6.73	0.39	0.32	0.88	1.07	1.47	19,432,774.93	No	0.88	6.73
CTS-410:CTS-400	27	233	0.004	6,240,511.56	Free Surface	5.07	0.48	0.47	1.09	1.07	0.97	13,213,927.18	No	1.09	5.07

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Central Trunk Sewer
Pipe Results

ID	Diameter (in)	Length (ft)	Slope	Total Flow (gpd)	Flow Type	Velocity (ft/s)	d/D	q/Q	Water Depth (ft)	Critical Depth (ft)	Froude Number	Full Flow (gpd)	Backwater Adjustment	Adjusted Depth (ft)	Adjusted Velocity (ft/s)
CTS-420:CTS-410	27	396	0.006	6,186,275.84	Free Surface	5.58	0.45	0.41	1.00	1.07	1.12	15,094,738.68	Yes	1.05	5.29
CTS-430:CTS-420	27	404	0.005	6,162,376.96	Free Surface	5.13	0.48	0.46	1.07	1.06	0.99	13,470,824.99	No	1.07	5.13
CTS-440:CTS-430	27	211	0.003	5,859,040.54	Free Surface	4.54	0.50	0.50	1.13	1.04	0.85	11,642,255.59	No	1.13	4.54
CTS-450:CTS-440	27	431	0.005	5,859,040.54	Free Surface	5.26	0.45	0.41	1.01	1.04	1.06	14,208,146.39	Yes	1.07	4.87
CTS-451:CTS-450	27	23	0.001	5,155,703.30	Free Surface	2.60	0.72	0.87	1.63	0.97	0.37	5,918,344.79	No	1.63	2.60
CTS-452:CTS-451	27	7	-0.003	5,155,703.30	Pressurized	2.01	1.00		2.25	0.00	0.24		No	2.25	2.01
CTS-453:CTS-452	27	318	0.001	5,155,703.30	Pressurized	2.01	1.00	1.08	2.25	0.93	0.24	4,774,983.50	No	2.25	2.01
CTS-460:CTS-450	12	655	0.001	668,604.42	Pressurized	1.32	1.00	1.07	1.00	0.41	0.23	625,005.78	Yes	1.00	1.32
CTS-460:CTS-453	27	350	0.001	5,132,339.42	Pressurized	2.00	1.00	1.07	2.25	0.93	0.24	4,797,667.63	Yes	2.25	2.00
CTS-470:CTS-460	21	279	0.002	1,434,644.54	Free Surface	2.53	0.39	0.33	0.69	0.54	0.62	4,390,122.23	Yes	1.75	0.92
CTS-480:CTS-470	21	272	0	1,434,644.54	Free Surface	1.12	0.77	0.94	1.35	0.54	0.17	1,525,052.52	Yes	1.62	0.95
CTS-490:CTS-480	21	161	0	1,434,644.54	Free Surface	1.18	0.73	0.89	1.28	0.54	0.19	1,618,492.47	Yes	1.62	0.96
CTS-500:CTS-490	21	247	0.001	1,434,644.54	Free Surface	1.76	0.52	0.53	0.91	0.54	0.37	2,693,826.43	Yes	1.23	1.23
CTS-510:CTS-500	21	348	0.001	1,433,987.55	Free Surface	1.76	0.52	0.53	0.91	0.54	0.37	2,696,557.12	Yes	0.99	1.58
CTS-520:CTS-510	21	370	0.001	1,414,950.64	Free Surface	1.77	0.51	0.52	0.90	0.53	0.37	2,721,945.58	No	0.90	1.77
CTS-530:CTS-520	21	438	0.001	1,407,622.68	Free Surface	1.77	0.51	0.52	0.89	0.53	0.37	2,731,727.77	No	0.89	1.77
CTS-540:CTS-530	21	441	0.001	1,399,020.73	Free Surface	1.76	0.51	0.51	0.89	0.53	0.37	2,722,420.32	Yes	0.89	1.76
CTS-550:CTS-540	21	245	0.001	1,347,378.00	Free Surface	1.74	0.50	0.50	0.87	0.52	0.37	2,704,799.29	No	0.87	1.74
