BACTERIAL INDICATORS
TOTAL MAXIMUM DAILY LOAD
FOR PALO VERDE OUTFALL DRAIN
Riverside and Imperial Counties, California

DRAFT

December 12, 2003

California Regional Water Quality Control Board
Colorado River Basin Region
Palm Desert, California

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LIST OF ACRONYMS

AB 885	Assembly Bill #885
BECC	Border Environmental Cooperation Commission
cfs	cubic feet per second
CRWQCB	California Regional Water Quality Control Board
CWC	California Water Code
LA	Load Allocation
MGD	Million Gallons per Day
ml	milliliter
MP	Management Practice
MPN	Most Probable Number
MRLC	USGS Multi-Resolution Land Characterization
MOS	Margin of Safety
MOU	Memoranda of Understanding
PVID	Palo Verde Irrigation District
PVOD	Palo Verde Outfall Drain
QAPP	Quality Assurance Project Plan
RARE	Preservation of Rare, Threatened, or Endangered Species Beneficial Use
REC I	Water Contact Recreation Beneficial Use
REC II	Non-contact Water Recreation Beneficial Use
RWQCB	Regional Water Quality Control Board
SSO	Site Specific Objective
TMDL	Total Maximum Daily Load
UCCE	University of California Cooperative Extension
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service

WARM	Warm Freshwater Habitat Beneficial Use
WDR	Waste Discharge Requirement
WILD	Wildlife Habitat Beneficial Use
WLA	Waste Load Allocation
WQO	Water Quality Objective
WWTF	Waste Water Treatment Facility
WWTP	Waste Water Treatment Plant

DRAFT RESOLUTION

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
COLORADO RIVER BASIN REGION

RESOLUTION NO.

A Resolution Amending the Colorado River Basin Water Quality Control Plan
To
Establish a Bacteria Indicators Total Maximum Daily Load for
Palo Verde Outfall Drain

WHEREAS, the California Regional Water Quality Control Board, Colorado River Basin Region (hereinafter Regional Board), finds that:

1. An updated Water Quality Control Plan for the Colorado River Basin (Basin Plan) was adopted by the Regional Board on November 17, 1993, approved by the State Water Resources Control Board (SWRCB) on February 17, 1994, and approved by the Office of Administrative Law on August 3, 1994.

2. Warm freshwater habitat (WARM), wildlife habitat (WILD), preservation of rare, threatened, and endangered species (RARE), water contact recreation (REC I), and non-contact recreation (REC II), are the beneficial uses designated for Palo Verde Outfall Drain.

3. Water quality objectives are not being met in Palo Verde Outfall Drain because natural background sources and indirect discharges of bacteria-laden agricultural tilewater and failing septic systems contribute pathogens to Palo Verde Outfall Drain and adversely impact the beneficial uses.

4. Pursuant to Section 303(d) of the Clean Water Act, Palo Verde Outfall Drain is listed as water quality limited because of pathogen impairments. Section 303(d) of the Clean Water Act requires the establishment of the Total Maximum Daily Load (TMDL) of pathogens that can be discharged while still ensuring compliance with water quality standards. Section 303(d) also requires the allocation of this TMDL among sources of pathogens, together with an implementation plan and schedule that will ensure that the TMDL is met and that compliance with water quality standards is achieved.

5. The Regional Board has reviewed the Palo Verde Outfall Drain Bacteria Indicators Project Report.

6. The Project Report and related Basin Plan amendment attached to this resolution meet the requirements of Section 303(d) of the Clean Water Act. The amendment requires, in part, nonpoint source Management Practices (MPs) to control pathogen inputs to provide a reasonable assurance that water quality standards will be met.

7. The Regional Board prepared and distributed written reports regarding adoption of the Basin Plan amendment in compliance with applicable state and federal environmental regulations (Title 23, California Code of Regulations, Section 3775 et seq.; and Title 40, Code of Federal Regulations, Parts 25 and 131).

8. The process of basin planning has been certified by the Secretary for Resources as exempt from the requirements of the California Environmental Quality Act (Pub. Resources Code, §

21000 et seq.) to prepare an Environmental Impact Report or Negative Declaration. In accordance with California Code of Regulations Title 23, §§3777-3781, a written Project Report, an Environmental Checklist, an assessment of the environmental impacts of the Basin Plan amendment, and a discussion of alternatives, among other analyses were prepared. The CEQA Checklist and CEQA Checklist Discussion take into account a reasonable range of environmental, economic, and technical factors. CEQA analysis determined that the proposed Basin Plan amendment would not have a significant adverse effect on the environment. The Regional Board certifies that the CEQA analysis has been completed in compliance with CEQA; the CEQA analysis was presented to Regional Board, which reviewed and considered analysis before adopting this amendment, and the CEQA analysis reflects the Regional Board's independent judgment and analysis.

9. The Regional Board has considered federal and state antidegradation policies and other relevant water quality control policies and finds the Basin Plan amendment consistent with those policies.

10. On July 16, 2002 a Public CEQA Scoping Meeting was held in Blythe, CA. Also, a public information meeting regarding the TMDL process was conducted in Blythe on November 19, 2002.

11. Consistent with Title 23, California Code of Regulations, Sections 3778 through 3780, Regional Board staff consulted about the proposed action with stakeholders in the Region and with other potentially affected parties and considered and addressed comments on the matter.

12. On, (date) the Regional Board held a Public Hearing to consider the TMDL Report and the Basin Plan amendment. Notice of the Public Hearing was given to all interested persons and published in accordance with Water Code Section 13244 and Title 40, Code of Federal Regulations, Part 25.

13. The Basin Plan amendment must be submitted for review and approval by the SWRCB, Office of Administrative Law (OAL), and U.S. Environmental Protection Agency. Once approved by the SWRCB, the amendment is submitted to OAL. A Notice of Decision will be filed after the SWRCB and OAL have acted on this matter. The SWRCB will forward the approved amendment to the U.S. Environmental Protection Agency for review and approval.

NOW, THEREFORE, BE IT RESOLVED THAT:

1. The Regional Board adopts the amendment to the Water Quality Control Plan for the Colorado River Basin as set forth in the attached Basin Plan Amendment to establish Palo Verde Outfall Drain Bacteria Indicators TMDL.

2. The Executive Officer is directed to forward copies of the Basin Plan amendment to the SWRCB in accordance with the requirement of Section 13245 of the California Water Code.

3. The Regional Board requests that the State Water Resources Control Board approve the Basin Plan amendment in accordance with Sections 13245 and 13246 of the California Water Code and forward it to the Office of Administrative Law and United States Environmental Protection Agency for approval.

4. The Executive Officer is directed to file a Notice of Decision with the California Secretary for Resources after OAL approval of the Basin Plan amendment, in accordance with

Section 21080.5(d) (2)(E) of the Public Resources Code and Title 23, California Code of Regulations, Section 3781.

5. If during its approval process the SWRCB or OAL determines that minor, non-substantive corrections to the language of the amendment are needed for clarity or consistency, the Executive Officer may make such changes, and shall inform the Board of any such changes.

I, Phil Gruenberg, Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of a resolution adopted by the California Regional Water Quality Control Board, Colorado River Basin Region, on ________________.

____
Phil Gruenberg
Executive Officer

PROPOSED BASIN PLAN AMENDMENT

An Amendment to the Water Quality Control Plan for the Colorado River Basin Region to Establish Palo Verde Bacterial Indicators Total Maximum Daily Load

AMENDMENT

(Proposed changes are in reference to the Basin Plan as amended through 2002. Proposed additions are denoted by underlined text, proposed deletions are denoted by ~~strikethrough~~ text)

Section V. TOTAL MAXIMUM DAILY LOADS add the following new subsequent Sections and renumber accordingly:

E. Palo Verde Bacterial Indicators Total Maximum Daily Load

1. TMDL ELEMENTS

Table E-1: Palo Verde Bacterial Indicators TMDL Elements

ELEMENT	
Problem Statement (Impaired water quality standard)	Excess delivery of bacteria to Palo Verde Outfall Drain (PVOD) in the Palo Verde Valley which lies in both Riverside and Imperial Counties of California, has resulted in degraded conditions that impairs designated beneficial uses: Water Contact Recreation (REC I), Water Non-Contact Recreation (REC II), Warm Freshwater Habitat (WARM), Wildlife Habitat (WILD), Preservation of Rare, Threatened, or Endangered Species (RARE). Bacteria pose a public health threat to people contacting water in PVOD and are in violation of water quality objectives.

ELEMENT	**CURRENT CONDITIONS**
Numeric Target	The following are the in-stream numeric water quality targets for this TMDL: **Indicator Parameters** / **30-day Geometric Mean[a]** / **Maximum** Fecal Coliforms / 200 MPN[b]/100 ml / c E. Coli / 126 MPN/100 ml / 400 MPN/100 ml Enterococci / 33 MPN/100 ml / 100 MPN/100 ml a. Based on a minimum of no less than 5 samples equally spaced over a 30-day period. b. Most probable number. c. No more than 10% of total samples during any 30-day period shall exceed 400 MPN/100 ml.

ELEMENT	CURRENT CONDITIONS
Source Analysis	The main sources of pathogens as indicated by fecal coliforms and E. coli bacteria in Palo Verde Agricultural Drain are natural background sources and dysfunctional septic systems. Natural sources of pathogens appear to play a significant role, but their actual contribution, and contributions from other nonpoint sources of pollution in general require proper characterization.

ELEMENT	CURRENT CONDITIONS
Margin of Safety	Discharges from point sources and nonpoint sources of pollution shall not exceed the following waste load allocations (WLAs) and load allocations (LAs), respectively: **WLAs and LAs** **Indicator Parameters — 30-Day Geometric Mean[a] — Maximum** Fecal Coliforms — 200 MPN[b]/100ml — c E. coli — 126 MPN/100 ml — 400 MPN/100 ml Enterococci — 33 MPN/100 ml — 100 MPN/100 ml a. Based on a minimum of no less than 5 samples equally spaced over a 30-day period. b. Most probable number. c. No more than 10% of total samples during any 30-day period shall exceed 400 MPN/100 ml. The allocations are applicable throughout the entire stretch of PVOD. The numeric target concentrations are based on extensive epidemiological studies conducted by USEPA and others. By setting the TMDL and each of the load and waste load allocations equal to the water quality objective, limits uncertainty about whether attainment of the TMDL and the individual allocations will result in attainment of the applicable numeric target. The TMDL analysis takes a conservative approach of providing load and wasteload allocations even for relatively minor loading sources, which provide additional assurance that the selected source control approach will result in attainment of the numeric objectives. To address uncertainty concerning the bacterial die-off and regrowth dynamics in PVOD, the TMDL provides an implicit margin of safety by including a relatively aggressive monitoring and review plan which ensures that additional data are collected and that, if necessary, the TMDL will be revised.

Seasonal Variations and Critical Conditions	Loading to PVOD is the result of contributions from septic systems and wildlife, both relatively constant in nature. Critical loading conditions are likely to occur during low flow periods. Low flows in the Palo Verde Irrigation District coincide with winter months, January and February in particular, when less water is diverted into the system for irrigation.
Load Allocations and Wasteload Allocations	The allocations are applicable throughout the entire stretch of Palo Verde Outfall Drain.
	Load Allocations: Based on the source assessment for PVOD, bacterial concentrations originate solely from nonpoint sources. As this TMDL is density-based, the effluent from any future point sources and dischargers are required to meet the bacteriological water quality objectives. The existing WWTPs in Palo Verde Valley discharge to percolation basins, not PVOD and therefore do not have NPDES permits. It is assumed that any future WWTPs in the valley will discharge effluent in the same manner and therefore not be considered a point source discharge.
	Natural Sources: Wildlife is considered a natural background source. Given the abundance of wildlife concentrations in and above Palo Verde drains, it is expected that fecal contributions from wildlife comprise a significant proportion of bacteria loading in the entire system.
	Waste Load Allocations: There are no point source discharges to Palo Verde Outfall Drain or Lagoon, and therefore no WLAs. Any future discharge from point sources (NPDES permits) shall not exceed the total limits specified under 40 CFR 122 et seq., and the corresponding mass loading rates. In accordance with NPDES permits, dischargers will continue to be required to take necessary action to ensure consistent compliance with their NPDES permits.

