CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

Total Maximum Daily Load Report for Pathogens In:

Five-Mile Slough, Lower Calaveras River, Mormon Slough, Mosher Slough, Smith Canal and Walker Slough

San Joaquin County, CA

FINAL STAFF REPORT

March 2008

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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Executive Summary:
Pursuant to the federal Clean Water Act (CWA) §303(d), the State Water Resources Control Board has compiled a list ("§303(d) list") of waterbodies for which water quality controls are insufficient to implement existing water quality standards. Six urban waterbodies in the City of Stockton are listed as impaired waterbodies on the §303(d) list due to elevated pathogen counts. Pathogens are assessed using indicator organisms such as *E.Coli* and fecal coliform. The six listed waterbodies are:

- Five-Mile Slough,
- Lower Calaveras River,
- Mormon Slough,
- Mosher Slough,
- Smith Canal, and
- Walker Slough.

The CWA mandates that the State establish a Total Maximum Daily Load (TMDL) for each impaired water body on the §303(d) list. For the six impaired urban waterbodies in the City of Stockton, TMDLs will be implemented by the provisions and requirements included in the City of Stockton Municipal Separate Storm Sewer System Permit (MS4) stormwater permit. *(Order No. R5-2007-0173; National Pollutant Discharge Elimination System (NPDES) No. CAS083470)* and Water Code §13267 Order (issued 14 November 2007).

Water Quality Targets
California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board) staff proposes establishing the fecal coliform water quality objectives and the U.S. Environmental Protection Agency's (US EPA) numeric criteria for E. coli as the numeric targets for this TMDL (see Table 1). These targets are considered to be protective of the water contact recreation (REC-1) beneficial use, and are expressed as a concentration with units of most probable number (MPN)/100ml. The numeric targets are applicable year-round.

Table 1: Pathogen Indicator Water Quality Targets

Parameter	Water Quality Target
Fecal coliform	200/100 ml Geometric Mean[1], nor 400/100 ml for 10% of samples[2]
E. coli	126/100 ml Geometric Mean[3], and 235/100 ml single sample maximum

[1] Geometric mean concentration of not less than five samples for any 30-day period

[2] During any 30-day period

[3] Geometric mean concentration of a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period)

TMDL Loading Capacity and Allocations

The loading capacity for pathogens in each of the six listed waterbodies/Sloughs is the same as the numeric target (assessed using pathogen indicators), which is protective of the REC-1 beneficial use. Concentration-based loads are proposed for this TMDL. In regards to seasonal variation due to lack of adequate information on frequency of recreational use and how background levels vary by season, the level necessary to attain water quality objectives is the same throughout the year. Since the loading capacity is expressed per unit volume rather than total mass load, the individual sources must not exceed the loading capacity. Therefore, the waste load allocations and load allocations are equal to the loading capacity (see Equation 1). This formula represents the concentration of fecal coliform and *E. coli* that can be in the stormwater that runs off or is discharged into any of the stretches of the six urban waterbodies covered by this TMDL.

LC=WLA=LA=Numeric Target (EQ 1)

Implementation

As part of its previous Municipal Separate Storm Sewer System (MS4) Stormwater Permit *(Order No. R5-2002-0181; NPDES No. CAS083470)*, the City of Stockton was instructed to develop and implement a pathogen pollution prevention plan (Pathogen Plan). This project plan[1] was submitted to the Central Valley Water Board Executive Officer and approved in 2004. The Pathogen Plan's goals were to evaluate the six listed waterbodies through a phased approach – two sloughs at a time. Each phase involves monitoring to characterize the waterbody and to identify sources. Once sources are identified, Best Management Practices (BMPs) are implemented and then evaluated for effectiveness. The Pathogen Plan has been initiated and is currently in phase one of the three-phased project.

The current MS4 Stormwater Permit *(Order No. R5-2007-0173; NPDES No. CAS083470)*, adopted on 6 December 2007, requires Stockton to continue its efforts under the Pathogen Plan. Also, the monitoring laid out in the Pathogen Plan will now be implemented under §13267 of the Porter-Cologne Water Quality Control Act. (Ca. Water Code §13267). By the end of the Pathogen Plan, pathogen sources should be identified (within the capability of methods used) and BMPs should be in place to solve the impairment. Microbial source tracking is a relative new technology and is rapidly evolving. Currently the method utilized allows detection of total, human, dog, and cow/horse sources.

[1] Larry Walker Associates. 2004. *City of Stockton San Joaquin County Pathogen Plan*. 1 April 2004 (Finalized August 2004).

If results from the Pathogen Plan indicate the implementation of BMPs to control pathogens does not resolve water quality impairments in the urban waterbodies, then additional controls or monitoring may be required of Stockton. In addition, the Central Valley Water Board may prepare a Basin Plan Amendment or take another action to address the sources of pathogens in the Stockton urban waterbodies. Actions that the Central Valley Water Board could take at the end of the Pathogen Plan include: studies to determine background bacteria levels, site specific water quality objectives, a use attainability analysis, etc.

Acronyms/Abbreviations

§	Section (as in a law or regulation)
§303(d) list	List of Impaired Waterbodies created pursuant to Clean Water Act §303(d)
Basin Plan	Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin, Fourth edition
BMPs	Best Management Practices
CCWD	Calaveras County Water District
CFR	Code of Federal Regulations
CFU	Colony Forming Unit
Central Valley Water Board	California Regional Water Quality Control Board, Central Valley Region
CWA	federal Clean Water Act
DWSC	Stockton Deep Water Ship Channel
E.coli	*Escherichia coli*
MEP	Maximum Extent Practicable
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer System
n.d.	No date of publication
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
Pathogen Plan	Pathogen Pollution Prevention Plan
SEWD	Stockton East Water District
SJR	San Joaquin River
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
USACE	United States Army Corp of Engineers
US EPA	United States Environmental Protection Agency
WDR	Waste Discharge Requirements

1 Introduction

Pursuant to the federal Clean Water Act (CWA) §303(d), the State Water Resources Control Board has compiled a list ("§303(d) list") of waterbodies for which water quality controls are insufficient to implement existing water quality standards. Six urban waterbodies in the City of Stockton are listed as impaired waterbodies on the §303(d) list: Five-Mile Slough, Lower Calaveras River, Mormon Slough, Mosher Slough, Smith Canal and Walker Slough. These waterbodies are listed because of various combinations of chlorpyrifos, pathogens, diazinon, and low dissolved oxygen. Walker Slough is only listed for pathogen impairment.

Two of the six impaired waterbodies (Five-Mile Slough and Smith Canal) are dead-end sloughs in the Stockton urban area. The other four waterbodies (Lower Calaveras River, Mormon Slough, Mosher Slough and Walker Slough) have upstream reaches beyond the City of Stockton, including areas used for agriculture. This Total Maximum Daily Load (TMDL) addresses impairments for pathogens in Lower Calaveras River, Five-Mile Slough, Mormon Slough (from the Stockton Deep Water Ship Channel (DWSC) to Commerce Street), Mosher Slough, Smith Canal, and Walker Slough. The TMDL will be implemented through Stockton's MS4 stormwater permit, and therefore areas outside the boundary of the City/permit cannot be included. If necessary, these areas will be addressed at a later time through an amendment of the Water Quality Control Plan for the Sacramento River Basin and the San Joaquin River Basin (Basin Plan) or other appropriate actions.

The dissolved oxygen impairment will likely be addressed in two future TMDLs, one for those sloughs with upstream reaches and one for the urban dead-end sloughs. Diazinon and chlorpyrifos listings for the City of Stockton's waterbodies have been addressed in the Sacramento-San Joaquin River Delta Pesticide TMDL.

1.1 Scope of this Report

The scope of this TMDL involves six listed waterbodies in the Stockton area: Five-Mile Slough, Lower Calaveras River, Mormon Slough, Mosher Slough, Smith Canal and Walker Slough. This TMDL will apply to the two dead-end sloughs in the Stockton area (Five-Mile Slough and Smith Canal), and the Calaveras River, Mormon Slough (from the DWSC to Commerce Street), Mosher Slough, and Walker Slough, which have upstream reaches beyond the City of Stockton. This report contains the following elements:

- summary of the regulatory background (Section 1);
- problem statement that identifies the context, background, and the nature of the impairment (Section 2);

- summary of available data (Section 3);
- numerical water quality targets (Section 5);
- identification and quantification of sources and source loads (Section 4 & 6);
- linkage analysis between the water quality targets and amount or load of contaminant(s) (Section 6);
- allocation of the necessary load reductions to the various sources and to a margin of safety that takes into account uncertainties and consideration of seasonal variations (Section 7 & 8); and
- implementation plan (Section 9).

1.2 Regulatory Background

This report was prepared by staff from the California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board). The TMDL will be adopted by the Central Valley Water Board prior to submittal to the U.S. Environmental Protection Agency (US EPA).

Water quality standards are enforced under the federal Clean Water Act and the California Porter-Cologne Water Quality Control Act, and consist of designated beneficial use(s) and water quality criteria or objectives designed to protect such uses.