CTS-560:CTS-550	21	250	0.001	1,327,508.10	Free Surface	1.76	0.49	0.48	0.86	0.52	0.38	2,755,242.79	Yes	0.87	1.73
CTS-570:CTS-560	21	185	0.001	1,257,746.46	Free Surface	1.72	0.48	0.46	0.84	0.50	0.38	2,721,945.58	Yes	0.85	1.69
CTS-580:CTS-570	21	442	0.001	1,235,152.58	Free Surface	1.71	0.47	0.45	0.83	0.50	0.38	2,719,338.92	Yes	0.83	1.70
CTS-590:CTS-580	21	450	0.001	1,116,702.20	Free Surface	1.83	0.42	0.36	0.73	0.47	0.44	3,099,411.91	Yes	0.73	1.83
CTS-600:CTS-590	21	247	0.001	1,114,772.21	Free Surface	1.82	0.42	0.36	0.73	0.47	0.43	3,064,477.87	No	0.73	1.82
CTS-610:CTS-600	21	264	0.001	1,109,975.23	Free Surface	1.83	0.41	0.36	0.72	0.47	0.44	3,095,973.85	Yes	0.73	1.82
CTS-620:CTS-610	15	396	0.004	1,028,942.65	Free Surface	3.13	0.43	0.39	0.54	0.50	0.86	2,644,203.91	No	0.54	3.13
CTS-630:CTS-620	15	389	0.004	1,020,096.70	Free Surface	3.12	0.43	0.39	0.54	0.50	0.86	2,650,949.73	Yes	0.54	3.11
CTS-640:CTS-630	15	259	0.003	819,520.74	Free Surface	2.65	0.41	0.36	0.52	0.44	0.75	2,297,266.68	Yes	0.53	2.58
CTS-650:CTS-640	15	246	0.005	819,520.74	Free Surface	3.08	0.37	0.29	0.46	0.44	0.93	2,811,952.17	Yes	0.49	2.85
CTS-660:CTS-650	12	355	0.007	602,154.87	Free Surface	3.30	0.39	0.32	0.39	0.41	1.08	1,882,460.56	No	0.39	3.30
CTS-670:CTS-660	12	428	0.006	594,072.91	Free Surface	3.15	0.40	0.33	0.40	0.40	1.02	1,778,603.06	No	0.40	3.15
CTS-680:CTS-670	12	310	0.006	567,157.05	Free Surface	3.13	0.39	0.32	0.39	0.39	1.03	1,788,379.52	Yes	0.39	3.07
CTS-690:CTS-680	12	166	0.005	536,904.21	Free Surface	2.88	0.40	0.33	0.40	0.38	0.94	1,632,559.67	No	0.40	2.88
CTS-700:CTS-690	12	334	0.005	529,809.25	Free Surface	2.87	0.39	0.33	0.39	0.38	0.93	1,627,664.43	Yes	0.39	2.86
CTS-710:CTS-700	12	367	0.006	513,206.33	Free Surface	3.07	0.37	0.28	0.37	0.37	1.04	1,807,766.31	Yes	0.38	2.91
CTS-720:CTS-710	12	360	0.005	498,280.41	Free Surface	2.83	0.38	0.31	0.38	0.37	0.94	1,632,559.67	No	0.38	2.83
CTS-730:CTS-720	12	359	0.005	484,784.48	Free Surface	2.80	0.37	0.30	0.37	0.36	0.94	1,630,284.32	Yes	0.38	2.77
CTS-740:CTS-730	12	450	0.005	319,415.34	Free Surface	2.50	0.30	0.20	0.30	0.29	0.95	1,632,559.67	Yes	0.34	2.13
CTS-750:CTS-740	12	450	0.005	314,424.37	Free Surface	2.48	0.30	0.19	0.30	0.29	0.95	1,632,559.67	Yes	0.30	2.47
CTS-760:CTS-750	12	450	0.005	190,657.01	Free Surface	2.15	0.23	0.12	0.23	0.22	0.94	1,632,559.67	Yes	0.26	1.78
CTS-770:CTS-760	12	450	0.005	171,248.11	Free Surface	2.09	0.22	0.11	0.22	0.21	0.94	1,632,559.67	Yes	0.23	2.01