TMDL attainment shall be in accordance with the schedule contained in the Numeric Target Section of Table E-1.

2. IMPLEMENTATION ACTIONS AND REGULATIONS FOR ATTAINMENT OF PALO VERDE BACTERIAL INDICATORS TMDL

The bacteria load allocations, any future waste load allocations, and water quality objectives shall be applicable to Palo Verde Outfall Drain for the protection of the REC I and REC II beneficial uses and shall be achieved within 10 years of USEPA approval of the TMDL. To this end, the following actions shall be implemented:

A. Designated Management Actions

Following USEPA approval, the proposed implementation plan will be in two phases. Phase I consists of actions to be accomplished between 2004 and 2007. Phase I relies on controlling nonpoint sources of bacteria to Palo Verde Outfall Drain via voluntary management practices and regulatory compliance. Phase I also depends on any future point source contributors to comply with the requirements of their NPDES permits, Waste Discharge Requirements (WDRs), or waivers.

If water quality targets are not achieved upon conclusion of Phase I in 2007, Phase II actions will begin and the time schedule for implementation will be revised. The phased approach allows for immediate control of major sources while allowing time for monitoring to provide an analytical basis for Phase II planning. Phase II requires further assessment of bacterial contributions from sources not addressed in Phase I and determines the development of implementation actions to control these sources. Phase II will be completed by 2014. In Phase II, plans for a wastewater treatment plant in the community of Palo Verde may be introduced as the best method for managing bacteria in Palo Verde Outfall Drain.

Additionally, a revision of Water Quality Objectives for Palo Verde Outfall Drain and Lagoon, such as a Site Specific Objective (SSO), will be considered for addressing natural background sources of bacteria by December 31, 2008.

1. Phase I Implementation Actions

Implementation Actions in this TMDL include both voluntary actions and those already required under existing or anticipated regulatory requirements. Voluntary actions will be taken by a variety of implementing parties, while the required actions are to be taken by identified responsible parties.

a. Septic System Maintenance and Education
Inform property owners that maintaining their septic systems is their personal responsibility and imperative to public health. Public outreach and education on this subject is the responsibility of Riverside and Imperial County Health Departments.

b. Septic System Maintenance Plan
The Regional and State Water Boards, with the cooperation of Riverside and Imperial Counties, will create a plan for the location identification and maintenance of septic systems based on CWC 13291. The Regional Board's existing waiver of waste discharge requirements will end on June 30, 2004. At that time, the Regional Board may adopt a new waiver policy consistent with State Board septic system regulations adopted in accordance with CWC 13291. Alternatively, the Regional Board may consider

entering Memoranda of Understanding (MOUs) with the counties for enforcement of septic system requirements, or begin taking enforcement action against individuals who are discharging illegally.

c. DNA Source Tracking Study
Staff will analyze results of on-going DNA source tracking study which will be completed in 2004.

d. Quality Assurance Project Plan and Monitoring Plan
Staff will develop a monitoring plan & Quality Assurance Project Plan (QAPP) within 180 days of USEPA approval.

e. Implementation Tracking Plan
Staff will track activities implemented by dischargers and responsible parties and surveillance conducted for Palo Verde Bacterial Indicators TMDL pursuant to an implementation tracking plan (ITP). The ITP will be developed within 180 days following USEPA approval of the TMDL. The Regional Board's Executive Officer shall approve the ITP after determining that the ITP satisfies the objectives and requirements of this Section. The objectives of Regional Board surveillance and implementation tracking are:

- Assess/track/account for practices already in place;
- Measure the attainment of milestones;
- Determine compliance with NPDES permits, WLAs, and LAs; and
- Report progress toward implementation of NPS water quality control, in accordance with the SWRCB NPS Program Plan (PROSIP).

Table E-2 Phase I Actions

PRACTICE	ACTION	SCHEDULE	IMPLEMENTING PARTIES
Septic system inspection and maintenance education	Inspection and approval of septic systems. Educate public on proper maintenance of septic systems	2004-Ongoing	County Health Departments
Septic system maintenance/ upgrade	Inspect and maintain all septic systems in watershed per AB 885	2004-Ongoing	Riverside County, Imperial County
Source tracking	Staff will analyze DNA Source tracking study	2004	Regional Water Quality Control Board
QAPP	Staff will develop a QAPP and Monitoring Plan	180 days after USEPA approval	Regional Water Quality Control Board
Implementation Tracking Plan	Staff will develop a Implementation Tracking Plan	180 days after USEPA approval	Regional Water Quality Control Board

2. Phase II Implementation Actions

If water quality targets are not achieved upon conclusion of Phase I on December 31, 2007, Phase II actions will begin and the time schedule for implementation will be revised. The phased approach allows for immediate control of major sources while allowing time for monitoring to provide an analytical basis for Phase II planning. Phase II requires Regional Board staff to:

a. Bacterial Source Contribution

Regional Board staff will conduct further assessment of bacterial contributions from sources not addressed in Phase I.

b. Source Control Implementation Plan
Regional Board staff will develop implementation actions to control these sources by 2008.

c. Wastewater Treatment Plan
If the pathogen problem persists, plans for a wastewater treatment plant in the community of Palo Verde may be introduced by the stakeholders as a method for managing pathogens in Palo Verde Outfall Drain.

d. Site Specific Objective/ Use Attainability Analysis
A revision of Water Quality Objectives for Palo Verde Outfall Drain and Lagoon, such as a Site Specific Objective or Use Attainability Analysis will be considered for addressing natural background sources of bacterial by December 31, 2008.

Table E-3 Phase II Actions

PRACTICE	ACTION	SCHEDULE	IMPLEMENTING PARTIES
Bacterial source Contribution	Assessment of bacterial contributions from sources not addressed in Phase I	2004-Ongoing	Regional Water Quality Control Board
Source Control Implementation Plan	Development of implementation actions to control the sources identified in assessment of bacterial contributions above.	2008	Regional Water Quality Control Board
Wastewater Treatment Plan	Development of a plan for a wastewater treatment plant in the community of Palo Verde	2010	Palo Verde Stakeholders
Designation Revision	Regional Board consideration of a UAA and/or Site Specific Objective for addressing natural background sources of bacteria.	2008	Regional Water Quality Control Board

3. Conditional Prohibition

A conditional prohibition of discharge of bacterial indicator organisms is hereby established for Palo Verde Outfall Drain and its tributaries in Palo Verde Valley. Specifically, beginning three months after OAL approval of the Palo Verde Bacterial Indicators TMDL, the direct or indirect discharge of bacterial indicator organisms to the Palo Verde Outfall Drain and its tributaries is prohibited, unless the Discharger is:

a. In compliance with applicable TMDL(s), including implementation provisions; or
b. Has a monitoring and surveillance program approved by the Executive Officer that demonstrates that discharges of bacterial indicator organisms into the aforementioned waters do not violate or contribute to a violation of the TMDL(s), the anti-degradation policy (State Board Resolution No. 68-16) or water quality objectives;
c. Is Covered by Waste Discharge Requirements (WDRs) or a Waiver of WDRs that

applies to the discharge; or
d. Demonstrates compliance with county sewage disposal ordinances.

Individual Dischargers must file a Report of Waste Discharge for general or individual Waste Discharge Requirements. Compliance with the conditional prohibition will be determined with respect to each individual Discharger. The intent of this conditional prohibition is to control, to the degree practicable, bacterial indicator organism discharges from irrigated lands, publicly owned treatment facilities, or privately owned treatment systems in amounts that violate or contribute to a violation of state water quality standards.
The Regional Board will not enforce this prohibition until it completes one of the following actions:

- adopts a new waiver policy consistent with State Board septic system regulations;
- enters into MOUs with the counties for enforcement of septic system requirements;
- adopts general waste discharge requirements;
- determines to do none of the above.

4. Time Schedule

Regional Board staff estimate a timeframe of 10 years to achieve control of pathogen loading in Palo Verde Outfall Drain. The limiting factor on this timeframe is upgrading septic systems in the community of Palo Verde or the subsequent installation of a wastewater treatment plant. All other actions (public outreach and education, implementing best management practices) should be in place within ten years. See table below.

Additionally, a revision of Water Quality Objectives for Palo Verde Outfall Drain and Lagoon, such as a Use Attainability Analysis (UAA) and/or a Site Specific Objective (SSO), will be considered for addressing natural background sources of bacteria by December 31, 2008.

Compliance is achieved initially by demonstrating through reporting mechanisms that implementation measures have been undertaken, and by consequently meeting numeric targets as illustrated through water quality monitoring.

At end of:	IMPLEMENTATION MILESTONE	Monitoring Activity
2004	• Initiate Phase I • RWQCB coordinates with the communities of Palo Verde and Ripley and the counties on public outreach and education topics • RWQCB coordinates with counties on monitoring of septic system maintenance in accordance with AB 885 • Consider revising Water Quality Objectives • Evaluate data collected over the year	fecal coliform E. coli, enterococci, fecal streptococci ↓
2005	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2006	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2007	• Evaluate data collected over the year • Evaluate progress on implementation actions • RWQCB, in coordination with the counties, evaluates the quality of septic systems in the community of Palo Verde • Initiate Phase II, adjust implementation time schedule • RWQCB discusses with stakeholders (community members, BECC, etc.) the option of installing a sewer system and WWTP in Palo Verde	
2008	• Evaluate data collected over the year • Evaluate progress on implementation actions • Revision to Water Quality Objectives must be completed	
2009	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2010	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2011	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2012	• Evaluate data collected over the year • Evaluate progress on implementation actions • RWQCB and stakeholders meet to evaluate TMDL compliance and further actions to be taken	
2013	Load Reductions and Numeric Targets achieved	

5. REGIONAL BOARD MONITORING FOR PALO VERDE BACTERIAL INDICATORS TMDL

Trend monitoring will document progress toward achieving the desired water quality conditions. It is important to track TMDL implementation, monitor water quality progress, and modify TMDLs and implementation plans as necessary to:

- Assess bacterial contributions from sources not addressed in Phase I;
- Address uncertainty that may exist in aspects of TMDL development;
- Track actions of the TMDL Implementation Plan to ensure that implementation is being carried out; and
- Ensure that the TMDL remains effective, given changes that may occur in the watershed after TMDL development.

The Regional Board will implement two types of trend monitoring to the extent funding is available: (1) quarterly water quality monitoring, and (2) surveillance and implementation tracking. Both are discussed further in the section below.

a. Monitoring and Tracking

Quarterly grab samples from sampling stations will be collected and analyzed for the following parameters:

- Fecal coliform organisms
- *E. coli*
- Fecal streptococci
- Enterococci
- Physical parameters (i.e. temperature, pH, dissolved oxygen)

Yearly assessments will be made to the Regional Board by Regional Board staff (staff) of the progress of the actions set forth in the TMDL Implementation Plan. Staff will coordinate with public and private entities in order to ensure likely success of the TMDL Implementation Plan in accordance with the Implementation Compliance Schedule milestones. Staff will present yearly reports to the Regional Board that discuss:

- Water quality improvements in terms of pathogen indicator organisms
- If milestones are being met according to the Implementation Compliance Schedule
- What changes, if any, need to be made to the Implementation Compliance Schedule and why

b. Data Management

Staff will compile Implementation Action Assessments and QA/QC validated monitoring data into an organized spreadsheet. The spreadsheet will be updated quarterly in order to maintain a current public record. The public record will be posted on the Region's website and stored in a Palo Verde Pathogen Implementation Monitoring File. Regional Board staff will evaluate the data to determine when numeric targets are attained.

c. Water Quality Assessment and Monitoring Palo Verde Outfall Drain

Monitoring activities are contingent upon adequate programmatic funding. Staff will conduct monitoring activities for Palo Verde Bacterial Indicators TMDL pursuant to a Regional Board Quality Assurance Project Plan for Palo Verde Outfall Drain (QAPP). The QAPP shall be developed by Regional Board staff and be ready for implementation within 30 days following USEPA approval of this TMDL. The Regional Board's Executive Officer shall approve the QAPP and monitoring plan after determining that the QAPP and monitoring plan satisfy the objectives and requirements of this Section. The objectives of the monitoring program shall include collection of water quality data for:

- Assessment of water quality standards attainment,
- Verification of pollution source allocations,
- Calibration or modification of selected models (if any),
- Evaluation of point and nonpoint source control implementation and effectiveness
- Evaluation of in-stream water quality,
- Evaluation of temporal and spatial trends in water quality, and
- Modification of the TMDL as necessary.