Clean Water Act §303(d)

The federal Clean Water Act (CWA) §303(d) requires States to: 1) identify those waters not attaining water quality standards (the "§303(d) list"); 2) set priorities for addressing impairments caused by pollutants; and 3) establish a TMDL for each identified water body/pollutant combination in order to attain water quality standards (the purpose of this report). TMDLs will be reviewed by the US EPA to determine whether all TMDL requirements are met.

A TMDL represents the maximum load expressed in terms of mass per time, toxicity or other appropriate measure of a pollutant that a water body can receive and still meet water quality standards (40 C.F.R. §130.2(i)). This load allocation is accepted as a TMDL when US EPA approves it.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (California Water Code § 13000 et seq.)(Porter-Cologne Act), establishes the responsibilities and authorities of each Regional Water Quality Control Board, including responsibility and authority for regional water quality control and planning. The Central Valley Water Board establishes water quality objectives and programs to implement the water quality objectives by amending the Basin Plan for the Sacramento River and San

Joaquin River basins. The Central Valley Water Board also regulates discharge through Waste Discharge Requirements (WDRs), waivers of WDRs, and prohibitions of discharge.

NPDES Waste Discharge Requirements

The Water Quality Act of 1987 added §402(p) to the CWA, creating a framework for regulating stormwater discharges under the NPDES program. (33 U.S.C. §1342(p)). Furthermore, CWA §402(p) provides that MS4 permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable (MEP), including management practices, control techniques and system, design and engineering methods, and such other provisions as the US EPA Administrator or the State determines appropriate for the control of such pollutants"(33 U.S.C. § 1342(p)(3)(B)(iii)). These are the statutory imperatives that direct the formulation of the MS4 permit.

City of Stockton MS4 Stormwater Permit

The City of Stockton's stormwater sewer system, which is connected to urbanized non-incorporated land administered by the County of San Joaquin, serves a population greater than 100,000 but less than 250,000, and is considered to be a medium municipality under federal regulations (40 C.F.R. § 122.26 (b)(7)). Therefore the City of Stockton must obtain a NPDES MS4 stormwater permit, The City is currently under Order No. R5-2007-0173, NPDES No. CAS083470 (Central Valley Water Board, 2007).

As part of the previous MS4 Stormwater Permit adopted in October 2002 (Order No. R5-2002-0181, NPDES No. CAS083470), the City of Stockton was instructed to develop and implement a pathogen pollution prevention plan (Pathogen Plan), and submit it to the Central Valley Water Board by 1 April 2004. The Pathogen Plan was required to include:

- a plan to identify areas and/or activities, which contributed to the high pathogen concentrations in storm water;
- a monitoring program to assess the contribution of pathogens from manmade and natural sources;
- identification, development, and implementation of Best Management Practices (BMPs) to address controllable discharges of pathogens to storm sewers to the MEP;
- development and adoption of policies, procedures, and/or ordinances to implement the Pathogen Plan;
- coordination with the San Joaquin County Environmental Health Department and other interested stakeholders to accomplish pathogen source identification and BMP development;
- coordination with the Central Valley Water Board to help develop a TMDL for pathogen-impaired waterbodies (Central Valley Water Board, 2002).

In April 2004, the City of Stockton provided to the Central Valley Water Board a Pathogen Plan prepared by Larry Walker Associates (Larry Walker and

Associates, 2004). The Pathogen Plan provided an overview of the problem in Stockton, a plan to identify pathogen sources, and a plan for BMP development and implementation. The Pathogen Plan provides for a ten-year effort to identify pathogen sources and implement a program to reduce pathogen levels for all of the impaired waterbodies in Stockton. On 18 August 2004, the City and County submitted plan revisions to the satisfaction of Central Valley Water Board staff (City of Stockton, 2004). The Executive Officer of the Central Valley Water Board approved the Pathogen Plan on 10 November 2004 (Central Valley Water Board, 2004).

The Pathogen Plan program to reduce pathogen levels consists of three phases. Each phase concentrates on two specific Stockton waterbodies that are impaired by pathogens. The City of Stockton is currently in Phase One of their Pathogen Plan, which includes Smith Canal and Mormon Slough. Phase Two will include Mosher Slough and Five Mile Slough. Each phase is broken up into four sequential steps, which are described in detail in the *City of Stockton San Joaquin County, Pathogen Plan*. These steps include: (i) Characterization Monitoring, (ii) Source Identification Studies, (iii) BMP Development and Implementation, and (iv) Effectiveness Monitoring and Plan Assessment.

Characterization Monitoring "helps determine long-term trends in bacteria loading as well as short-term variations in bacteria concentrations" (Larry Walker Associates, 2004). Characterization Monitoring also will help the City to determine which locations would be best to use for Source Identification Studies. Source Identification Studies are comprised of Microbial Source Tracking Studies, which evaluate the organisms (human or non-human) from which the indicator bacteria likely originated, and Location Tracking Studies, which are used to identify spatial patterns of bacterial contamination. Once sources are identified, BMPs are developed and implemented to address controllable sources of pathogens. Effectiveness Monitoring and Plan Assessment monitoring is then used to evaluate the success of the implemented BMPs.

2 Problem Statement

This section:

- Summarizes the environmental characteristics of each of the impaired Stockton urban waterbodies;
- Describes the applicable water quality standards (beneficial uses and water quality objectives as specified in the Basin Plan;
- Describes the numeric targets used to meet the water quality objectives;
- Discusses the sources and effects of pathogens in the Stockton urban waterbodies; and,
- Summarizes the monitoring data that indicates the extent of pathogen impairment.

The Stockton urban waterbodies are impaired due to high pathogen levels (assessed using pathogen indicators). These conditions occur year round and may be more severe during the storm season. These conditions often violate the Basin Plan water quality objectives for fecal coliform, and the US EPA criteria for *E. coli*.

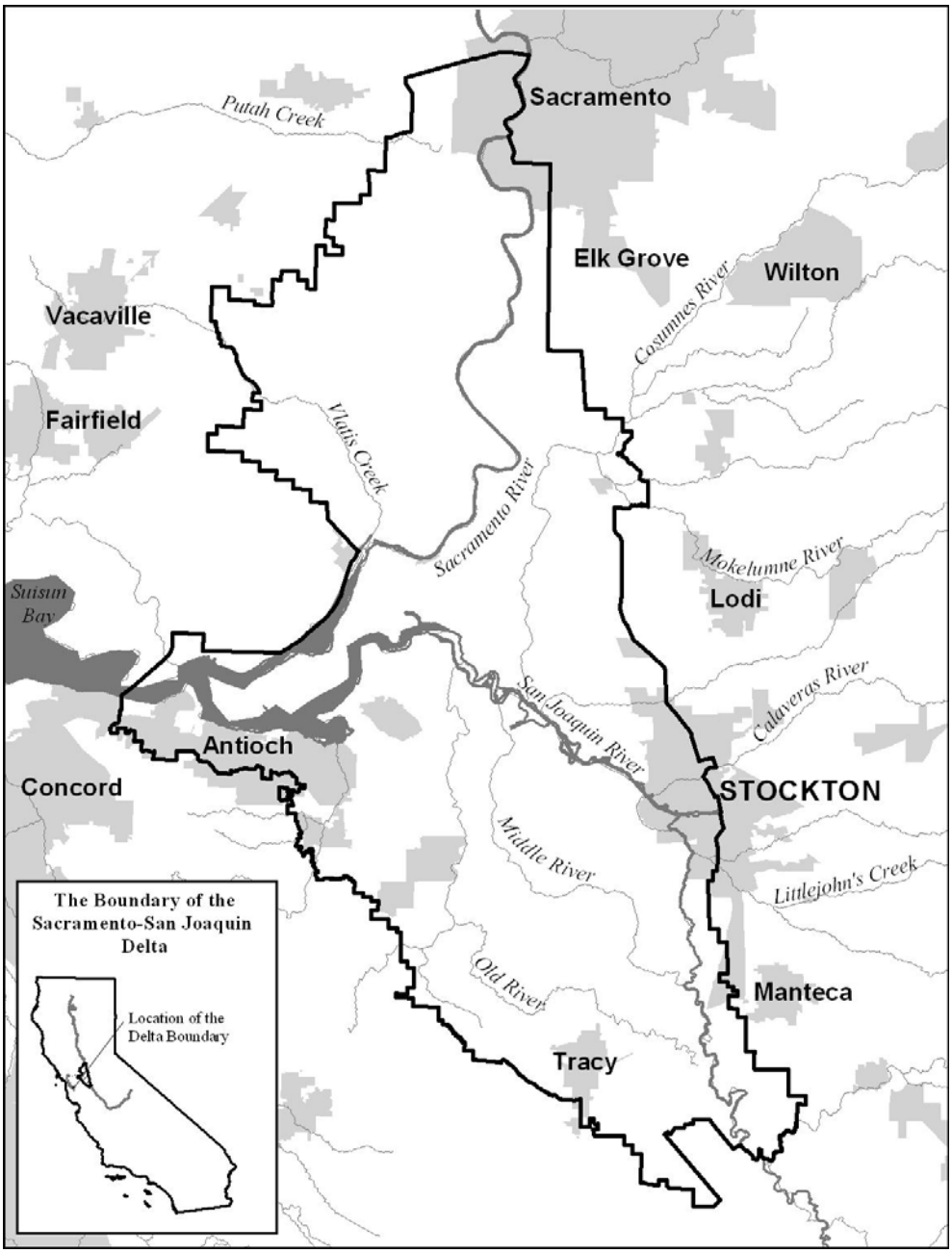
The City of Stockton has two sloughs surrounded by urban area on the §303(d) list due to high pathogen levels. These are: Five-Mile Slough and Smith Canal. Also listed on the CWA's 303(d) list for impairment by pathogens are Lower Calaveras River, Mormon Slough, Mosher Slough, and Walker Slough, which have upstream water sources outside of the Stockton urban area.