Appendix A
Scenario 1: CLIBP Phase 1 (Year 2018-2028)
Central Trunk Sewer
Pipe Results

ID	Diameter (in)	Length (ft)	Slope	Total Flow (gpd)	Flow Type	Velocity (ft/s)	d/D	q/Q	Water Depth (ft)	Critical Depth (ft)	Froude Number	Full Flow (gpd)	Backwater Adjustment	Adjusted Depth (ft)	Adjusted Velocity (ft/s)
CTS-780:CTS-770	12	244	0.006	171,248.11	Free Surface	2.16	0.21	0.10	0.21	0.21	0.99	1,717,339.00	Yes	0.22	2.12
CTS-790:CTS-780	12	354	0.012	171,248.11	Free Surface	2.87	0.18	0.07	0.18	0.21	1.45	2,565,211.33	No	0.18	2.87
CTS-800:CTS-790	12	95	0.008	171,248.11	Free Surface	2.45	0.20	0.08	0.20	0.21	1.17	2,051,412.00	No	0.20	2.45
CTS-810:CTS-800	12	449	0.008	61,185.68	Free Surface	1.81	0.12	0.03	0.12	0.13	1.12	2,064,467.81	Yes	0.16	1.20
CTS-820:CTS-810	12	456	0.008	61,185.68	Free Surface	1.81	0.12	0.03	0.12	0.13	1.12	2,065,608.79	Yes	0.12	1.81
CTS-830:CTS-820	12	456	0.008	0	Free Surface	0.00	0.00		0.00	0.00	0.00	2,065,608.79	Yes	0.06	0.00

Appendix A
Scenario 2: Buildout
South Patterson Trunk Sewer
Manhole Results

ID	Rim Elevation (ft)	Total Flow (gpd)	Grade (ft)	Status	Hydraulic Jump	Surcharge Depth (ft)	Unfilled Depth (ft)
STS-010	55	0	47.331	Not Full	No	-1.569	7.669
STS-020	67	0	58.938	Not Full	No	-1.562	8.062
STS-030	75	277,812.56	63.039	Not Full	No	-1.561	11.961
STS-040	76	141,659.26	67	Not Full	No	-1.6	9
STS-050	93	365,078.10	79.853	Not Full	No	-1.747	13.147
STS-060	96	86,397.55	83.245	Not Full	No	-1.555	12.755
STS-070	108	0	98.402	Not Full	No	-1.398	9.598
STS-080	109	276,230.56	99.677	Not Full	No	-1.123	9.323
STS-090	122	46,091.76	106.888	Not Full	No	-1.112	15.112
STS-100	127	175,500.09	111.9	Not Full	No	-1.1	15.1
STS-110	133	191,129.01	118.094	Not Full	No	-0.806	14.906
STS-120	136	6,262,211.45	125.198	Not Full	No	-0.802	10.802

Appendix A
Scenario 2: Buildout
South Patterson Trunk Sewer
Pipe Results

Pipe ID	Diameter (in)	Length (ft)	Slope	Total Flow (gpd)	Velocity (ft/s)	d/D	q/Q	Water Depth (ft)	Critical Depth (ft)	Froude Number	Full Flow (gpd)
STS-010:CTS-010	36	2,730.00	0.002	7,822,110.34	3.64	0.48	0.46	1.43	1.10	0.61	16,953,783.51
STS-020:STS-010	36	5,684.00	0.002	7,822,110.34	3.61	0.48	0.47	1.44	1.10	0.60	16,813,011.21
STS-030:STS-020	36	2,715.00	0.002	7,822,110.34	3.61	0.48	0.47	1.44	1.10	0.60	16,796,945.88
STS-040:STS-030	36	2,586.00	0.002	7,544,297.78	3.61	0.47	0.44	1.40	1.08	0.61	16,999,613.48
STS-050:STS-040	36	3,947.00	0.002	7,402,638.52	4.09	0.42	0.37	1.25	1.07	0.74	20,293,145.75
STS-060:STS-050	36	2,653.00	0.001	7,037,560.41	3.23	0.48	0.47	1.45	1.05	0.54	15,011,693.05
STS-070:STS-060	30	1,627.00	0.004	6,951,162.86	5.16	0.44	0.40	1.10	1.10	0.99	17,310,174.73
STS-080:STS-070	30	353	0.002	6,951,162.86	3.88	0.55	0.59	1.38	1.10	0.65	11,836,746.59
STS-090:STS-080	30	2,076.00	0.002	6,674,932.30	3.69	0.56	0.60	1.39	1.07	0.61	11,221,679.74
STS-100:STS-090	30	1,927.00	0.002	6,628,840.54	3.63	0.56	0.60	1.40	1.07	0.60	10,999,850.82
STS-110:STS-100	24	1,353.00	0.004	6,453,340.45	5.11	0.60	0.67	1.19	1.13	0.90	9,680,947.36
STS-120:STS-110	24	1,280.00	0.004	6,262,211.45	4.93	0.60	0.67	1.20	1.11	0.87	9,344,099.15

Appendix D
Water Balance Data

OPTION 1 100% Irrigation with Storage Basin

Table 1. Crows Landing - Irrigation Demand Calculation for an average year.