The monitoring program shall include a sufficient number of sampling locations and sampling points per location along Palo Verde Outfall Drain. Samples collected quarterly from the above-mentioned surface waters shall be collected and analyzed for the parameters listed above.

Staff will track activities implemented by dischargers and responsible parties and surveillance conducted for Palo Verde Bacterial Indicators TMDL pursuant to an implementation tracking plan (ITP). The ITP will be developed within 180 days following USEPA approval of the TMDL. The Regional Board's Executive Officer shall approve the ITP after determining that the ITP satisfies the objectives and requirements of this Section. The objectives of Regional Board Surveillance and implementation tracking are:

- Assess/track/account for practices already in place;
- Measure the attainment of Milestones;
- Determine compliance with NPDES permits, WLAs, and LAs; and
- Report progress toward implementation of NPS water quality control, in accordance with the SWRCB NPS Program Plan (PROSIP).

1. INTRODUCTION

Palo Verde Lagoon and Outfall Drain are located in Palo Verde Valley located in both Riverside and Imperial Counties of California. Agriculture in the valley is sustained by irrigation water provided by Palo Verde Irrigation District (PVID). The valley has a system of agricultural drains that include a large outfall drain and a lagoon around which the community of Palo Verde is centered. Palo Verde Outfall Drain (PVOD) discharges its waters into the Colorado River upstream of the Cibola National Wildlife Refuge (CRWQCB 2002, QAPP). Figure 1.1, shows the entire Palo Verde Valley. Figure1.2 shows the area of the community and the Lagoon.

The State Board's 303(d) list of impaired water bodies identifies Palo Verde Outfall Drain as water quality limited because bacteria concentrations violate water quality objectives that protect the following beneficial uses: contact and non-contact water recreation (REC I and REC II); warm freshwater habitat (WARM); wildlife habitat (WILD); and preservation of rare, threatened, or endangered species (RARE). Fecal coliform and *E. coli* bacteria are associated with human and animal fecal waste, and indicate the likelihood of the presence of infectious pathogens.

The purpose of Palo Verde Outfall Drain Bacterial Indicator Total Maximum Daily Load (TMDL) is to protect Palo Verde Lagoon and Outfall Drain beneficial uses by reducing bacterial indicator organism concentrations in the water. Palo Verde Outfall Drain discharges to the Colorado River upstream of the River's outlet to the Sea of Cortez in Mexico.

A TMDL is defined as the sum of the individual waste load allocations (WLAs) for point sources of pollution, plus the sum of the load allocations (LAs) for nonpoint and natural background sources of pollution, plus a margin of safety (MOS), such that the capacity of the water body to assimilate pollutant loadings without violating water quality objectives is not exceeded. That is,

$$TMDL = \sum WLA + \sum LA + MOS$$

where $\sum$ = sum, WLA = waste load allocation (for point sources), LA = load allocation (for nonpoint and natural background sources), and MOS = margin of safety.

This TMDL addresses Palo Verde Outfall Drain bacterial impairments, and identifies allowable bacterial loads for point and nonpoint sources discharging into Palo Verde Outfall Drain. When allowable loads are achieved, they are expected to eliminate bacteria-caused impairments.

After examining the potential point and nonpoint source contributions of bacteria to Palo Verde Outfall Drain, modeling scenarios conducted by Tetra Tech, Inc. show the majority of bacteria loading to entire length of the Palo Verde Outfall Drain appear to originate from natural background sources. Assuming a septic system failure rate of 20% in the model, waterfowl contribute about 97% of bacteria while septic systems contribute less than one percent. At an assumed failure rate of 20%, septic systems are potentially contributing about 15% of overall loading to the Lagoon alone. If the failure rate is 100%, septic systems may be responsible for about 46% of overall loading to the Lagoon area of the Outfall Drain. (See discussion on page 32).

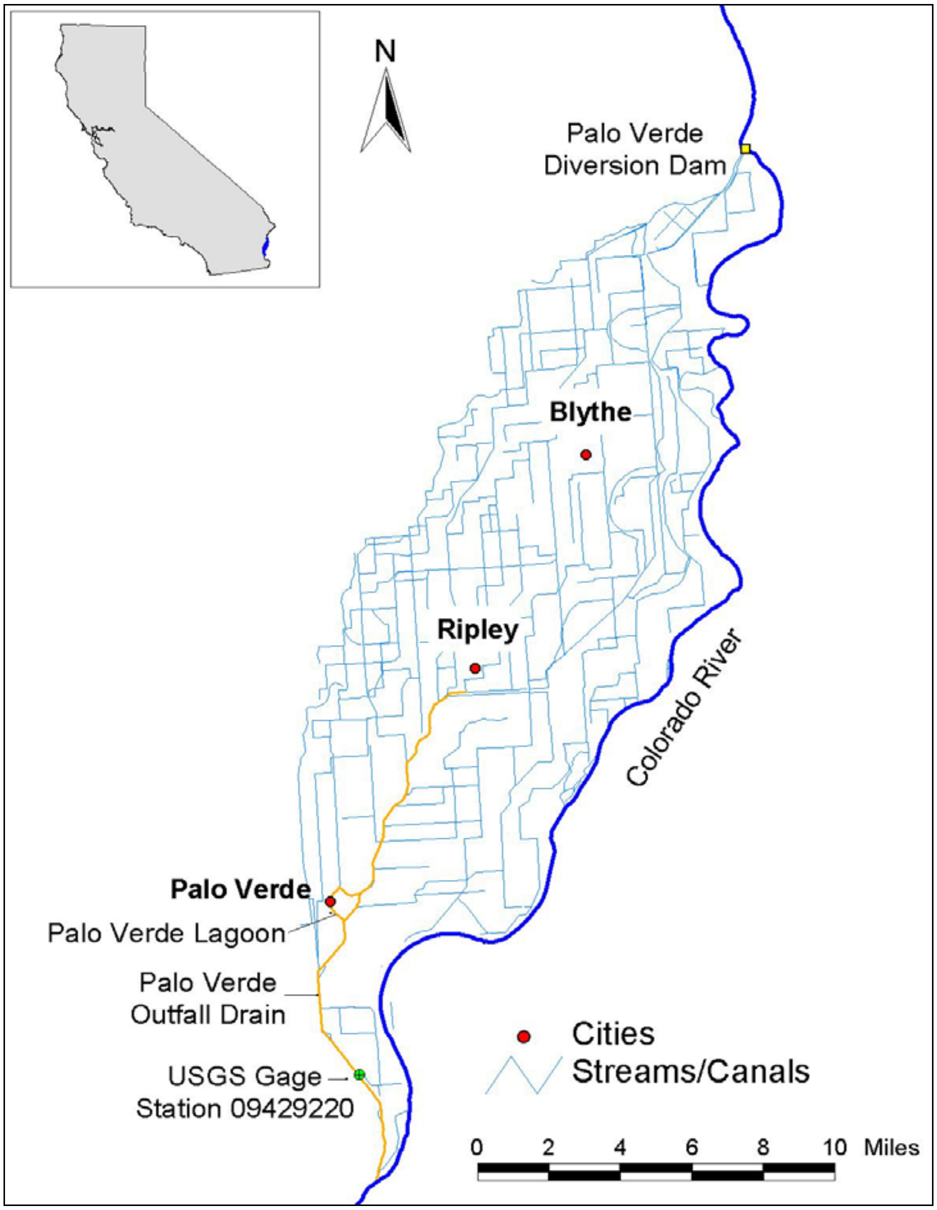
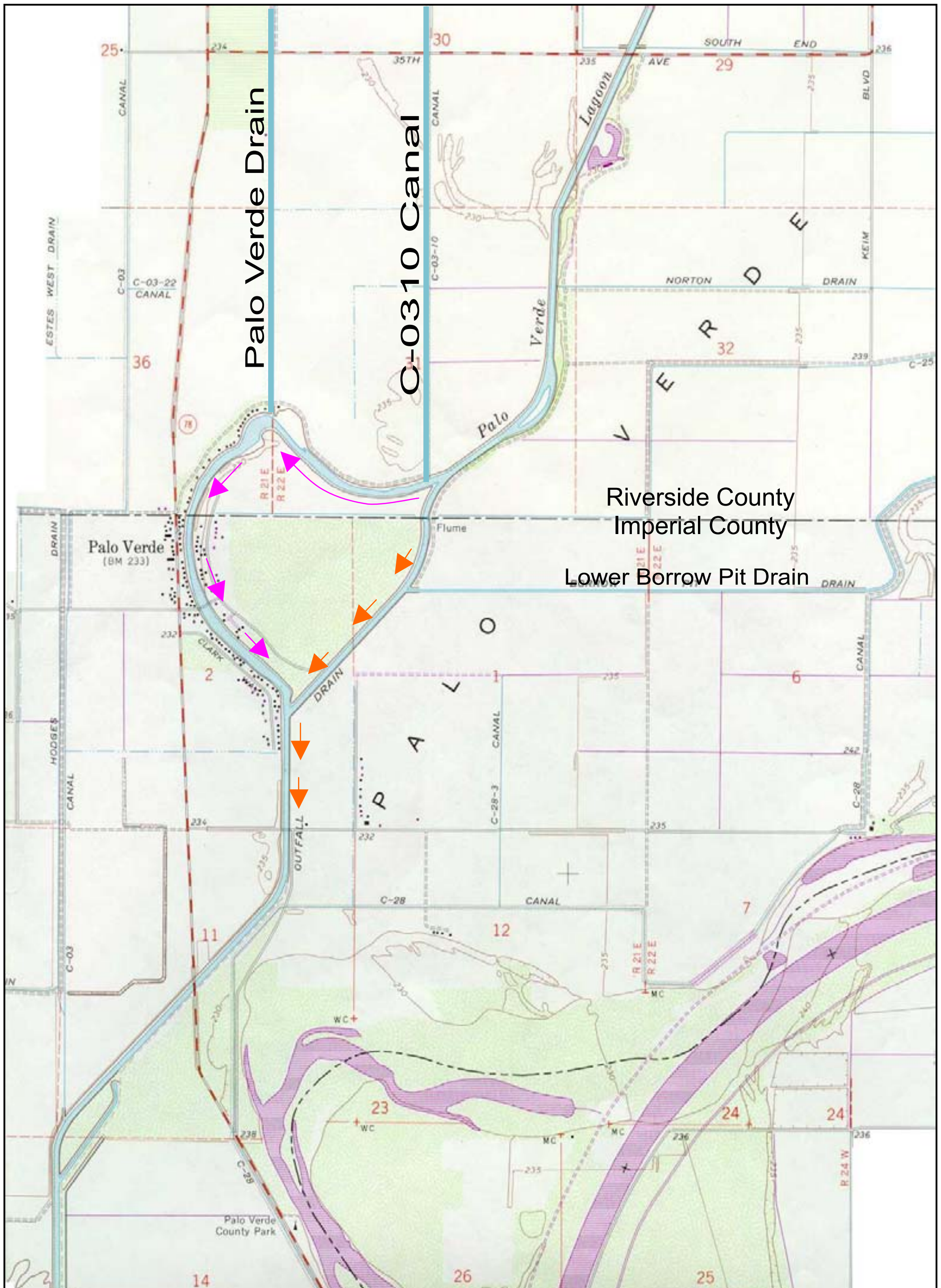


Figure 1.1 Palo Verde Valley



Location Map
Palo Verde Lagoon
Section 36, R21E, T8S; Section 31, R22E, T8S;
and Sections 1 and 2, R21E, T9S, SBB&M
Palo Verde USGS Quadrangle
Scale 1" = 2000'

Notes:

Direction of Flow in PV Lagoon

Direction of Flow in Palo Verde Outfall Drain

2. PROBLEM STATEMENT

This Problem Statement includes a description of: (a) violated Water Quality Objectives that prompted TMDL development; (b) watershed characteristics; and (c) impairments caused by bacteria loading.