In 2002, the State Water Resources Control Board (State Water Board) adopted a §303(d) list identifying the pathogen impairment in these waterbodies. This initiated the need to develop a TMDL with a program of implementation for the listed impaired waters.

2.1 Stockton Watershed Setting

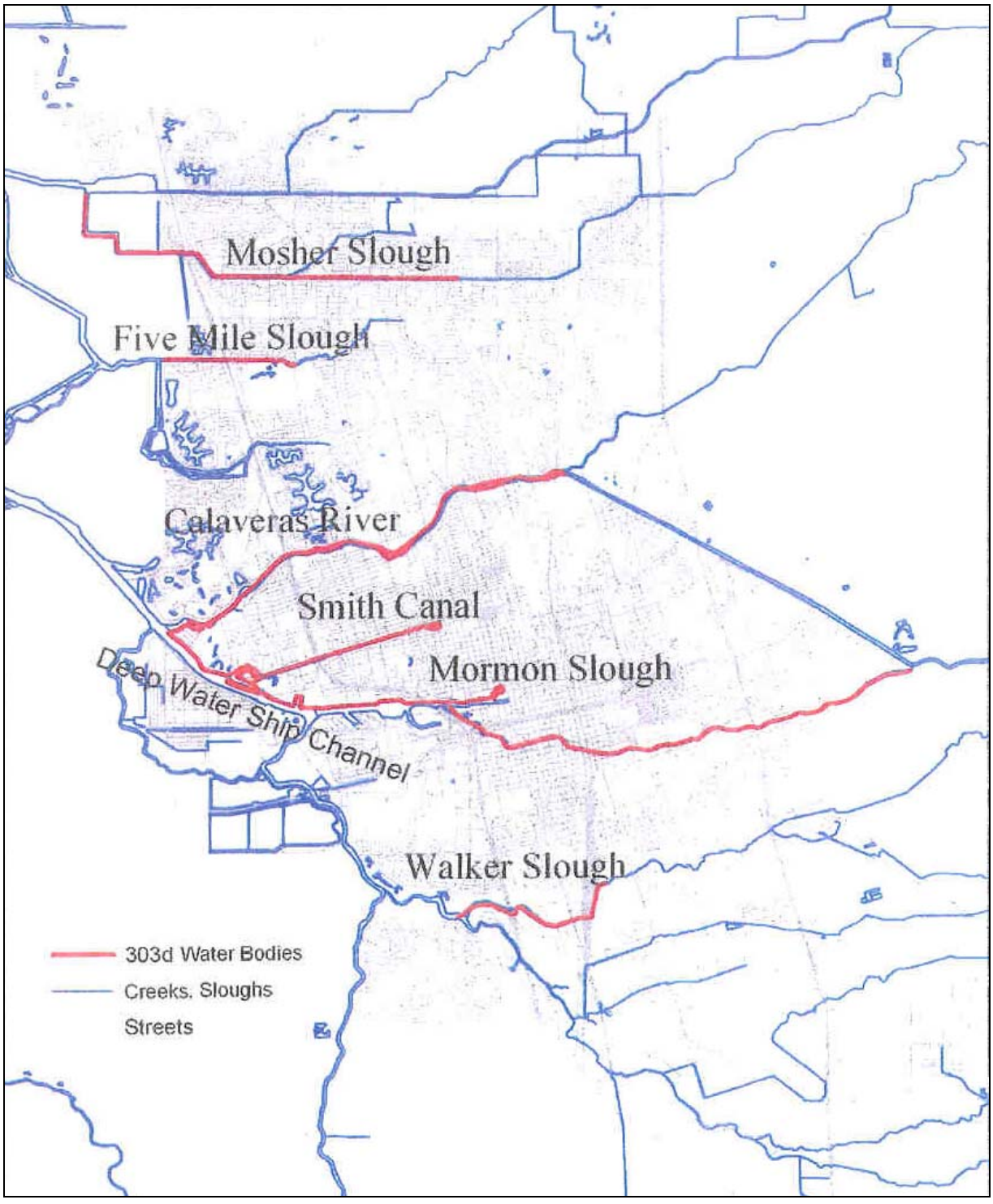
The City of Stockton is located in California's Central Valley approximately 50 miles south of Sacramento and partially within California's Sacramento-San Joaquin Delta (Figure 1). The Stockton urban waterbodies are in a temperate climate, with warm dry days and cool nights. Stockton tends to have mild winters and warm summers. The average annual precipitation for Stockton is approximately 13.84 inches per year with an average annual temperature of 16.6^{o}C (61.8^{o}F) (NOAA). The following provides a description of each of the pathogen-impaired waterbodies.

Figure 1: Boundary of the Sacramento-San Joaquin Delta



Source: Central Valley Water Board

Figure 2: Pathogen Impaired Waterbodies



Source: City of Stockton Pathogen Plan

2.1.1 Calaveras River, Mosher Slough and Upper Mormon Slough

2.1.2 Watershed Setting

The Calaveras River drains a small watershed in the Sierra Nevada, located within Calaveras, San Joaquin, and Stanislaus counties, and is tributary to the San Joaquin River. Due to its low elevation, the watershed receives its precipitation predominantly as rainfall. The River receives high flows during the late fall, winter, and early spring, while flows in the summer and early fall tend to be minimal or non-existent (DWR, 2003). The Calaveras River Watershed supports many different land uses including: residential, industrial, forested, agricultural, and recreational (Tetra Tech EM Inc., 2001).

The Calaveras River originates in the western Sierra Nevada Mountains. The north fork originates at Pine Ridge at an elevation of approximately 4,000 ft., and the south fork originates from San Antonio Creek which begins at Summit Level Ridge at an elevation of 6,000 ft (Fishery Foundation, 2003). The north and south forks join together at New Hogan Reservoir to form the main stem of the Calaveras River. New Hogan Reservoir is a 317,000 acre-foot lake, which was created in 1964 when the United States Army Corps of Engineers (USACE) built New Hogan Dam (Calaveras River Watershed Stewardship Group, n.d). The dam provides flood protection, and water for irrigation, drinking, recreation, and hydroelectric power. The USACE determines when flood releases into the Calaveras River are necessary, while Stockton East Water District controls municipal and irrigation releases. Below New Hogan Dam, the Calaveras River continues until it reaches the Bellota Weir, a diversion structure that divides the river into the Old Calaveras River Channel and Mormon Slough. The Bellota Weir, a structure built by the USACE, is operated by Stockton East Water District.

Above the Bellota Weir, the Calaveras River is a natural stream channel. At the Bellota Weir water is diverted into Mormon Slough, which becomes the primary channel of the watershed. Mormon Slough continues toward the city of Stockton where it is diverted into the Stockton Diverting Canal, a USACE flood control channel. The Stockton Diverting Canal then delivers the water back to the Old Calaveras River Channel, which continues on to the confluence with the San Joaquin River. Mormon Slough, after the Stockton Diverting Canal, is a low-flow stream until reaching an area in Stockton where it becomes tidally-influenced from the Stockton Deep Water Ship Channel (DWSC).

Past the Bellota Weir, both the Old Calaveras River Channel and Mormon Slough channels to carry irrigation water during the summer months and act as flood control during the winter. The Old Calaveras River Channel only receives water after the diversion when there are flood flows, or through culverts during the irrigation season (Fishery Foundation, 2003). The old channel remains dry most of the summer and early fall months. The lower Calaveras River, which

"flows through central Stockton and joins the San Joaquin River near Rough and Ready Island," receives its source water from the DWSC and is impaired between the Stockton Diverting Canal and the San Joaquin River (Central Valley Water Board – 303 (d) Appendix B, 2002). Lower Calaveras River also receives stormwater runoff from the Stockton urban area. The Stockton Diverting Canal water could potentially be negatively impacting the lower Calaveras River. Land uses in the drainage area include mostly open space (43.6%) and residential (37.5%). Open space includes cropland, pasture, herbaceous rangeland, orchards, groves, vineyards, nurseries, streams, and canals. Commercial land use, industrial land use, and mixed urban land use comprise the other 18.9% of land uses in the Calaveras River drainage area. (Larry Walker Associates, 2004.) The Calaveras River (lower and upstream) does not contain any city gravity outfalls, but it does contain ten city pump stations, eight within the impaired region and two closely upstream.