Calendar Month (1)	Reference Evapotranspiration, ET_o in. (2)	ft.	Precipitation, P (Average) in. (3)	ft.	Irrigation Hydraulic Loading Rate, L ft./month (4)	Irrigation Demand gal./month (5)	AF/month
Jan	1.40	0.12	2.36	0.20	-0.16	0	0.0
Feb	2.28	0.19	2.00	0.17	-0.02	0	0.0
Mar	4.16	0.35	1.86	0.16	0.19	15,931,742	48.89
Apr	5.55	0.46	0.98	0.08	0.45	37,564,925	115.28
May	7.79	0.65	0.43	0.04	0.76	63,092,389	193.62
Jun	8.68	0.72	0.12	0.01	0.89	74,226,682	227.79
Jul	8.23	0.69	0.02	0.00	0.86	71,372,882	219.04
Aug	7.28	0.61	0.04	0.00	0.76	62,897,671	193.03
Sep	5.79	0.48	0.17	0.01	0.58	48,559,159	149.02
Oct	4.09	0.34	0.60	0.05	0.35	29,001,028	89.00
Nov	1.99	0.17	1.20	0.10	0.05	4,267,162	13.10
Dec	1.36	0.11	2.03	0.17	-0.12	0	0.00
Totals	**58.60**	**4.88**	**11.81**	**0.98**	**4.59**	**406,913,639**	**1,248.77**

		Percent Irrig.
(A) Irrigation Application Area, acres:	254.8	20%
(B) Crop Coefficient, unitless:	0.8	
(C) Irrigation Efficiency, percent:	70	
(D) Leaching Requirement, percent:	10	

Conversions

325851	1 acre-ft to gallons of water
43560	1 acre to SF

Estimated Field Area (acres) 217.35

Table 2. Water balance using Average Dry Weather Flow.

Calendar		Average Dry Weather Flow	Recycled Water Production, Q		Irrigation Demand		Change in Storage	
Month	**Days**	**gpd**	**gal./month**	**AF/month**	**gal./month**	**AF/month**	**gal./month**	**AF/month**
(6)	**(7)**	**(8)**	**(9)**		**(10)**		**(11)**	
Jan	31	891,000	27,621,000	84.77	0	0.00	27,621,000	84.77
Feb	28	891,000	24,948,000	76.56	0	0.00	24,948,000	76.56
Mar	31	891,000	27,621,000	84.77	15,931,742	48.89	11,689,258	35.87
Apr	30	891,000	26,730,000	82.03	37,564,925	115.28	-10,834,925	-33.25
May	31	891,000	27,621,000	84.77	63,092,389	193.62	-35,471,389	-108.86
Jun	30	891,000	26,730,000	82.03	74,226,682	227.79	-47,496,682	-145.76
Jul	31	891,000	27,621,000	84.77	71,372,882	219.04	-43,751,882	-134.27
Aug	31	891,000	27,621,000	84.77	62,897,671	193.03	-35,276,671	-108.26
Sep	30	891,000	26,730,000	82.03	48,559,159	149.02	-21,829,159	-66.99
Oct	31	891,000	27,621,000	84.77	29,001,028	89.00	-1,380,028	-4.24
Nov	30	891,000	26,730,000	82.03	4,267,162	13.10	22,462,838	68.94
Dec	31	891,000	27,621,000	84.77	0	0.00	27,621,000	84.77
Totals			**325,215,000**	**998.05**	**406,913,639**	**1,248.77**		