A. WATER QUALITY OBJECTIVES

Bacterial indicators are present in Palo Verde Lagoon at levels that violate quantitative water quality objectives (WQOs) established by the Regional Board to protect Palo Verde beneficial uses. These violations of water quality objectives indicate that Palo Verde Lagoon and Outfall Drain beneficial uses are impaired. Table 2.1 summarizes pathogen indicator organism WQOs. Table 2.2 summarizes Palo Verde Lagoon and Outfall Drain beneficial uses.

Table 2.1 Water Quality Objectives

Indicator Parameter	30-Day Geometric Mean	30-Day Log Mean[a]	Maximum
E. coli	126 MPN[b]/100 ml	--	400 MPN/100 ml
Enterococci	33 MPN/100 ml	--	100 MPN/100 ml
Fecal Coliform	--	200 MPN/100ml	c

a. Based on a minimum of no less than 5 samples equally spaced over a 30-day period.
b. Most probable number.
c. No more than 10% of total samples during any 30-day period shall exceed 400 MPN/100 ml.

Total coliform bacteria are found in human and animal feces, and in soil, and are not considered useful pathogenic indicators. Fecal coliform and *E. coli* bacteria are associated with human and animal fecal waste, and are more representative of the sanitary quality of surface waters than are total coliform organisms (DHS 1987). Major health concerns usually focus on fecal associated pathogens, however, warm waters also harbor other free-living organisms that may cause serious illness in humans. High concentrations of fecal coliform and *E. coli* bacteria indicate the high likelihood of infectious diseases. TMDL Monitoring, as well as TMDL Implementation, will focus on characterizing pathogen-indicator organisms and tracking compliance with numeric targets in order to protect beneficial uses.

Table 2.2 Palo Verde Lagoon and Outfall Drain Beneficial Uses

Designated Beneficial Uses of Water	Description
Water Contact Recreation (REC I)	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water skiing, skin and scuba diving, surfing, whitewater activities, fishing, and use of natural hot springs.

Designated Beneficial Uses of Water	Description
Water Non-Contact Recreation (REC II)	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Warm Freshwater Habitat (WARM)	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Wildlife Habitat (WILD)	Uses of water that support terrestrial ecosystems including but not limited to, the preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
Preservation of Rare, Threatened, or Endangered Species (RARE)	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Source: California Regional Water Quality Control Plan for the Colorado River Basin Region 2003.

B. WATERSHED CHARACTERISTICS

Hydrogeological Setting

Palo Verde Lagoon and Outfall Drain are located in Palo Verde Valley located in both Riverside and Imperial Counties of California. The area is 29 miles long and 15 miles across at its widest point (USDA 1974). The Valley is bounded on the north by the Big Maria Mountains, on the west by Palo Verde Mesa, and on the south and east by the Colorado River. The outfall drain discharges into an old channel of the Colorado River and enters the present river channel upstream of the Cibola National Wildlife Refuge. The flow in Palo Verde Outfall Drain in 2002 ranged from approximately 370 cubic feet per second (cfs) to 639 cfs, with an average for the year of 524 cfs.

Large acreages of land in the valley are used to grow crops such as melons, cotton, alfalfa, and produce vegetables (USDA 1974). Agriculture in the valley is sustained by irrigation water provided by PVID. Water is diverted from the Colorado River at Palo Verde Diversion Dam and drainage is provided by a 150 mile system of open drains that discharge into Palo Verde Outfall Drain. PVID allows farmers to divert runoff from their fields into the drains. However, drains in the valley contain mainly groundwater seepage, with very little agricultural return water entering the drains (Hanson and Gruenberg 1975).

The Outfall Drain and its tributary drains have steep banks, not easily accessible on foot. The channels of the drains are maintained by PVID; they are excavated and graded often leaving soft exposed soil. Trees grow on the banks of the Outfall Drain while the tributary drains usually have cattails and tall reeds growing directly inside them. The larger Outfall Drain has a more stable riparian habitat while the tributary drains appear more like marsh lands adjacent to cropped fields.

Palo Verde is an unincorporated community overlapping the border of Imperial and Riverside Counties, located about 6 miles west of the Colorado River, with a population of roughly 1,000. The community consists of mostly residential housing, but also includes two RV parks. The community's wastewater is treated by septic tanks and disposed of via leachfield systems (CRWQCB 2002, QAPP).

The community of Palo Verde is centered around the lagoon area of the Outfall Drain. The Lagoon is a small canal-like lake that is used for water contact recreation such as boating and swimming. The Lagoon is a section of Palo Verde Outfall Drain.

Soil Classifications

Palo Verde Valley floor is alluvium. The soils are generally level, moderately to well-drained sandy loams and loamy sands. Average annual precipitation in the valley is usually less than 4 inches while evapotranspiration totals about 48 inches per year (USDA 1974).

Table 2.3 Soil Associations in Palo Verde Valley

1	Rositas-Gilman	Nearly level	Somewhat excessively drained and well-drained	Fine sands, fine sandy loans, and silty clay loams
2	Cibola-Ripley-Indio	Nearly level	Well-drained	Fine sandy loams, very fine sandy loams, or silty clay loams
3	Imperial-Holtville Meloland	Nearly level	Well-drained and moderate to well-drained	Fine sandy loams, silty clay loams, and silty clays

3. DATA ANALYSIS

A. AVAILABLE DATA

To develop the TMDL for Palo Verde Outfall Drain, a wide variety of information for the watershed was analyzed, including data related to water quality, point sources, land use and land cover, land characteristics, meteorology, wildlife populations, septic system use statistics, and flow in the system. Major sources of information for this effort include Regional Board water quality monitoring files; Cibola National Wildlife Refuge data; Palo Verde Irrigation District data; United States Geological Survey (USGS) data; and United States Environmental Protection Agency (USEPA) BASINS system data. Local information was utilized whenever possible. The following sections describe available flow and water quality information.

Flow Data

Basic flow information was obtained from USGS and PVID. Annual diversions at the Intake structure for the period 1992-2002 were provided by PVID. Based on these data, minimum, average, and maximum annual flow into the system was calculated (Table 3.1).

Table 3.1 Annual Flow Diversions into Palo Verde Intake Dam

	Inflow at Intake			Return at Gage
Year	**Measured Diversion (acre feet)**	**cubic feet/year**	**cfs**	**cfs**
1992	766,698	33,397,495,219	1,059	544
1993	729,820	31,791,083,269	1,008	405
1994	812,450	35,390,460,117	1,122	441
1995	885,700	38,581,242,569	1,223	478
1996	963,510	41,970,659,397	1,331	526
1997	931,580	40,579,783,169	1,287	561
1998	901,930	39,288,224,128	1,246	558
1999	941,910	41,029,759,725	1,301	527
2000	977,580	42,583,550,989	1,350	526
2001	965,595	42,061,482,351	1,334	510
2002	998,352	43,488,382,840	1,379	522
Low	**729,820**	**31,791,083,269**	**1,008**	**405**
Average	**897,739**	**39,105,647,616**	**1,240**	**509**
High	**998,352**	**43,488,382,840**	**1,379**	**561**

Flows returning from the canals and irrigation fields are referred to as return flows and are measured at USGS Gage 09429220 south of Palo Verde Lagoon (See Figure 1.1) Comparison of annual diversions with annual return flows at the gage station provides a crude estimation of consumptive use from processes such as plant uptake, evapotranspiration, groundwater loss, etc.

Average annual intake for the 10-year period was 897,739 acre feet (1,240 cfs), while average return flows at the gage were 367,444 (509 cfs). The lowest annual intake and returns for the same period were 1,008 cfs and 405 cfs respectively. For modeling purposes, total return flow volume is assumed to be representative of flow volumes in tributary drains.
In order to distribute this flow among all tributary drains, an approximate drainage area for each tributary drain was established. Using the lowest annual return flow value from the 10-year period (405 cfs), total return flow volume was divided among each tributary drain based on the drainage area proportion (Table 3.2, Figure 3.1).

Table 3.2 Flow Distribution to Tributary Drains based on flow of 405 cfs

Subwaternm	Area Drained (Acres)	Area Drained (Hectares)	As % of Total Area	Inflow per drain (cfs)
Township Dr*	43908	17769	38	155
West Side Dr	18534	7501	16	66
Borrow Pit Dr	13956	5648	12	49
Rannels Dr	12436	5033	11	44
PVOD	7096	2872	6	25
Hodges Dr	4721	1910	4	17
Browns Dr	3808	1541	3	13
Palo Verde Dr	3438	1391	3	12
South End Dr	3352	1357	3	12
Estes Dr	2049	829	2	7
Norton Dr	752	304	1	3
Lagoon	531	215	0	2

*Township Drain includes flow from Central, East Side, and Lovekin Drains

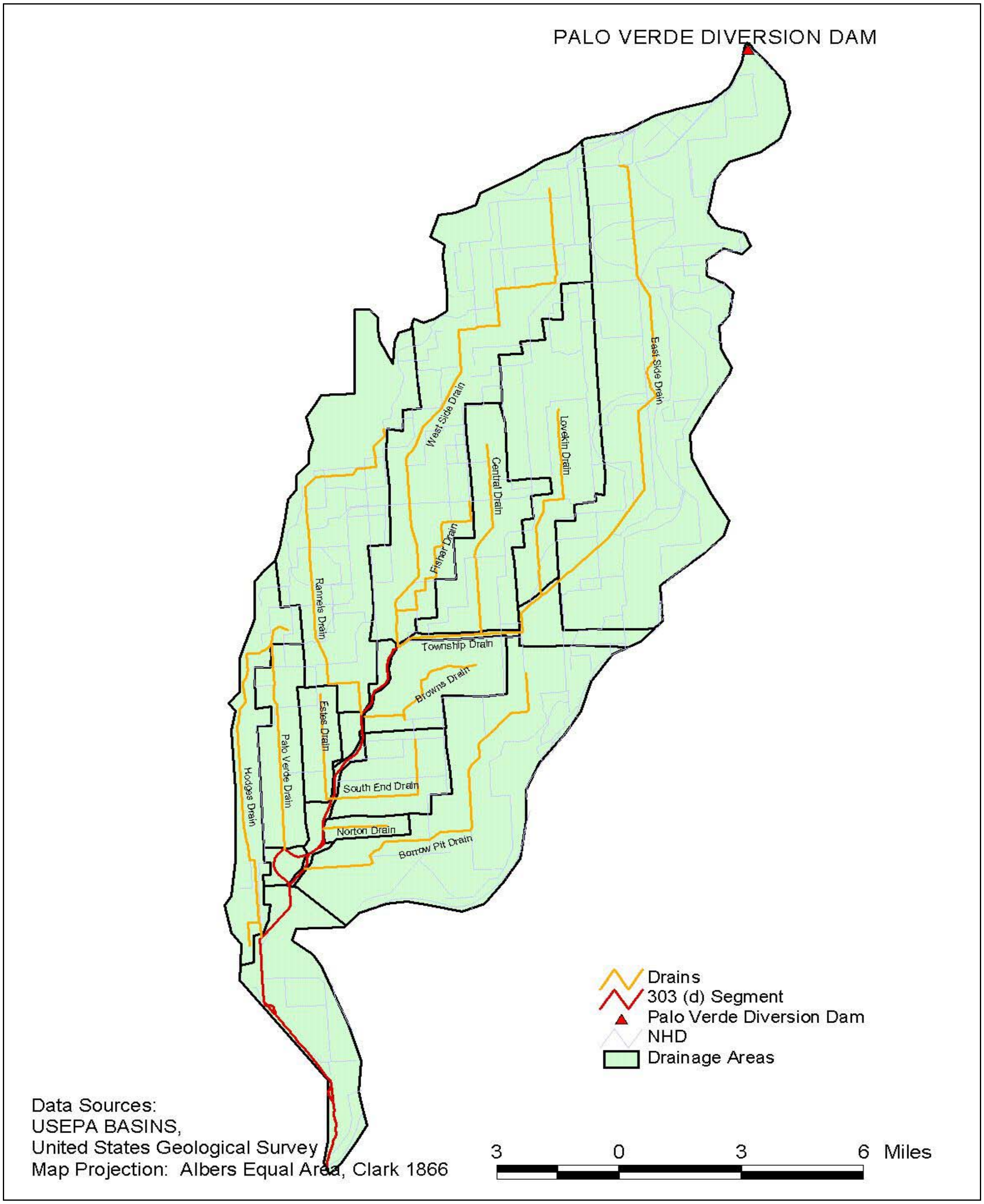


Figure 3.1. Drainage Areas of Tributary Drains

Table 3.3 shows average monthly flow statistics based on daily flow measurements at USGS gage station 09429220 for the period 1968–2002. Figure 3.2 depicts this information graphically. Average January (low) flows are 405 cfs; while average August (high) flows are 643 cfs.