A few miles beyond Bellota Weir, Mosher Creek branches off of the Old Calaveras River Channel and continues west until reaching its confluence with Pixley Slough and eventually the San Joaquin River. The land around Mosher Creek, which becomes Mosher Slough downstream, is agriculture on the eastern side of Stockton and urban on the western side of Stockton. Flow is continuous from the confluence with the Calaveras River until the confluence with the San Joaquin River.

2.1.3 Mosher Slough

Mosher Slough is located primarily in the residential north side of Stockton and is impaired from the confluence with the DWSC to 3.5-miles upstream of Interstate 5. Land uses in the drainage area include mostly open space (72.6%) and some residential (21.1%). Commercial land use, industrial land use, and mixed urban land use make up the other 6.3% of land uses in the Mosher Slough drainage area. (Larry Walker Associates, 2004.) Mosher Slough contains eight city pump stations within the impaired reach. The locations of these pumps are as follows: near Deep Water Lane, Kelly Drive, Bainbridge Place, Mason Drive, Don Avenue, Thornton Road, El Dorado Street, and Cayuga Drive. Mosher Slough has one gravity outfall located at Thornton Road. There are also two pump stations upstream of the impaired stretch of Mosher Slough. Bear Creek, which flows into Mosher Slough, has six gravity outfalls and two pump stations near the confluence with the slough. The runoff from these sites could be contributing to the impairment of Mosher Slough.

2.1.4 Walker Slough

Walker Slough is located within the legal boundary of the Delta in the southern part of Stockton near Highway 4. The slough lies between French Camp Slough and Duck Creek. The entire waterbody length of two miles is impaired by pathogens. The Walker Slough watershed has the following land uses:

residential (42.1%), commercial (12.9%), industrial (5.9%), mixed urban (11.5%), and open space (27.8%) (Larry Walker Associates, 2004). Some of these land uses include the upstream reach of Duck Creek. Walker Slough is near Van Buskirk Park and Golf Course. The slough has one city pump station located along Turnpike Road. There are no pump stations located around Walker Slough.

2.1.5 Five-Mile Slough

"Five-Mile Slough is located in the Delta, extends through urban Stockton from Five-Mile Creek, and is bordered by residential housing, schools, a park, and a golf course" (Central Valley Water Board – 303 (d) Appendix B, 2002). Five-Mile Slough is indirectly tributary to the DWSC. It enters Fourteen-Mile Slough, which then flows into the DWSC. Upstream of Five-Mile Slough is Five-Mile Creek, which originates near Pacific Avenue. Five-Mile Slough is impaired from Pacific Avenue to the confluence with Fourteen-Mile Slough. The slough is a dead-end slough ending near Pacific Avenue. The land uses within the drainage area include residential (44.4%), commercial (11.2%), mixed urban (22.3%), and open space (22.1%). (Larry Walker Associates, 2004) Five-Mile Slough has no upstream contribution to the pathogen impairment. There are two city pump stations located in the impaired region of Five-Mile Slough, one near Lighthouse Drive, and the other located near Plymouth Road. Five-Mile Slough also has three city gravity outfalls.

2.1.6 Lower Mormon Slough

Lower Mormon Slough begins where upper Mormon Slough is diverted into the Stockton Diverting Canal. Past the Stockton Diverting Canal, lower Mormon Slough continues until it reaches the DWSC, however; there may not be continuous water flowing between the Stockton Diverting Canal and the lower portion of Mormon Slough year round. Lower Mormon Slough does contain water year-round in the stretch from the DWSC to Madison Street. Past this point, water may be present only during high-flow events. The Slough, which is impaired from Commerce Street to the DWSC, is directly tributary to the DWSC, entering it near the Port of Stockton. The land uses within the drainage area includes mostly residential (39.2%) and commercial (31.2%), with small percentages of industrial, mixed urban, and open space. (Larry Walker Associates, 2004.) The impaired region of Mormon Slough (from the DWSC to Commerce Street) contains ten city gravity outfalls. There are seven more outfalls upstream. There are no city pump stations located along Mormon Slough. The CWA 303(d) List also lists a second reach on Mormon Slough impaired by pathogens from Commerce Street to the Stockton Diverting Canal. This reach will not be addressed by this TMDL because a portion of the impaired waterbody lies outside of the Stockton city limits and will require a Basin Plan Amendment.

2.1.7 Smith Canal

Smith Canal, a straight canal surrounded by urban land, is a dead-end slough connecting the San Joaquin River near Rough and Ready Island with Yosemite Lake in downtown Stockton. It is tidally-influenced and is directly tributary to the DWSC. Smith Canal has two parks associated with it: Louis Park near the mouth of the Canal, and American Legion Park at the end of the Canal. Smith Canal is impaired from its dead end terminus (Yosemite Lake) to the confluence with the San Joaquin River. It receives stormwater discharges exclusively from 3,300 acres of urban downtown Stockton area" (Central Valley Water Board – Appendix B, 2002). The land uses within the drainage area are residential (71.5%), commercial (18.3%), industrial (2.1%), mixed urban (7%), and open space (1.2%) (Larry Walker Associates, 2004). Smith Canal contains three city gravity outfalls, all located along Shimizu Drive near the confluence with the DWSC. It also has three city pump stations; one at the end of the canal near Yosemite Lake, one in the middle near Buena Vista Avenue, and one located near I-5 and Shimizu Drive.

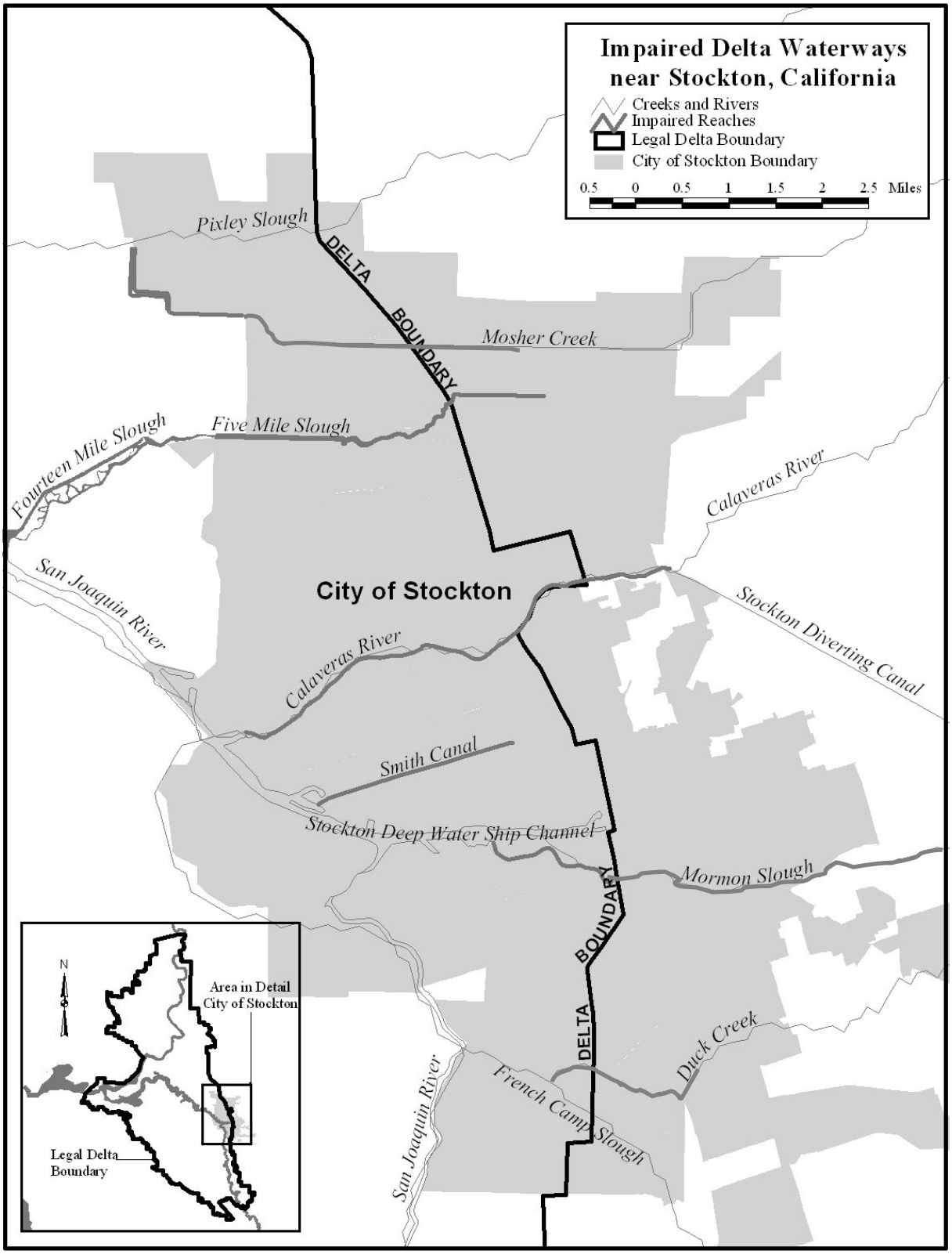
2.2 Water Quality Standards

Water quality standards consist of beneficial uses and water quality objectives, as defined in the Basin Plan. The Basin Plan lists (designates) beneficial uses applicable to major waterbodies located within the Central Valley including waterbodies within the legal boundary of the Sacramento-San Joaquin Delta (Figure 1). Since a portion of all six Stockton urban waterbodies lie within the legal boundary of the Delta (Figure 3), those beneficial uses apply.