Monthly Average Flow: 891,000

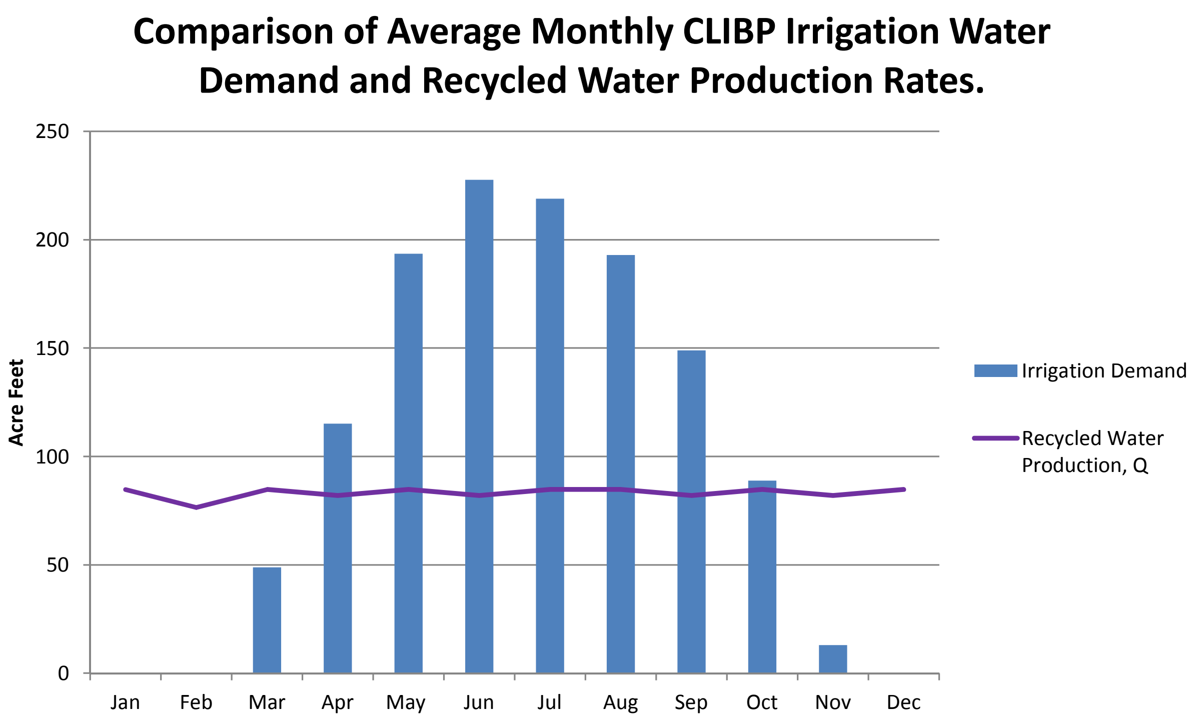
Comparison of Average Monthly CLIBP Irrigation Water Demand and Recycled Water Production Rates.
Acre Feet
250
200
150
100
50
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Irrigation Demand
Recycled Water Production, Q

Table 7. Description of numbered water balance parameters and calculations for Tables 1 and 4.

Callout	Parameter or Label	Value or Calculation	Source or Narrative
(1)	Month	Varies	Calendar listing of months.
(2)	Reference Evapotranspiration, ET_o (in/month)	Total ET_o 58.60 in/year	Monthly average reference evapotranspiration (ET_o) from California Irrigation Management Information System (CIMIS) of California Department of Water Resources for Station 161, Patterson (Department of Water Resources,).
(3)	Precipitation Data Average Year Total Annual Precipitation (in/year)	Total Precipitation 11.81 in/year	Average annual precipitation for the nearby Modesto station (Western Regional Climate Center, accessed 2017). The precipitation data for each month is a percentage of the total precipitation for an average year. The precipitation data is available in the Appendix.
(3)	Precipitation Data 100-Year Total Annual Precipitation (in/year)	Total Precipitation 28.57 in/year (Assumed to have the same percentage of precipitation per month as average conditions)	100-year annual precipitation (annual rainfall with 0.01 probability of occurring in any given year) for the nearby Modesto station (Western Regional Climate Center, accessed 2017). The precipitation data is available in the Appendix.
(4)	Irrigation Hydraulic Loading Rate (ft/month)	[((**B**)x(**2**))-(**3**)]x[1+((**D**)/100)]x(100/(**C**))	Irrigation is necessary when the rainfall does not meet the crop irrigation needs. The values of ET_o can be converted into crop evapotranspiration by multiplying ET_o **(2)** by the crop coefficient **(B)**. This value is subtracted from precipitation **(3)** to calculate the net evapotranspiration. The irrigation efficiency **(C)** and leaching requirement **(D)** are estimated values and are shown in Table 8.
(5)	Irrigation Demand (AF/month)	**(4)**x**(A)**	The irrigation demand is calculated by multiplying the irrigation hydraulic loading rate **(4)** by the application area **(A)**.

Table 8. Description of Lettered Water Balance Parameters.