Table 3.3 Monthly Flow Statistics at Gage 09429220 1968-2002

Month	Average Flow (cfs)	Minimum (cfs)	Maximum (cfs)
January	405	210	592
February	428	236	609
March	474	248	670
April	532	322	745
May	575	390	720
June	590	426	780
July	614	444	881
August	643	456	1200
September	629	448	1190
October	560	412	812
November	506	348	657
December	469	336	856

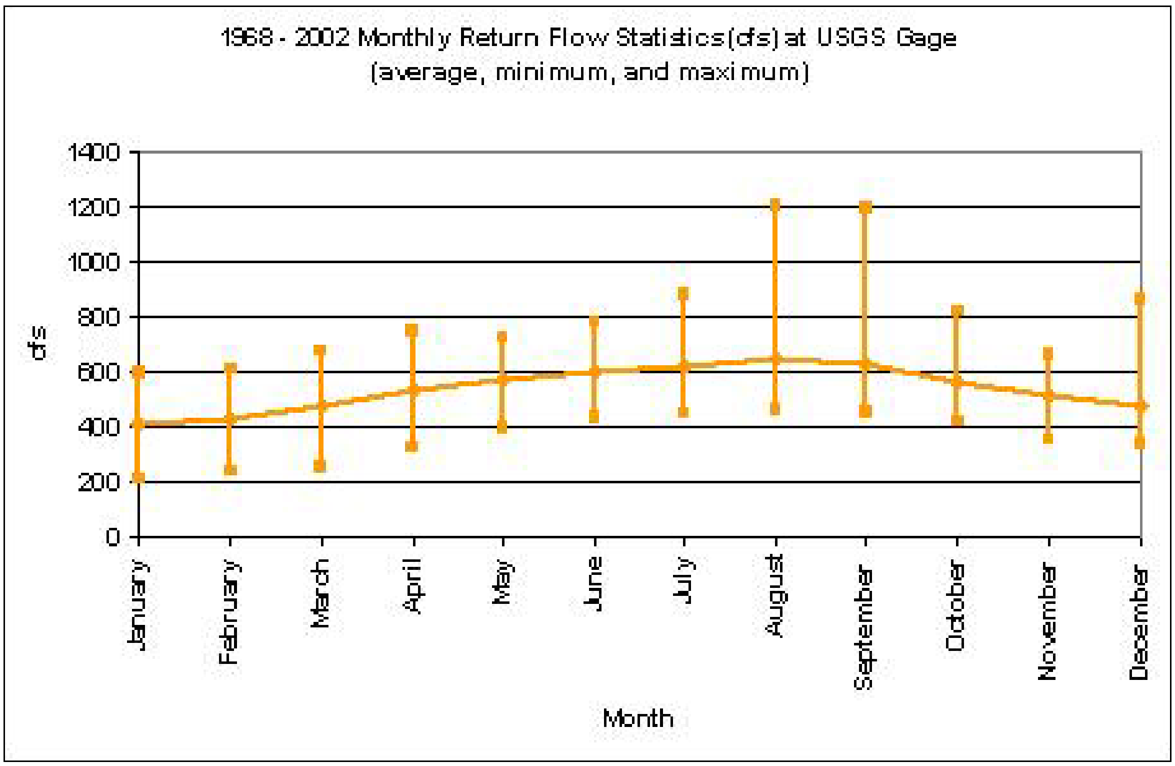


Figure 3.2 Monthly Flow Statistics USGS Gage 09429220

Water Quality Data

In order to establish an understanding of bacteria loading to the water body, Regional Board staff began collecting water quality samples in Palo Verde Lagoon area in October 2000. In June, July, August, November, and December 2002, sampling occurred in the Lagoon area as well as additional locations upstream of the Lagoon in an effort to establish a boundary for background conditions. There are limited observations available for each established monitoring station. By December 2002, the maximum number of observations available for most stations is six (newly established stations upstream of the Lagoon will have fewer.) Additional stations were established further upstream in 2003 in an effort to locate the nearest areas in which water quality satisfies bacteria WQOs. Data from all additional stations, including source water from the Colorado River, indicated violations of WQOs.

Data are available for stations around the Lagoon and for the tributaries draining into the Lagoon. For national security reasons, we have been directed not to disclose these locations. As Palo Verde Valley is located immediately adjacent to the Colorado River, which is one of the nation's major water supply rivers, these locations are considered sensitive.

In PVOD, water quality data was needed to 1) identify any water quality trends that may be related to bacteria loading and 2) to establish an understanding of the geographic area that is affected by water quality violations. The sampling methodology has attempted to satisfy both of these needs.

Sampling was initially conducted (2000-2001) at sites in the Lagoon because water quality violations were first reported there. Next, samples were obtained at mouths of tributary drains. As it was determined that concentrations were in violation of water quality objectives at tributary mouths, the next sampling trip gathered data from the same tributary but upstream from the mouth. For example, on August 6, 2002 a sample was obtained at the mouth of the West Side Drain (WSDR). The next trip on November 11, 2002 sampled in the West Side Drain at 20th Avenue (WSDR2). The next trip on December 5, 2002 sampled in the West Side Drain at 18th Avenue (WSDR3). These locations span a distance of approximately 2 miles.

Figure 3.3 shows for each water quality sampling location, average fecal coliform bacteria concentrations, average E. coli concentrations, and the E. coli REC I water quality standard. Figure 3.4 shows the same for streptococci concentrations, enterococci concentrations, and the enterococci REC I standard. While sampling data are limited, average concentrations of each indicator show levels in excess of criteria throughout the watershed with large spikes in concentration near the CO3 canal and the Borrow Pit Drain.

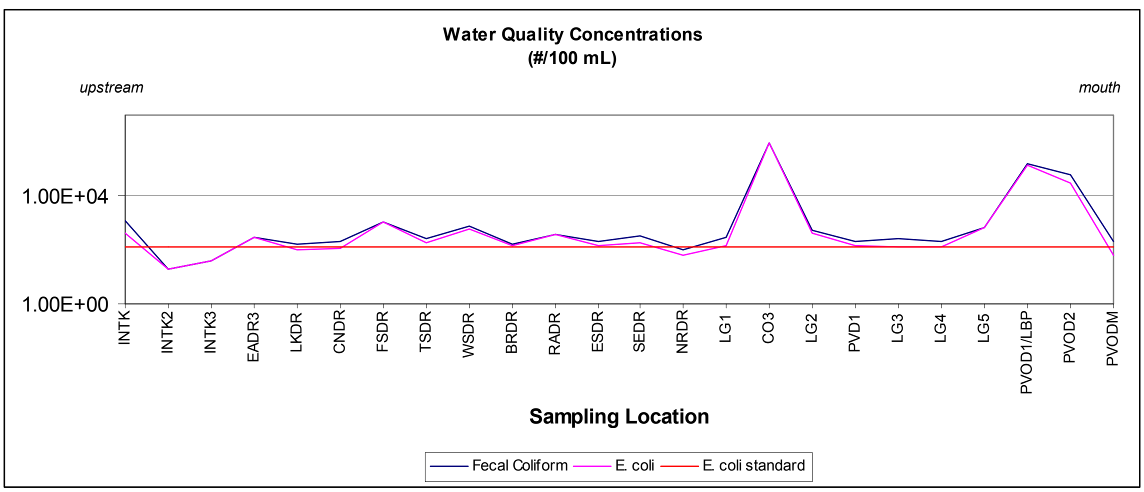


Figure 3.3 Fecal coliform and E. coli Observations vs. E. coli Standard

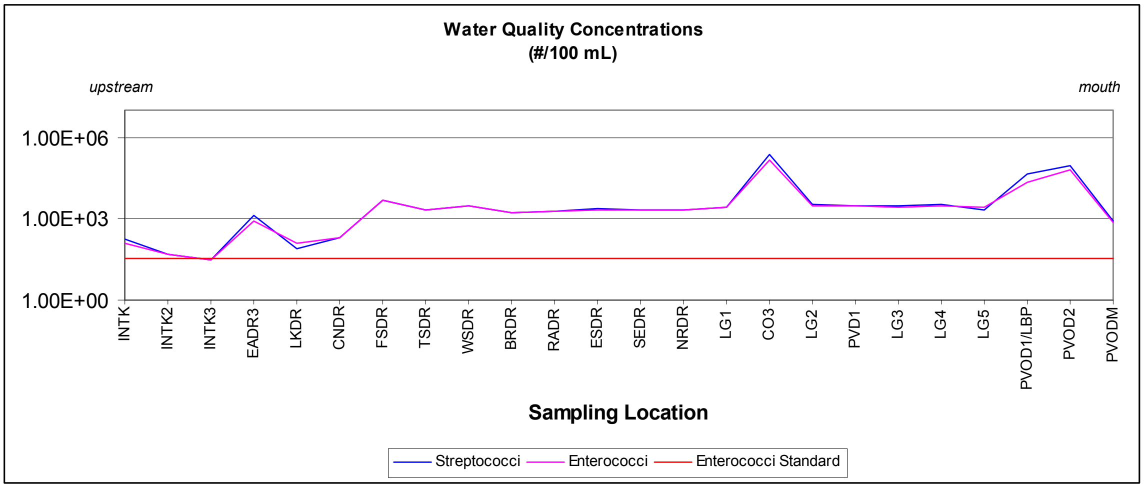


Figure 3.4 Streptococci and Enterococci Observations vs. Enterococci Standard

In addition to bacteria analysis, simultaneous samples were collected to analyze nitrate, ammonia, and total organic carbon (TOC). It is understood that nutrients and organic carbon have effects on survival and growth rates of bacteria in water (as well as UV radiation exposure and predation rate). The 2000-2002 data does not suggest nutrient rich waters in the Palo Verde Outfall Drain. However, almost all Palo Verde TOC data exceeds the contract lab's 0.7 mg/L reporting limit (RL) for liquid.

Trend Monitoring
Monitoring will continue after TMDL approval and adoption in order to assess the effectiveness of implementation actions and the changes in conditions over time relative to the numeric target values. Trend monitoring will document progress toward achieving the desired water quality conditions and will allow for refinement of the Source Analysis and TMDL Implementation Plan. Please see Section 11 of this document, *Monitoring Plan*.