According to the Basin Plan the existing Sacramento-San Joaquin Delta beneficial uses include: Municipal (MUN), Agriculture (AGR), Industrial Process Supply (PROC), Industrial Service Supply (IND), Contact Recreation (REC-1), Non-Contact Recreation (REC-2), Warm Freshwater Habitat (WARM), Cold Freshwater Habitat (COLD), Migration (MIGR), Spawning (SPWN), Wildlife Habitat (WILD), and Navigation (NAV). All nine beneficial uses apply directly to the portions of all six Stockton urban waterbodies that lie within the Delta.

Three of the six Stockton urban waterbodies have impaired reaches that lie outside the legal boundary of the Delta. For these sections, the Basin Plan states, "The beneficial uses of any specifically identified water body generally apply to its tributary streams." (Central Valley Water Board, 1998, pg. II-2.00) Since those sections of the Stockton urban waterbodies are tributary to waterbodies within the Delta, the Sacramento-San Joaquin Delta beneficial uses would apply.

Figure 3: Delta Boundary



Source: Central Valley Water Board

2.2.1 Pathogen Water Quality Objectives

Water quality objectives for pathogens are usually based on indicator organisms. Indicator organisms for pathogens are organisms that likely indicate the presence of human pathogenic organisms. Indicator organisms are used to infer the potential for the presence of disease-causing pathogens because pathogenic organisms are usually difficult to identify and isolate. Indicator organisms used for pathogens tend to include total coliforms, fecal coliforms, and *Escherichia coli* (*E. coli*) (US EPA, 2001).

The Basin Plan contains a specific objective for fecal coliform bacteria. It states:

> "In waters designated for contact recreation (REC-1), the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 ml, nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 ml."(Central Valley Water Board, 1998, pg III-3).

All six listed waterbodies are waters designated for contact recreation; therefore, the above water quality objective is applicable.

The Basin Plan also has a narrative toxicity objective stating that:

> "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances." (Central Valley Water Board, 1998, pg III-8.00.)

Because illnesses are considered detrimental physiological responses in humans, the toxicity objective applies. *E. coli* is an indicator for disease causing pathogens. The Basin Plan does not have a specific *E. coli* objective, however the toxicity objective states that:

> "The Regional Water Board will also consider all material and relevant information submitted by the discharger and other interested parties and numerical criteria and guidelines for toxic substances developed by the State Water Board, the California Office of Environmental Health Hazard Assessment, the California Department of Health Services, the U.S. Food and Drug Administration, the National Academy of Sciences, the U.S. Environmental Protection Agency, and other appropriate organizations to evaluate compliance with this objective."(Central Valley Water Board, 1998, pg. III-8.0-9.00).

Because the Basin Plan does not have a specific objective for *E. coli*, the US EPA criteria can be used to interpret the toxicity narrative (US EPA, 1986). The US EPA criteria will be one of the numeric targets for this pathogen TMDL. See section 5, Water Quality Targets, for further discussion of the *E. coli* numeric target.

Currently, the State Water Board is working on developing statewide bacteria objectives, which would include objectives for *E. coli.*

3 Data Summary

Since 1995 there have been studies and monitoring conducted on the Stockton urban waterbodies showing pathogen impairment. These include studies completed by DeltaKeeper, the City of Stockton, Stockton East Water District and Calaveras County Water District, and the Central Valley Water Board. The study/monitoring dates span from October 1995 to June 2006. These studies show pathogen indicator levels (fecal coliform and *E. coli*) that are above the water quality objectives (Geometric mean fecal coliform concentration of 200/100 ml of not less than 5 samples for any 30-day period; nor should more than 10% of the total number of samples taken during any 30 day period exceed 400/100 ml) and US EPA Criteria (Geometric mean *E. coli* concentration of 126/100 ml of not less than 5 samples equally spaced over a 30-day period; and no sample should exceed a single sample maximum allowable MPN concentration of 235/100ml). The following summarizes the data that is currently available. Central Valley Water Board staff combined all available data and calculated the overall median and geometric mean for each sampling location in the six waterbodies, and graphed the results in box and whisker plots (see Appendix B).

3.1 DeltaKeeper Study (2000-2005)

Deltakeeper collected grab samples in the Stockton urban creeks from April 2000 through August 2001. Staff has obtained data from a May 2001 Deltakeeper comment letter regarding the §303(d) List Update. The collected data included total coliform and *E. coli* levels in the Calaveras River, Five Mile Slough, Mormon Slough, Mosher Slough, Smith Canal, and Walker Slough as well as for other sloughs not included in this TMDL. Based on Deltakeeper independent analysis, the *E. coli* data from 2000 and 2001, showed that “39% of the results are equal to or greater than 120 MPN/100ml, 12% of the results are equal to or greater than 1000 MPN/100ml, and 9% of the results are equal to or greater than 2419 MPN/100ml” (Jennings, 2001). The data also showed that many of the *E. coli* results corresponded to the beginning of the 2000 Stockton rainy season. According to Deltakeeper, these results indicated that the elevated *E. coli* levels might be related with stormwater runoff.

Staff also has unpublished data (available in Appendix A) from 2000 to 2005 for total coliform and *E. coli* in the Calaveras River, Five Mile Slough, Mormon

Slough, Mosher Slough, Smith Canal, and Walker Slough as well as in other Stockton sloughs not included in this TMDL. The Deltakeeper pathogen data provided MPN total coliform and MPN *E. coli* levels for the past 5 years. The provided data showed pathogen levels that exceed the US EPA criteria level for *E. coli*. Since there are no water quality objectives for total coliform, staff only analyzed *E. coli* levels from the Deltakeeper pathogen data.

3.2 The City of Stockton

Stormwater Management Program 2003/04 Annual Report

As required by Stockton's MS4 Stormwater Permit, work plans and monitoring took place for pathogens in the Calaveras River, Smith Canal, and Mosher Slough. The goal of the work plan was to identify sources that contribute to the high pathogen levels, and to evaluate potential mechanisms for controlling the sources. Monitoring for the Pathogen Plan was scheduled to begin in the fall of 2004.

In 2003/2004, urban runoff monitoring occurred in the Calaveras River, Smith Canal, and Mosher Slough. Each slough was monitored at one discharge location and at one receiving water location. Two wet weather events (24 December 2003 and 2 February 2004) and two dry weather events (16 May 2004 and 13 June 2004) were monitored. Numerous parameters were analyzed, including fecal coliform and *E. coli*. Though sparse, the data did show values that exceeded the water quality objectives for pathogens (City of Stockton, 2004) Report on file at the Central Valley Water Board.

Stormwater Management Program 2004/2005 Annual Report

In 2004, monitoring for Phase I of the Pathogen Plan began. Phase I involved Characterization Monitoring for Smith Canal and Mormon Slough. Characterization monitoring helps "determine the long-term trends in bacteria loading, as well as short-term variations in bacteria concentrations." (Larry Walker Associates, 2004). The Characterization Monitoring phase helped determine which locations along Smith Canal and Mormon Slough were best to use for the Source Identification Studies which were scheduled for the 2005/2006 monitoring year.

The results of the receiving water monitoring were similar for both sloughs. It was shown that the geometric mean concentrations for fecal coliform and *E. coli* increased as the distance from the San Joaquin River increased. The results of the stormwater discharge monitoring showed that the geometric mean concentrations for fecal coliform and *E. coli* were above the water quality objectives. As a result of the discharge monitoring, a stormwater media filter was installed at the Smith Canal Legion Park pump station to help treat dry weather

flows and the first flush of storm events. It is expected that pathogen loads discharged to Yosemite Lake will be reduced with time. (City of Stockton, 2004).

During the 2004/2005 reporting period, urban discharge and receiving water monitoring occurred on Mosher Slough, Calaveras River, and Smith Canal. Two locations were sampled for each of those sloughs, one urban discharge location and one receiving water location. Each location was monitored during two wet weather events and two dry weather events. Fecal coliform and *E. coli* were two of the constituents analyzed for in the water samples taken. The results of the discharge and receiving water monitoring for pathogens showed that "all receiving waters and urban runoff location grab samples were above water quality objectives during at least two events, and all stations exceeded water quality objectives during at least one storm event." (City of Stockton, 2005.)