Callout	Parameter	Value	Source
(A)	Irrigation Application Area (acres)	TBD	Acreage of landscape irrigation.
(B)	Crop Coefficient (unitless)	0.8	0.8 was used in the Crows Landing SB 601 Report-Appendix D City of Patterson Urban Management Plan (pdf pg 189 out of 473)
(C)	Irrigation Efficiency (percent)	70	Estimated based on *Guidelines for Water Reuse* (U.S. EPA, 2004). 70% Landscape irrigation efficiency used in the Modesto Irrigation District-2015 AWMP
(D)	Leaching Requirement (percent)	10	Estimated value based on irrigation demand. Reference from Stanislaus County. Leaching requirements vary by crop type, soil type, and other factors. The leaching requirement of 10 percent was assumed for this site based on the Modesto Irrigation District 2012 AWMP
(E)	Surface Area of Storage Basin (acres)	TBD	Crows Landing Industrial Business Park Sanitary Sewer Infrastructure and Facilities Study (AECOM and VVH Consulting Engineers, 2016).
(F)	Soil Infiltration Rate	**0.05-0.15 in/hr** **0.5 in/hr**	Soil type C – Sandy clay loam. Infiltration rate when thoroughly wetted and consist primarily of soils with a layer that impedes downward movement of water as specified in the AECOM CLIBP Storm Drain Report. Increased rate used for “engineered” percolation area

Table 9. Description of numbered water balance parameters and calculations for Tables 2 and 5.

Callout	Parameter or Label	Value or Calculation	Source or Narrative
(6)	Month	Varies	Calendar listing of months.
(7)	Days	Varies	Number of days in the month.
(8) and (9)	Recycled Water Production Average (gpd and AF/month)	Varies	Average Dry Weather Flows from the Crows Landing Industrial Business Park Sanitary Sewer Infrastructure and Facilities Study (2016).
(8) and (9)	Recycled Water Production 100-year (gpd and AF/month)	Varies	100-year monthly recycled water flows were estimated using the ratio of adjusted 100-year precipitation values to adjusted average precipitation values, and then multiplying the ratio by the average recycled water flow for each month.
(10)	Irrigation Demand (AF/month)	**(4)**x**(A)**	See Callout **(5)** in Table 7.
(11)	Change in Storage or Recycled Water (AF/month)	**(9)**-**(10)**	The change in storage is the difference between recycled water production **(9)** and irrigation demand **(10)**, which is used to compare seasonal irrigation demand and the production of recycled water.

Table 10. Description of Numbered Water Balance Parameters and Calculations.

Callout	Parameter or Label	Value or Calculation	Source or Narrative
(12)	Month	Varies	Calendar listing of months.
(13)	Days	Varies	Number of days in the month.
(14)	Change in storage (AF/month)	**(9)**-**(10)**	See Callout **(11)** in Table 9.
(15)	Cumulative Storage (AF/month)	**(14)+(15 from previous month)**	To obtain cumulative storage volume for each month a running total is used by adding the previous month's storage **(15)** and the change in storage **(14)**. The cumulative storage in this column does not consider precipitation or evaporation. The information in this column is used as an estimate to see when the lake is empty to assume no evaporation.
(16)	Precipitation Data Average Year Total Annual Precipitation (in/year)	Total Precipitation 11.81 in/year	See Callout **(3)** in Table 7.
(16)	Precipitation Data 100-Year Total Annual Precipitation (in/year)	Total Precipitation 24.10 in/year	See Callout **(3)** in Table 7.
(17)	Storage Basin	**(2)**x1	The lake evaporation can be estimated using ET_o **(2)**

	Evaporation (in/month)		multiplied by the crop coefficient for a free water surface, which generally ranges from 1.05 to 1.15. Open water surface evaporation in California is 1.1 multiplied by ET_o **(2)** (Department of Water Resources, 1999). A conservative estimate of 1.0 was used as the factor. When there is no recycled water in the storage basin, the value was set to zero.
(18)	Percolation/Seepage		Soil type C – Sandy clay loam as specified in the AECOM CLIBP Storm Drain Report. Increased rate used for “engineered” percolation area
(19)	Net Gain or Loss in Storage Basin (AF/month)	(**(14)**-**(15)**)x**(E)-(18)**	To find the net gain or loss in storage volume, add the precipitation **(16)** and subtract the lake evaporation **(17)**. Multiply the calculated value by the application area **(E)** and subtract the seepage **(18)**
(20)	Irrigation Demand (AF/month)	**(4)**x**(A)**	See Callout **(5)** in Table 7.
(21)	Change in Storage (AF/month)	**(9)**+**(16)- (20)**	The change in Storage can be estimated by adding the inflows and subtracting the outflows.
(22)	Cumulative Storage (AF/month)	**(19)**+**(20 from previous month)**	To obtain cumulative storage volume for each month a running total is used by adding the previous month’s storage **(22)** and the change in storage **(21)**.

References

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