4. NUMERIC TARGET

The designated beneficial uses for Palo Verde Outfall Drain are water contact recreation (REC I); water non-contact recreation (REC II); warm freshwater habitat (WARM); wildlife habitat (WILD); and preservation of rare, threatened or endangered species (RARE). The REC I beneficial use requires the most stringent bacteria WQOs, and includes such activities as swimming, wading, and fishing. Bacteria WQOs serve to protect human health from direct and indirect contact with sewage-contaminated water (USEPA Jan 1986; USEPA May 1986; USEPA Sep 1988; USEPA May 1998).

Palo Verde Lagoon

The California Regional Water Quality Control Board Colorado River Basin Region has adopted USEPA-established bacteria water quality criteria as bacteria WQOs in the Region's Water Quality Control Plan. This TMDL uses those bacteria indicator organisms (Fecal coliform, *E. coli*, and enterococci) set forth as WQOs in the Region's Water Quality Control Plan as the Numeric Target. Margins of safety have been set so as to always meet the numeric criteria specified in the WQOs. For Fecal coliform the target is 200 counts/100ml; the E. coli target is 126 counts/100 ml; for enterococcus the target is 33 counts/100 ml. Meeting these values ensures the geometric mean criteria are always satisfied, as are instantaneous "not to exceed" objectives.

Table 4.1: Numeric Targets

Indicator Parameter	30-Day Geometric Mean	30-Day Log Mean[a]	Maximum "not to exceed"
E. coli	126 MPN[b]/100 ml	--	400 MPN/100 ml
Enterococci	33 MPN/100 ml	--	100 MPN/100 ml
Fecal Coliform	--	200 MPN/100ml	c

a. Based on a minimum of no less than 5 samples equally spaced over a 30-day period.
b. Most probable number.
c. No more than 10% of total samples during any 30-day period shall exceed 400 MPN/100 ml.

Total coliform bacteria are found in human and animal feces, and in soil, and are not considered useful pathogenic indicators. Fecal coliform and *E. coli* bacteria are associated with human and animal fecal waste, and are more representative of the sanitary quality of surface waters than are total coliform organisms (DHS 1987). High concentrations of fecal coliform and *E. coli* indicate the high likelihood of infectious pathogens. Monitoring, as well as Implementation, will focus on characterizing pathogen-indicator organisms and tracking compliance with numeric targets.

5. SOURCE ANALYSIS

Fecal coliform bacteria enter surface waters from both point and nonpoint sources. Point sources are facilities that discharge at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities to a surface water body. All point sources must have a National Pollutant Discharge Elimination System (NPDES) permit. Nonpoint sources are diffuse sources that have multiple routes of entry into surface waters. Some nonpoint sources are related to land use activities that accumulate fecal coliform bacteria on the land surface (i.e., livestock pasture land or application of manure fertilizer) that runs off during storm events. Other nonpoint sources, such as in-stream cattle, are more or less continuous (Tetra Tech Jan. 2003).

A. PERMITTED POINT SOURCES

Table 5.1 shows the two wastewater treatment facilities in Palo Verde Valley: the Ripley Wastewater Treatment Facility (addressed under CRWQCB Order No.R7-2003-0012), and the Municipal Wastewater Treatment Plant (WWTP) for the City of Blythe (addressed under CRWQCB Order No. 94-039 and revisions thereto) both use percolation basins to handle treated effluent.

Table 5.1 Permitted Point Sources in Palo Verde Valley

Facility	Design Flow	Fecal coliform Limits	Discharges to Surface Waters
Blythe WWTP	2.4 MGD	none	none
Ripley WWTF	0.035 MGD	none	none

Of these facilities, only the Ripley facility is in the immediate drainage area of Palo Verde Outfall Drain. Located adjacent to the Township Drain on Highway 78, the Ripley treatment facility is designed to discharge a maximum 35,000 gallons per day of domestic sewage from two mechanically aerated and lined basins into two lined settling basins followed by four infiltration basins for disposal. A tile underdrain system, designed to prevent the water table from rising, has been installed about eight feet below the bottom of the infiltration basins. Discharge from the tile underdrain system would flow into the Township Drain; however, to date, there has been no observed flow to the Township Drain from this facility. Additionally, the permit for the facility states, “there shall be no surface flow of wastewater away from the designated disposal area.”

Because neither facility discharges into Palo Verde Outfall Drain, they are assumed to not be contributing sources of bacteria loading to the system.

B. NONPOINT SOURCES

Nonpoint sources are the major contributor of bacteria loading to Palo Verde Outfall Drain. Nonpoint sources are diffuse sources that enter surface waters through multiple routes rather than through a single defined outlet. The major potential nonpoint sources of fecal coliform bacteria in the drainage area are failing septic systems (including unregulated discharges), and wildlife (which includes mammals and birds). Domestic animals and livestock may contribute fecal loading to land surfaces in Palo Verde Valley; however, they do not contribute significantly to drain water due to the lack of rainfall and runoff in the area.

The land use distribution in Palo Verde Valley provides insight into determining possible nonpoint sources of fecal coliform bacteria. Predominant land uses in Palo Verde Valley were identified based on the USGS Multi-Resolution Land Characterization (MRLC) land use data (Figure 5.1). The majority of the area (85%) consists of agricultural land, on which various crops are grown (Table 5.3). The remaining 15% is distributed between natural shrub-land (7.4%), residential/commercial uses (1.9%), barren land (1.5%), open water (1.2%) and a mixture of forest, orchard land, grassland, and wetland. There are no large livestock operations in the area.

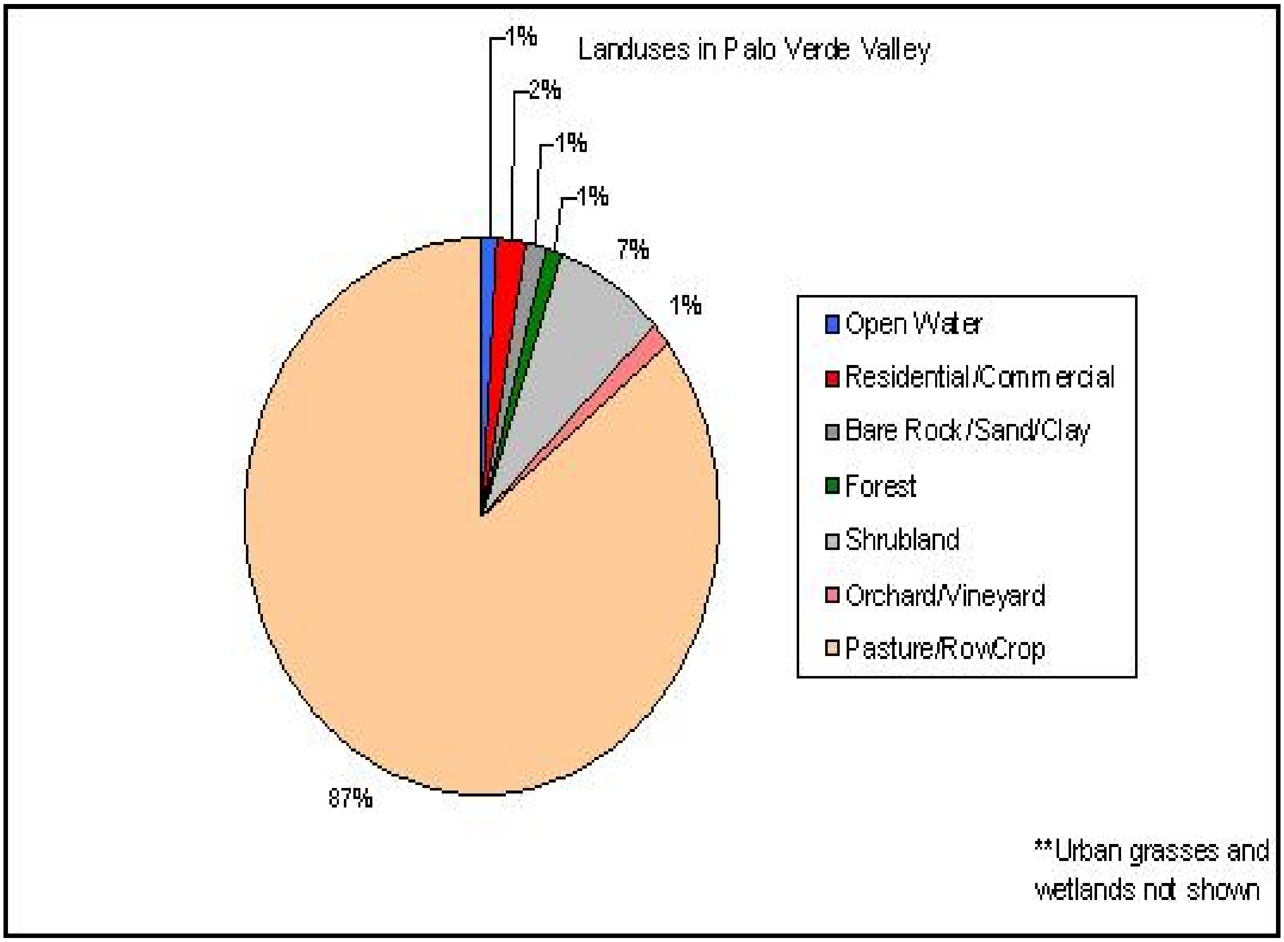


Figure 5.1 Percent Land Use in Palo Verde Valley

Table 5.2 Crops Grown in Palo Verde Valley (2000)

Crop	Cropped Acreage	Percent of Total Cropped Acreage (%)
Alfalfa (hay, seed, etc)	59,700	54.6
Sudan (hay, seed)	1,512	1.4
Bermuda (pasture grass seed)	2,641	2.4
Wheat and Barley	6,424	5.9
Corn	300	0.3
Oats	335	0.3
Cotton	17,498	16.0
Misc. Field Crops	4,655	4.3
Citrus, Orchard Palm Trees	2,713	2.5
Misc. Vegetables	2,343	2.1
Broccoli	1,879	1.7
Lettuce	2,362	2.2
Cantaloupes	3,686	3.4
Honeydews	518	0.5
Mixed Melons and Watermelons	1,430	1.3
Idle	1,310	1.2
Fish Ponds	72	0.1
Total	**109,378**	**100.0**

Source: From PVID Land Management, Crop Rotation and Water Supply Program Draft EIR (pp. 1-4)

Agricultural lands can be a source of fecal coliform bacteria. Runoff from pastures and animal operations, improper land application of animal wastes, and animals with access to waterways are all potential sources of fecal coliform bacteria. Due to the low amount of rainfall in the area, precipitation driven build-up and runoff of bacteria is not an issue in Palo Verde Valley. Table 5.3 shows monthly rainfall totals as measured at the Blythe airport for 2000-2002. The three-year average is 1.72 inches per year.

Table 5.3 Monthly Rainfall Totals (inches) at Blythe Airport

MONTH	2000	Year 2001	2002
Jan	-	0.81	-
Feb	-	0.67	0.06
Mar	-	1.5	-
Apr	-	0.01	-
May	-	-	-
Jun	-	-	-
Jul	-	-	-
Aug	0.54	-	-
Sep	-	0.6	0.75
Oct	-	-	0.04
Nov	-	0.11	0.03
Dec	-	0.04	-
Total	**0.54**	**3.74**	**0.88**

Grazing

While there are no permanent livestock operations in the Valley, approximately 19,000 sheep are imported during the winter months (November through May) to graze alfalfa fields not slated for market. When the animals leave the Valley in spring, their population has grown by about one and one half times the original population, due to lambing. Any manure produced by these animals is left on fields and allowed to decompose naturally. Since low moisture and exposure to ultraviolet light are two factors that contribute to bacteria die-off (Auer and Niehaus, 1992; Anderson, 1986), fecal matter left by sheep is not expected to be a major contributor of bacteria to drains in the area. Estimated bacteria loading by sheep to grazing areas is presented in Table 5.4. Loading is based on an estimated January population (prior to lambing) of 19,000 animals. The estimated sheep population is assumed to be distributed evenly throughout the Valley.