Stormwater Management Program 2005/2006 Annual Report

In 2005/2006, monitoring for Phase I of the Pathogen Plan was still underway. Characterization Monitoring for Smith Canal and Mormon Slough was completed and the Source Identification Studies and Microbial Source Tracking Monitoring were initiated. Overall, the Characterization Monitoring showed that the "frequency of exceedances was relatively high, especially during wet weather." (City of Stockton, 2006). It was also shown that the geometric mean concentrations for *E. coli* and fecal coliform, in both Smith Canal and Mormon Slough, increased with distance from the San Joaquin River. (City of Stockton, 2006).

As of September 2006, the City of Stockton expected to complete four more Microbial Source Tracking monitoring events and conduct Location Tracking Studies during the 2006/2007 monitoring period.

During the 2005/2006 reporting period, urban discharge and receiving water monitoring occurred on Mosher Slough, Calaveras River, Smith Canal, and Duck Creek. Monitoring occurred from December 2005 until June 2006. Each location was monitored during two wet weather events and two dry weather events. Overall, the results of the monitoring events showed that levels in the Stockton urban waterbodies were still above the US EPA criteria for *E. coli* and the water quality objective for fecal coliform.

As of 2006, several BMPs had been established in the Stockton area with the purpose of reducing bacteria levels in the urban area waterbodies. These include: "street sweeping, storm drain system cleaning and stenciling, illicit discharges inspection and elimination, and pet waste disposal stations at city parks" (City of Stockton, 2006).

3.3 Stockton East Water District and Calaveras County Water District

Calaveras River Baseline Water Quality Monitoring Program

Stockton East Water District and Calaveras County Water District are working together on a Calaveras River Watershed Management Plan. The purpose of the plan is to "provide a framework for evaluating issues and concerns related to the watershed and provide management strategies to improve the watershed." (Thomas, J. 2005). Stockton East Water District and Calaveras County Water District have jointly applied for project grants relating to the Calaveras River Watershed Management Plan. One such project was the Calaveras River Watershed Management Plan Implementation Program (Phase II): Baseline Water Quality Monitoring completed by Tetra Tech, Inc. The purpose of this project was to "evaluate issues, concerns, and opportunities within the watershed." (Tetra Tech, Inc, 2005). Monitoring of the Calaveras River took place between January 2002 and May 2004. The entire stretch of the Calaveras River, from its headwaters to the confluence with the San Joaquin River, was monitored. Fecal coliform was one of the many parameters analyzed. Samples for pathogens were taken at all monitoring sites. The overall monitoring results showed elevated fecal coliform levels throughout the watershed, with 32% of sites sampled having fecal coliform levels above the 200 colony forming units (CFU)/100ml and 16% above the 400 CFU/100ml. It was also determined that "concentrations were slightly higher in the middle watershed areas than in either the lower or upper areas" (Tetra Tech, Inc., 2005).

3.4 Central Valley Water Board

Central Valley Water Board SWAMP Data

In 2002, twenty-five water samples were taken on the Calaveras River at Highway 88 for the Surface Water Ambient Monitoring Program (SWAMP) (Appendix A). Parameters analyzed included Total most probable number (MPN)/100 ml and *E. coli* MPN/100 ml, as well as many other constituents. Pathogen indicator organism levels exceeded the US EPA criteria for *E. coli*.

San Joaquin River TMDL Unit

In October 2005 Central Valley Water Board staff began monitoring for pathogen indicator organisms in Stockton. Samples were collected from a total of 15 different locations along five of the pathogen-impaired waterbodies. Sample locations included sites along Five-Mile Slough, Calaveras River, Mormon Slough, Mosher Slough and Smith Canal. A total of 86 samples were collected and analyzed for fecal coliform and *E. coli*. Samples were collected approximately every three weeks from October 2005 until December 2005, with another sampling event in February 2006 triggered by a rain event. Analysis of the pathogen indicator organism data showed that the geometric mean was above the water quality objective for fecal coliform at every sampled location, and eleven of the fifteen locations for *E. coli*. Data values ranged between two data

values to fourteen data values per site. The collected data can be found in Appendix A. This monitoring was not completed under an approved Quality Assurance Project Plan.

3.5 Conclusions

The prior section describes all data the Central Valley Water Board has acquired for the Stockton urban waterbodies for pathogen indicator organisms. Central Valley Water Board staff combined all data and calculated the overall median and geometric mean for each sampling location in the six waterbodies, and graphed the results in box and whisker plots (see Appendix B). The results do not show any strong conclusions about sources for the Stockton area thus emphasizing the need for continued investigation under the Pathogen Plan. Overall, the Stockton urban waterbodies revealed elevated levels of *E. coli* and fecal coliform in all six sloughs (Appendix B).

Sources of pathogens are still unknown. Further monitoring and analysis is needed in order to identify pathogen sources. This monitoring and analysis should be completed through Stockton's Pathogen Plan. Below, Table 2 and Table 3 provide the calculated medians and geometric means for each sampling location discussed above. Table 4 provides a summary of monitoring activities through 2006.

Table 2: *E. coli* Statistics

Waterbody	Receiving Water Sampling Locations (Downstream to Upstream)	No. of Data Points[1]	No. of Data Points Above 235/100mL	Percent of Data Above 235/100mL	*E. Coli* Medians[2]	*E. coli* Geometric Mean[3]
Calaveras	Deltakeeper Dock	44	7	15.9	69.05	71.0
	University of the Pacific	62	21	33.9	108.3	206.3
	El Dorado Street	10	8	80.0	1650.0	1374.6
	Stockton Diverting Canal	5	1	20.0	44.0	59.0
	McAllen Road	4	4	100.0	450.0	572.8
	Hwy 88	12	3	25.0	114.5	104.0
Mosher	Mariners Drive	65	38	58.5	288.0	566.7
	Kelley Drive	38	26	68.4	447.6	633.7
	Loch Lomand	4	3	75.0	436.5	378.5
	Hwy 99	6	3	50.0	696.0	245.4
Walker	Manthey	64	42	65.6	342.5	540.7
	Turnpike Road	10	6	60.0	253.8	219.7
	O'Dell Ave	10	7	70.0	600.0	641.3
Smith	Shimizu Drive	4	3	75.0	450.0	320.1
	I-5	10	2	20.0	57.8	88.5
	Pershing Ave	17	14	82.4	1119.0	1273.9
	Harding Way	4	2	50.0	250.0	175.1
	Yosemite Lake	55	38	69.0	405.0	616.6
Five Mile	Plymouth Road	75	22	29.3	63.0	138.2
	Swenson Golf Course	4	0	00.0	48.5	35.7
	Alexandria Place	7	3	42.9	63.0	118.8
Mormon	Morelli Park	12	8	66.7	630.0	543.9
	Lincoln Street	92	71	77.2	725.5	1071.7

[1] Data sources are provided on Table 4. Pathogen Monitoring Summary Table
[2] Medians are calculated based on the entire set of data.
[3] Value is a geometric mean of the entire set of data values. There was not enough data to calculate for a 5-sample monthly geometric mean.
Shaded cells represent sampling locations outside the urban area.

Table 3: Fecal coliform Statistics

Waterbody	Receiving Water Sampling Locations (Downstream to Upstream)	No. of Data Points[1]	No. of Data Points Above 400/100mL	Percent of Data Above 400/100mL	Fecal coliform Medians[2]	Fecal coliform Geometric Mean[3]
Calaveras	Deltakeeper Dock	8	6	75.0	1670.0	1720.5
	University of the Pacific	9	7	77.8	1660.0	1349.7
	El Dorado Street	12	7	58.3	850.0	1008.2
	Stockton Diverting Canal	4	1	25.0	347.0	282.9
	McAllen	3	3	100.0	3000.0	2460.1
	Main Stem Ag	16	1	6.3	66.0	68.7
	Main Stem	21	0	0.0	9.5	9.4
Mosher	Mariners Drive	12	8	66.7	11000.0	3686.9
	Kelley Drive	9	9	100.0	5200.0	4324.5
	Loch Lomand	4	4	100.0	3450.0	3298.7
	Hwy 99	6	5	83.3	3250.0	1708.1
Walker	O'Dell Ave	13	7	53.8	700.0	630.6
Smith	Shimizu Drive	4	3	75.0	2260.0	2038.4
	Pershing Ave	12	7	58.3	800.0	726.5
	Harding Way	4	4	100.0	5590.0	4604.2
	Yosemite Lake	4	4	100.0	8180.0	5302.1
Five Mile	Plymouth Road	4	3	75.0	1300.0	1402.7
	Swenson Golf Course	4	3	75.0	656.5	850.8
Mormon	Morelli Park	4	4	100.0	1440.0	1111.1
	Lincoln Street	4	4	100.0	1236.5	1297.4

[1] Data sources are provided on Table 4. Pathogen Monitoring Summary Table
[2] Medians are calculated based on the entire set of data.
[3] Value is a geometric mean of the entire set of data values. There was not enough data to calculate for a 5-sample monthly geometric mean.
Shaded cells represent sampling locations outside the urban area.