Table5.4 Estimated daily Fecal coliform loading (January) from grazing sheep in Palo Verde Valley*

Drain	No. sheep	No. grazing	FC loading (No.FC/day)
Township	7,248	7,248	1.42E+14
WestSide	3,214	3,214	6.30E+13
Ra/Br	2,660	2,660	5.21E+13
Es/SE	966	966	1.89E+13
Norton	131	131	2.57E+12
Lagoon/PVD	699	699	1.37E+13
BorrowPit	2,323	2,323	4.55E+13
PVOD	958	958	1.88E+13
Hodges	802	802	1.57E+13
Total Loading			**3.72E+14**

* Estimates based on the Mass Balance Spreadsheet Model (Tetra Tech, Inc. 2003).

Croplands

On croplands, application of manure fertilizers is a potential source of bacteria to nearby water bodies as bacteria can be washed off the land surface either from rainfall or irrigation. When manure is applied in Palo Verde Valley, it is typically disced into the soil one to two months prior to planting for non-direct consumption crops such as cotton and alfalfa. Manure was last applied to fields in the Valley during the winter of 2000 (Mike Rethwisch, personal communication, UCCE). As the water quality data collected for this TMDL were all obtained since 2000, manure is not considered a significant source of bacteria to the drain system. There were no manure applications to croplands in Palo Verde Valley from 2001 to 2003. Moreover, given the one to two month “shaping” time between application of manure and the planting and irrigation of crops, it is likely that most bacteria die before being washed into the drain system via irrigation. Bacteria loading from manure application was considered and rejected as a source of bacteria for this TMDL.

A second mechanism through which bacteria might enter the drain system from croplands is from pests (mice, rabbits, rats, etc.) foraging in fields and depositing fecal matter, which is then carried into the drains during irrigation. Studies indicate that the more rapid the transport of water through the soil matrix and the more shallow the groundwater, the more likely bacteria are to survive (Howell et al., 1996, Novotny and Olem, 1994). While this is a potential source of bacteria to the drains, it appears to be minor. Therefore bacteria loading from cropland pests were not estimated for this TMDL.

Septic Inputs

Failing septic systems and other illegal discharges represent nonpoint sources that can contribute fecal coliform to receiving water bodies through surface and subsurface malfunctions or direct discharges. In Palo Verde Valley, the Blythe and Ripley treatment facilities provide wastewater treatment to areas north of 25th Avenue. Any septic contributions in the area are assumed to originate from dwellings located south of 25th Avenue. Commercial and residential land uses are concentrated in an area immediately surrounding the Lagoon in Imperial County. Septic system permit information is unavailable for Imperial County. Both Riverside and Imperial Counties have ordinances regulating the discharge of sewage to on-site sewage treatment facilities (Riverside County Ordinance No. 650.4, 1988; Imperial County Code Section 91012.00-91012.10). As standard policy, applicants are encouraged to place leachfields at least 200’ feet back from the Lagoon if possible. When this is not possible, leachfields are placed at the most distant end of the property from the Lagoon. The majority of leachfields are at least 50-100’ from the Lagoon (Mark Johnson, personal communication, Imperial County Public Health Department).

Palo Verde County Water District supplies community water to the residences and businesses in the area, and provided information regarding the number of water use accounts. This information was used to estimate the number of occupied houses and businesses located on the Lagoon. According to the Water District, there are approximately 150 to 155 water use meters in the immediate community of Palo Verde. Six or seven of these are connected to commercial water use accounts, while the remaining are residential. For loading analysis purposes, no distinction is made between residential and commercial septic systems. Figure 5.2, based on USGS quadrangle maps of the area, provides a depiction of the housing situated around the Lagoon. With the exception of a few seasonal inhabitants, residents live in the community year-round. In January 2003, pumpage equaled 121,452 cubic feet; July 2003 pumpage equaled 216,371 cubic feet. The seasonal increase in water usage is attributed to increased residential watering activities during summer.

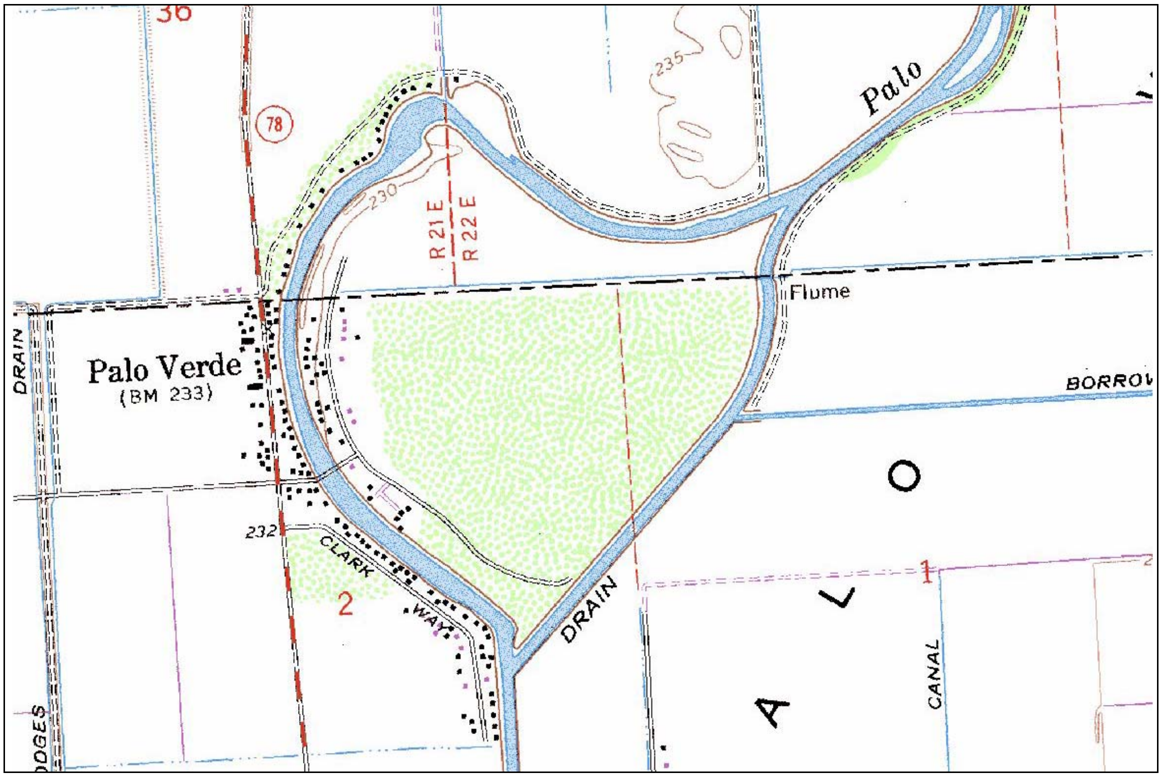


Figure 5.2 Structures on Palo Verde Lagoon

Since these dwellings are served by individual septic systems, they represent a potential source of bacterial input to the Lagoon. Information regarding septic system failure rates is not available for this area. During a visual survey conducted by the Regional Water Quality Control Board and the Imperial and Riverside County Health Departments in the early 1990's, no direct discharges into the Lagoon were detected (Mark Johnson, Imperial County Health Department); however there are pipes leading from homes in the area to the Lagoon. It is not clear what the pipes are used for. They may be used to dump unregulated discharges of wastewater into the Lagoon; alternatively, they may be used to take or return irrigation water to the Lagoon. Without additional verification that septic systems along the Lagoon are not contributing to the bacteria loads, and given the age of the houses as well as their proximity to the Lagoon, an estimate of the potential bacteria loading from this area was conducted. Various septic system failure rates were modeled to estimate the relative bacterial contribution to the Lagoon from septic systems versus other sources such as wildlife and birds.

Loadings from failing septic systems were simulated in a mass balance model developed by Tetra Tech, Inc. (see Section 5.E, Mass Balance Spreadsheet Model) using constant flows and the following references and assumptions :

- Number of septic systems (155 determined from Palo Verde Co. Water District)
- Estimated population served by the septic systems (an average of 3.3 people per household based on US Census 2000—for Riverside and Imperial Counties)
- An average daily discharge of 70 gallons/person/day (Horsley & Witten 1996)
- Septic effluent concentration of 10^4 counts/100mL (Horsley & Witten 1996)
- Septic failure rate of 0, 20, 50, and 100 per cent

Based on the information above, septic loading, regardless of failure rate does not appear to be the predominant source of bacteria to the Lagoon when compared to loading from wildlife (see below, *Wildlife*). However, any septic input to the Lagoon represents a violation of water quality objectives. Table 5.5 and Figure 5.3 present estimated septic inputs based on varying failure rates. At an assumed failure rate of 20 per cent, septic systems are potentially contributing about 15 percent of overall loading to the Lagoon. At 100 per cent, septic systems may be responsible for about 46 percent overall loading to the Lagoon. Increasing the assumed septic system failure rate to 100 per cent results in an increase in septic loading to the Lagoon of approximately 1.08 x 10^{10} fecal coliform bacteria per day.

Table 5.5 Estimated Loading from Septic Inputs and Varying Failure Rates

Failure **Rate**	# septics	# failing **septics**	Septic flow **(gal/day)**	Septic flow **(ml/hr)**	Fecal coli rate **(#/hr)**	Septic flow **(cfs)**	Fecal coli rate **(#/day)**
0%	155	0	0	0	0	0.00	0.00E+00
20%	155	31	7161	1129349	112934938	0.01	2.71E+09
50%	155	78	17903	2823373	282337344	0.03	6.78E+09
100%	155	155	35805	5646747	564674688	0.06	1.36E+10

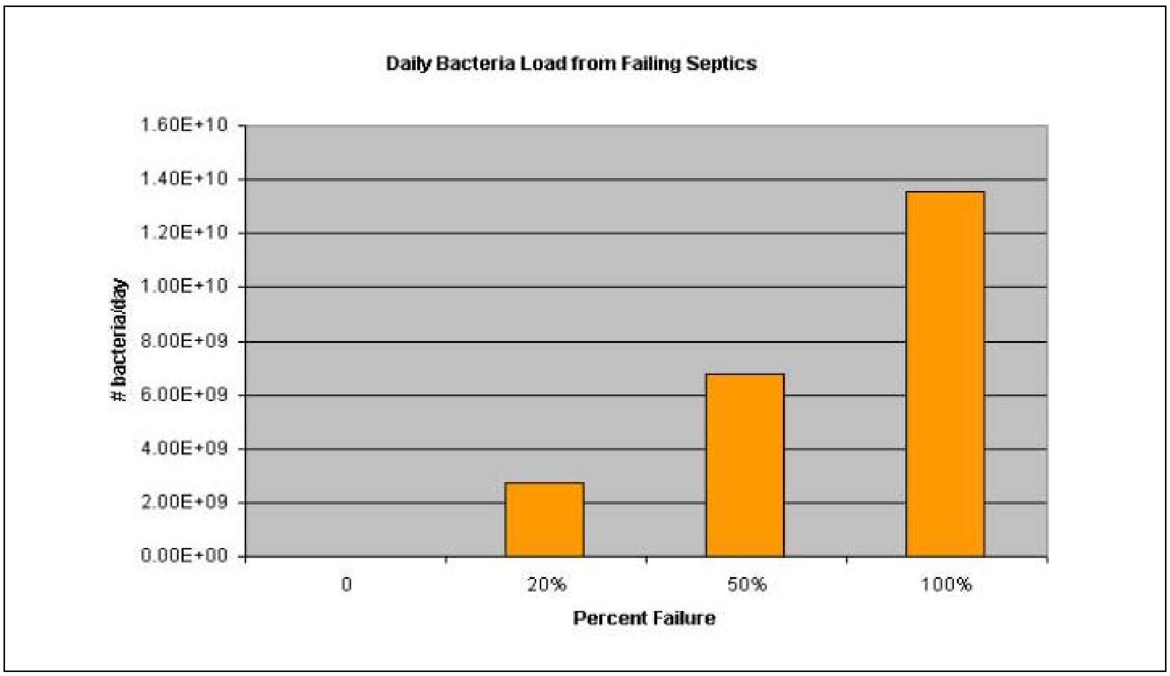


Figure 5.3 Estimated Septic Loading Relative to Failure Rate

Wildlife

Fecal coliform bacteria are found in natural areas due to the presence of wild animal sources such as beaver, raccoon, waterfowl, etc. The irrigation canals and drains of the arid Palo Verde Valley provide an ideal haven for many types of wildlife including migratory and non-migratory birds, beaver, and muskrat. Wildlife directly contact the surface water and therefore directly contribute fecal matter and bacteria to the water in the drains and canals in Palo Verde.