Table 4: Pathogen Monitoring Summary Table

Entity	Dates	Sites	Parameters
Deltakeeper	November 2000 – May 2005	Five Mile at Alexandria Five Mile at Plymouth Calaveras at Deltakeeper Dock Calaveras at UOP footbridge Calaveras at Diverting Canal Calaveras at El Dorado St Mormon at Lincoln Mormon at Morelli Park Mosher at Mariners Mosher at Sandman Dr. Mosher at Kelley Dr. Smith at I-5 Smith at Pershing Smith at Yosemite Lake Walker at Manthey Rd Walker at Turnpike Rd	Total coliform *E. coli*
City of Stockton	December 2003 – June 2004; September 2004 – June 2005; and December 2005 – June 2006	Calaveras at North West Lane Calaveras at El Dorado St. Mormon at Morelli Mormon at Lincoln St. Mormon at Commerce St. Mormon at Wilson Way Mosher at Kelley Dr Mosher at Mariners Dr Smith at Legion Park Pump Station Smith at Shimizu Dr. Smith at Yosemite Lake Smith at Pershing Smith at Baker Place	Total coliform Fecal coliform *E. coli*
SEWD and CCWD	January 2002 – May 2004	Calaveras River (headwaters to San Joaquin River confluence including tributaries)	Total coliform Fecal coliform
Central Valley Water Board - SWAMP	January 2002 – December 2002	Calaveras at Highway 88	Total coliform *E. coli*
Central Valley Water Board – SJR TMDL Unit	October 2005 – February 2006	Five Mile at Swenson Park Golf Course Five Mile at Plymouth Calaveras at Deltakeeper Dock Calaveras at UOP footbridge Calaveras at Diverting Canal Calaveras at McAllen Rd Mormon at Hwy 4 Mormon at Morelli Park Mosher at Kelley Dr. Mosher at Loch Lomand Park Mosher at Hwy 99 Mosher at Hildreth Smith at Yosemite Lake Smith at Shimizu/Harding Smith at Shimizu/Occidental Ave	Fecal coliform *E. coli*

4 Sources and Effects of Pathogens

Fecal coliforms, including *E. coli*, belong to the family *enterobacteriaceae* and are bacteria that live in the intestines of warm-blooded organisms (humans, pets, farm animals, and wildlife). (Prescott et al., 2002). These bacteria are not harmful on their own, however; they are indicators of other disease-causing bacteria, such as those that cause "gastrointestinal, respiratory, eye, ear, nose, throat, and skin disease." (US EPA, 1986). Waters that tend to be used for recreation are of greater concern, because contact with contaminated water will increase chances of developing diseases from pathogens entering the body through the mouth, nose, ears, or open wounds.

Fecal coliform bacteria may be introduced to a waterbody from many sources, including faulty sewer and septic systems, runoff, animal wastes, and land-use runoff from both developed and undeveloped systems (US EPA, 2001). Fecal coliform in human waste can find its way to waterbodies through discharges from sanitary sewer connections, septic systems, and wastewater treatment plants. These bacteria can also be found in animal wastes like livestock in rural areas, or cats and dogs in urban areas. Another possible source of fecal coliform is marinas. Both Smith Canal and the Calaveras River have marinas. Discharge of waste from docked boats can contribute to pathogen impairment.

Often, storm events are associated with increased fecal coliforms (pathogen indicators) in the water due to stormwater runoff. (US EPA, 2001). Material that contains pathogens accumulates on surfaces and is then flushed into the storm drains and eventually into creeks, streams, and rivers.

5 Water Quality Targets

Federal regulations state "TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure." (40 CFR § 130.2 (i)). For pathogen indicators, the target is expressed as the number of organisms in a given amount of water. The numeric water quality targets for this TMDL are as follows:

1. Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 200/100 ml; nor shall more than ten percent of the total number of samples taken during any 30 day period exceed 400/100 ml. (Central Valley Water Board, 1998, p. III-3.00).
2. Geometric mean *E. coli* concentration of 126 /100 ml, based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period); and no sample should exceed a single sample maximum allowable concentration of 235 MPN/100ml. (US EPA, 1986).

The first target is based on the Basin Plan's fecal coliform water quality objectives presented in Section 2.2.1, Pathogen Water Quality Objectives.

The second target is based on US EPA guidance for bacteria criteria. In the document *Ambient Water Quality Criteria for Bacteria – 1986*, US EPA has determined that "Based on a statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period), the geometric mean of the indicated bacterial densities should not exceed one or the other of the following: *E. coli*, 126 per 100 ml, as well as a 235 per 100 ml single sample maximum in waters designated for contact recreation (US EPA, 1986).

The use of US EPA's *E. coli* criteria as a numeric target is appropriate based on the Basin Plan's narrative toxicity objective discussed in Section 2.2.1, Pathogen Water Quality Objectives.

6 Source and Linkage Analysis

According to a recent update by the City of Stockton (City of Stockton, 2008), the Pathogen Plan is currently in Phase One. The timeline provided in the Pathogen Plan states that Phase Two would be completed by June 2007 (See Section 1.2.) The City of Stockton has requested an extension of Phase One until June 2012, and extension of the entire Pathogen Plan until June 2018, to allow more time for BMP implementation. Until an extension is granted, the timeline identified in approved Pathogen Plan remains in effect.

As noted, the Pathogen Plan is currently in Phase One. Microbial source tracking of Smith Canal and Mormon Slough is partially completed and efforts are underway to identify specific pathogen sources. Some BMP implementation is already underway, and additional efforts will occur as sources are identified in Smith Canal and Mormon Slough. Pathogen sources for Mosher Slough, Five-Mile Slough, Lower Calaveras River and Walker Slough will be identified in later phases of the Pathogen Plan. Stockton's Pathogen Plan should also identify whether or not the upstream reaches of Calaveras River, Mosher Slough, Mormon Slough, and Walker Slough are a pathogen source for the Stockton urban area. Upon completion of the Pathogen Plan, Central Valley Water Board staff will re-evaluate if these upstream waterbodies should be provided a load allocation for non-point source contributions.

Some of the data collected in Stockton implies that the upstream locations on the Calaveras River and Mosher Slough may have elevated levels of pathogen indicators, however, the data does not meet the requirements of the State Water Board's *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (September 2004). There is insufficient data to determine if there are significant contributions from these upstream reaches. Stockton's Pathogen Plan will look at pathogen levels as they enter the city limits. If it is determined that upstream is contributing to the impairment, then actions will need to be taken by the Central Valley Water Board to address the upstream sources. All specific pathogen sources (within the capability of methods used) in the MS4 urban area will be identified by the end of the Pathogen Plan.

7 TMDL Loading Capacity and Allocations

For this TMDL, the loading capacity is the amount of pathogens at any point in the urban waterbodies such that the numeric targets are not violated. This does not include consideration of a margin of safety or other factors that reduce loading capacity. The waste load allocation is the portion of the loading capacity assigned to NPDES discharges, while the load allocation is the portion of the loading capacity assigned to non-point sources. The loading capacity for pathogens in the six listed Stockton waterbodies is the same as the numeric target, which are protective of the REC-1 beneficial use. Concentration-based loads are proposed for this TMDL. Since the loading capacity is expressed per unit volume rather than total mass load, the individual sources (i.e. single discharge points) must not exceed the total loading capacity. Therefore, the waste load allocations and load allocations are equal to the loading capacity (see Equation 1 and Table 4). This formula represents the concentration of fecal coliform and *E. coli* that can be in the stormwater that runs off or is discharged into any of the urban waterbodies. Currently there is a lack of adequate data on frequency of recreational use and how background levels vary by season. Until such a time when sufficient information is developed to justify otherwise, these allocations will be applicable year-round.

LC=WLA=LA=Numeric Target (EQ 1)

Where:

LC = Loading Capacity

WLA = Waste Load Allocation

LA = Load Allocation

Numeric Target = Fecal coliform Water Quality Objective and US EPA *E. coli* criteria

Each of the listed waterbodies (Table 5) has its own specific waste load allocation (see Tables 6, 7).

- Five-Mile Slough and Smith Canal are entirely impaired waterbodies that are surrounded by urban area. As a result, these two waterbodies are given a loading capacity and waste load allocation only.
- Mosher Slough and Walker Slough are impaired within the urban area, but also have upstream urban reaches that are not listed as impaired. Mosher Slough and Walker Slough also have upstream reaches outside of the urban area. At this time, there is not enough information available to determine if non-point sources upstream are significant contributors to pathogen load. Upon completion of the Pathogen Plan, Central Valley Water Board staff will re-evaluate the need for load allocations. The waterbodies are, therefore, assigned a loading capacity and waste load allocation only.

- Mormon Slough is impaired from the DWSC to Commerce Street and from Commerce Street to the Stockton Diverting Canal. The first reach (DWSC to Commerce Street) is assigned a loading capacity and waste load allocation. As with Mosher and Walker Sloughs, though there are upstream segments of the waterbodies above the urban area, there is insufficient data to conclude, at this time, that the upstream sources are significant enough to justify a load allocation. Thus, upon completion of the Pathogen Plan, Central Valley Water Board staff will re-evaluate the need for load allocations in Mormon Slough from the DWSC to Commerce Street.
- The second reach (Commerce Street to Stockton Diverting Canal) is not addressed by this TMDL since a portion of the impairment lies outside the city limits and would require a Basin Plan amendment, and will be addressed at another time.
- The final waterbody addressed by this TMDL is the lower portion of the Calaveras River. The entire urban portion of the Calaveras River is impaired (from the DWSC to the Stockton Diverting Canal). Upstream of the Stockton Diverting Canal is outside the urban area. The Calaveras River is assigned a loading capacity and a waste load allocation. There are reaches of the Calaveras River upstream of the urban area, however the significance of loading from upstream non-point sources has not yet been determined. Upon completion of the Pathogen Plan, Central Valley Water Board staff will re-evaluate if load allocations are appropriate for the Calaveras River from the DWSC to the Stockton Diverting Canal.

Table 5: Waterbody reaches addressed by Stockton Sloughs Pathogen TMDL

Water Body	Length	Reaches[1]
Five-Mile Slough	1.6 miles	Entire length (from Alexandria Place to Fourteen Mile Slough).
Smith Canal	2.4 miles	Entire length (from Yosemite Lake to the confluence with the San Joaquin River).
Mosher Slough	4.8 miles	Impaired from 3.5 miles upstream of Interstate 5 to confluence with the Stockton Deep Water Ship Channel (1.3 miles downstream of Interstate 5).
Walker Slough	2.3 miles	Entire length (From Duck Creek confluence to French Camp Slough).
Mormon Slough	0.93 miles	TMDL addresses impairment from Commerce Street to Stockton Deep Water Ship Channel.
Lower Calaveras River	5.8 miles	Impaired from Stockton Diverting Canal to Stockton Deep Water Ship Channel.

[1] All reaches described are tidally influenced. Mosher Slough, Walker Slough, Mormon Slough and Lower Calaveras River have upstream contributions.

Table 6: Waste Load and Load Allocations

Allocations	Fecal Coliform Allocation	*E. coli* Allocation
Waste Load Allocations	200/100 ml Geometric Mean[1], nor 400/100 ml for 10% of samples[2]	126/100 ml Geometric Mean[3], and 235/100 ml single sample maximum
Load Allocations	200/100 ml Geometric Mean[1], nor 400/100 ml for 10% of samples[2]	126/100 ml Geometric Mean[3], and 235/100 ml single sample maximum

[1] Geometric mean concentration of not less than five samples for any 30-day period

[2] During any 30-day period

[3] Geometric mean concentration of a statistically sufficient number of samples (generally not less than five samples equally spaced over a 30-day period)

Table 7: Waterbody Allocations

Waterbody	Waste Load Allocation	Load Allocation
Five-Mile Slough Smith Canal	**X**	
Mosher Slough Walker Slough	**X**	**See footnote below[1]**
Mormon Slough (DWSC to Commerce Street)	**X**	**See footnote below[1]**
Calaveras River	**X**	**See footnote below[1]**

[1] The Central Valley Water Board staff does not have sufficient data to assign load allocations to these waterbodies at this time, but acknowledges that each of these water bodies has upstream reaches outside of the urban area. The load contribution from these upstream reaches will be re-evaluated after completion of the Pathogen Plan.

8 Margin of Safety

The CWA and US EPA regulations require a Margin of Safety to account for uncertainty concerning the relationship between waste load, load allocations and water quality. For this TMDL, the Margin of Safety is an implicit Margin of Safety. Pathogens cannot survive for long periods of time outside of the host body, human or other. Because of this, pathogen concentrations are expected to decrease as they move away from the source due to factors that influence their die-off rate. These factors include sunlight, temperature, and predation. (US EPA, 2001). Additionally, the *E.Coli* single sample numeric target (235/100 mL) is based on the most conservative recreational use frequency. Therefore an implicit Margin of Safety is provided for the TMDL and an additional explicit Margin of Safety is not required.

9 Implementation Plan

As discussed earlier in this report, the City of Stockton's pathogen pollution prevention plan (Pathogen Plan) is an in-depth analysis of the sources of pathogens in all six 303(d) listed waterbodies addressed in this TMDL. Central Valley Water Board staff recognizes the efforts that the City of Stockton is putting forth in their Pathogen Plan. By the end of the implementation of the Pathogen Plan, the Central Valley Water Board expects sources of pathogens for the listed waterbodies to be identified and management practices to control the urban sources should be underway. Therefore, this TMDL is being implemented through the NPDES City of Stockton and San Joaquin County Municipal Separate Storm Sewer Systems Permit (Stockton MS4 Permit/Permit). The monitoring requirements associated with Stockton's Pathogen Plan will be implemented under §13267 of the Porter Cologne Water Quality Control Act (Central Valley Water Board -Technical Report, 2007). All provisions necessary to achieve the load reductions have been incorporated into the NPDES permit and the 13267 requirements so the Central Valley Water Board does not need an additional regulatory program (e.g., a Basin Plan Amendment) to address pathogens in the identified reaches.

The Stockton Stormwater Program Permittees (Permittees) have jurisdiction over urban stormwater runoff within the Stockton urbanized area and the San Joaquin County urbanized areas. The Permittees are responsible for meeting the NPDES permit requirements, which include the requirement to reduce the discharge of pollutants in the Stockton municipal stormwater to the maximum extent practicable.

The NPDES permit requirements include a number of provisions related to the presence of pathogens in the Stockton urban area. For example, Finding 79 of the permit states that water quality targets for fecal coliform and *E. coli* will be used to assess the effectiveness of Stockton's efforts to reduce pathogens

through their Pathogen Plan. The receiving water limitations (C.1.n) state that discharges shall not cause pathogen concentrations to be present that exceed criteria or threaten public health.

As discussed, the Pathogen Plan serves as the implementation plan for this TMDL. Central Valley Water Board staff encourages an adaptive implementation approach as the Pathogen Plan moves forward. The City of Stockton may wish to pursue a revision to the Pathogen Plan to include special studies. These may include proposing studies to aid in possible development of seasonal load allocations, by investigating seasonal variations in recreational use and background pathogen contributions.

For TMDL purposes, staff anticipates evaluation of progress towards meeting TMDL targets following completion of the Pathogen Plan. This is discussed in the Public Review Draft Resolution Whereas No.5, which states: *NPDES permit Order No. R5-2007-0173; NPDES No. CAS083470 requires the Pathogen Plan to be completed by the end date specified in the plan, at which point water quality objectives for bacteria should be met. Should the water body still fail to meet water quality objectives, the TMDL will be reevaluated to determine what additional measures need to be taken.*

Additionally, the Stockton MS4 Permit states reevaluation may also occur during permit renewal. *Order No. R5-2007-0173; NPDES No. CAS083470* (D.28.c.iii, pg 59) states *"Regional Water Board staff will reevaluate the impairment problem in the Stockton urban waterways upon the expiration date of this Order and/or at the conclusion of the Pathogens Plan. If necessary, additional controls and regulatory options will be identified by the Regional Water Board with assistance by the Permittees to address the impairment."*

When review occurs, staff will need to determine if the impairment has been adequately addressed, or if additional efforts are necessary. Staff anticipates review topics to include[2]:

1. Are the Stockton urban waterbodies progressing toward or meeting the TMDL targets? If progress is unclear, what possible future actions can be taken to better to detect trends? If there has not been adequate progress, how might the implementation actions or allocations be modified?
2. What has the Pathogen Plan identified in terms of pollutant loads for the various source categories?
3. What information has the Pathogen Plan developed on how loads changed over time, how they vary seasonally, and how might source control measures be modified to improve load reduction?

[2] Review topics developed based on adaptive management approach in the Napa River Bacteria TMDL (Pathogens in Napa River Watershed TMDL, Appendix B Final Staff Report pg 48, available at: http://www.waterboards.ca.gov/sanfranciscobay/napariverpathogens/Item8NapaPathsAppB.pdf)

4. Is there new, reliable, and generally accepted scientific information that suggests there is a need to modify any of the TMDL targets, allocations, or implementation actions? If so, how should the TMDL be modified? This may include modification of the requirements included in Stockton MS4 permit and/or other Regional Board action, such as development of a Basin Plan Amendment, if necessary.

Additional questions will likely be developed in collaboration with stakeholders, including the City of Stockton, during the review period.

If results from the Permittee's Pathogen Plan (see most current version of Pathogen Plan for end date) indicate the implementation of BMPs to control pathogens does not resolve water quality impairments in the urban waterbodies, then additional controls or monitoring may be required of the Permittees. In addition, the Central Valley Water Board may prepare a Basin Plan Amendment or take other action to address the sources of pathogens in the Stockton urban waterbodies. Actions that the Central Valley Water Board could take at the end of the Pathogen Plan include: studies to determine background bacteria levels, site-specific water quality objectives and a use attainability analysis.

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