Population estimates for various birds in Palo Verde Valley are not directly available. Anecdotal evidence from Palo Verde Irrigation District indicates they are plentiful along the drains, with potentially several hundred birds per mile nesting in bushes and vegetation along channels in the Outfall System. Table 5.6 provides migratory bird estimates for the Cibola Wildlife Refuge located at the terminus of the Outfall Drain. The birds counted in the refuge most likely also frequent the Outfall Drain System. The Refuge encompasses 16,627 acres and is 12 miles long. Spring and fall months see the greatest variety of bird species, while the winter months typically see the greatest number of bird species.

Table 5.6 Population Data for Migratory Birds in Cibola National Wildlife Refuge

	Dec. 2002	**Jan. 2003**	**Average**
Ducks	5589	4230	4909.5
Geese	4572	10730	7651

Source: Cibola National Wildlife Refuge Aerial Bird Surveys, December 2002 and January 2003

Using information available regarding bird densities in the Cibola Wildlife Refuge, estimates of bird densities were derived for Palo Verde Valley by assuming densities are one half of one percent of those in the refuge. Songbirds were assumed to occur 100 per drain mile. These assumptions are considered to be conservative as the actual number of birds in the Outfall Drain System may be greater considering the close proximity to the wildlife refuge and the anecdotal evidence provided by PVID. Table 5.7 presents estimates of various bird populations in the drainage areas.

Table 5.7 Estimated Number of Birds per Tributary Drain

Model Segment	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	Township	**WestSide**	**Ra/Br**	**Es/SE**	**Norton**	**Lagoon/PVD**	**BorrowPit**	**PVOD**	**Hodges**
Acres of drain area	43261	18531	16220	5405	752	3971	13627	6957	4716
Miles of drain	36	22	18	9	2	7	12	17	12
# Ducks	64	27	24	8	1	6	20	10	7
# Geese	100	43	37	12	2	9	31	16	11
# Songbirds	3622	2186	1832	876	160	710	1186	1690	1236

In addition to migratory songbirds and aquatic birds, Palo Verde irrigation system provides ideal habitat for other animals including beaver and muskrat. Numerous beaver take advantage of the slow moving water in the drains, foraging on vegetation in the drains themselves as well as in the nearby farm fields. Palo Verde Irrigation District has an annual beaver depredation permit from California Department of Fish and Game due to the damage they inflict on the drain system. For trapping purposes, PVID estimates 5 beaver per linear mile of drain. With approximately 120 miles of drains tributary to the Outfall Drain, in addition to the 16 miles of the Outfall Drain itself, this equates to about 679 beaver in the drains of the irrigation system. PVID estimates muskrat to be at least twice as plentiful as beaver. Table 5.8 shows estimated numbers of beaver and muskrat in Palo Verde Valley.

Table 5.8 Estimated Number of Beaver and Muskrat per Tributary Drain

	Drainage Area									
	1	2	3	4	5	6	7	8	9	**TOTAL**
	Township	WestSide	Ra/Br	Es/SE	Norton	Lagoon/PVD	BorrowPit	PVOD	Hodges	**PVValley**
Length of channel (mi)	36.22	21.86	18.32	8.76	1.6	7.1	11.86	16.9	12.36	**134.98**
# Beaver	181.1	109.3	91.6	43.8	8	35.5	59.3	84.5	61.8	**674.9**

# Muskrat	362.2	218.6	183.2	87.6	16	71	118.6	169	123.6	**1349.8**

Given the abundance of wildlife concentrations in and above Palo Verde drains, it is expected that fecal contributions from wildlife comprise a significant proportion of bacteria loading in the entire system. Birds, especially waterfowl have been shown to have very high impacts to water quality, by contributing fecal matter with viable pathogens and high levels of bacteria (Fleming, 2001). Potential for impacts are especially high in areas where birds may be concentrated and on smaller bodies of water where dilution capacity is lower. Typical fecal production rates for ducks and geese are 7.35×10^9 (Virginia Dept. of Environmental Quality, 2002) and 7.99×10^8 (ASAE, 1998) per day respectively.

Songbird fecal bacteria production rates were based on those of chickens--1.36×10^8 per day (ASAE, 1998). Using a value of 0.03 pounds to represent the average body mass of a songbird and 4.9 lbs to represent the average body mass of a layer chicken, the weight ratio of songbird to chicken was determined to be 0.006. The bacteria production rate of chickens was multiplied by this ratio to determine a rate for songbirds (8.16×10^5). Because songbirds nest and roost under bridges over PVOD and in trees that line the banks of the drains, it is thought that songbirds often make direct fecal contributions to the water in the drains. (There are very few trees in arid Palo Verde Valley that are not located along the banks of the agriculture drains or Colorado River).

Beaver and muskrat, being predominantly aquatic in nature, have the potential to adversely impact water quality because fecal contributions are often made directly to the water body in which they live. Due to the high populations of these animals in Palo Verde drain system, they are a major potential source of bacterial loading. Beaver are estimated to contribute 2.0×10^5 bacteria per day, while muskrat are estimated to produce 2.5×10^7 bacteria per day (Virginia Dept. of Environmental Quality, 2002).

C. RELATIVE CONTRIBUTIONS

A version of EPA's fecal coliform loading estimates spreadsheet tool (FCLES) was used to calculate the amount of fecal coliform introduced directly to drains by septic systems and wildlife in the area. The FCLES tool quantifies the fecal coliform bacteria component of waste generated by warm-blooded animals and distributes these quantities to streams and to the land surfaces based on land use type. The tool reflects seasonal trends in grazing animals, and local trends in septic failure rate values based on local population and local septic system information. For purposes of this TMDL, only the direct contribution to streams component of the tool was used. Land accumulation related to sheep grazing was estimated; however, wash-off was not simulated. For calculation purposes, individuals are assumed to be evenly distributed throughout the watershed. Figure 5.4 shows the percentage of estimated loading by category to each tributary drain. These estimates are based on populations listed above and assume a 20 per cent failure rate for septic systems. Table 5.9 provides the percentage loading per source category. Figures 5.5 shows the loading when the septic failures rate is 20 per cent.

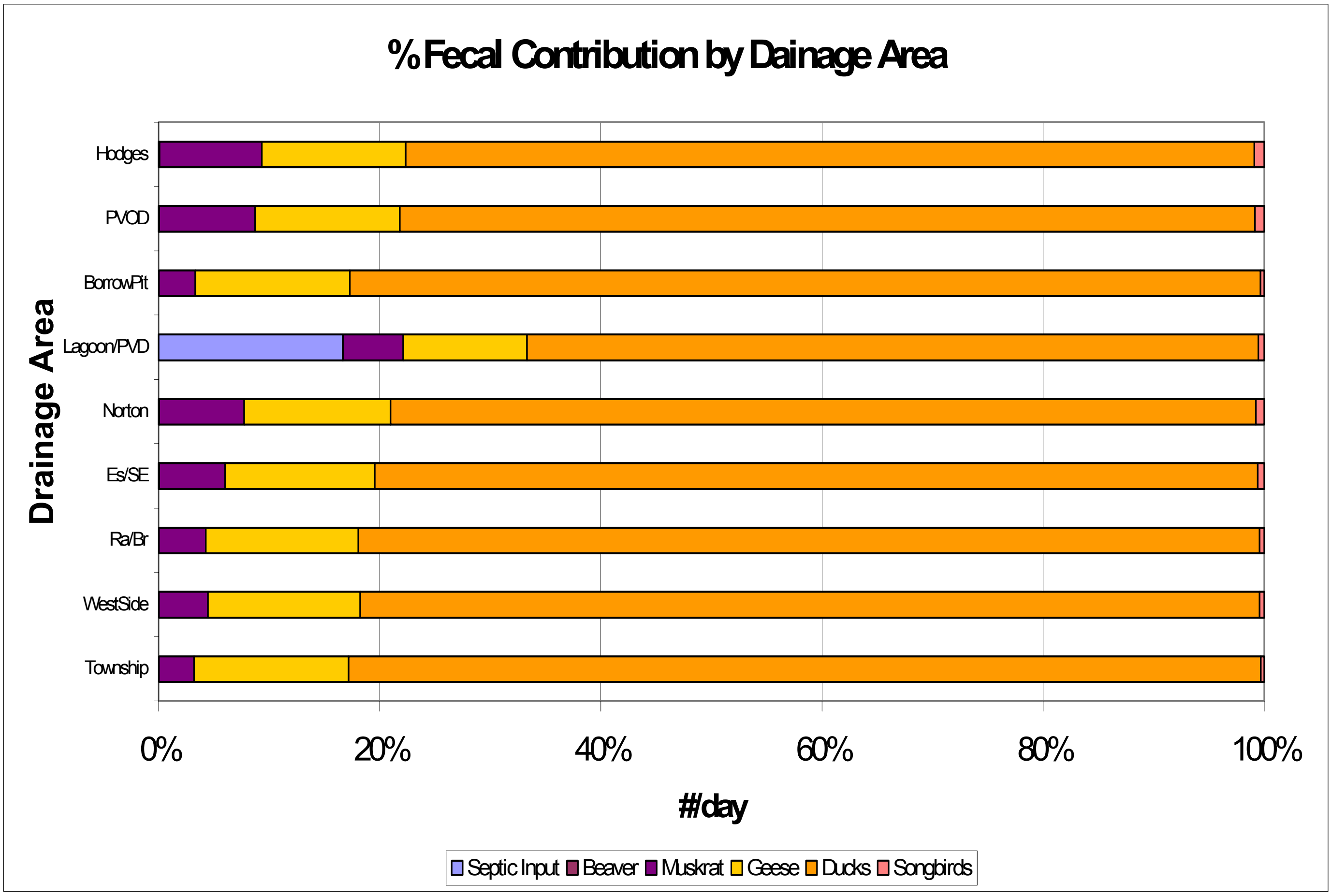


Figure 5.4 Relative Bacteria Contribution to Tributary Drains by Source Category

Table 5.9 Estimated Daily Contribution to Tributary Drains by Source Category

Drain	Septic Fecal Coli rate (#/day)	Beaver Fecal Coli rate (#/day)	Muskrat Fecal Coli rate (#/day)	Geese FecalColi rate (#/day)	Ducks FecalColi rate (#/day)
Township	0.0E+00	3.6E+07	4.5E+09	2.3E+10	1.7E+11
WestSide	0.0E+00	2.2E+07	2.7E+09	1.0E+10	7.4E+10
Ra/Br	0.0E+00	1.8E+07	2.3E+09	8.8E+09	6.5E+10
Es/SE	0.0E+00	8.8E+06	1.1E+09	2.9E+09	2.2E+10
Norton	0.0E+00	1.6E+06	2.0E+08	4.1E+08	3.0E+09
Lagoon/PVD	2.7E+09	1.2E+07	1.5E+09	2.1E+09	1.6E+10
BorrowPit	0.0E+00	7.1E+06	8.9E+08	7.4E+09	5.4E+10
PVOD	0.0E+00	1.7E+07	2.1E+09	3.8E+09	2.8E+10
Hodges	0.0E+00	1.2E+07	1.5E+09	2.5E+09	1.9E+10
Total	2.7E+09	1.3E+08	1.7E+10	6.1E+10	4.5E+11
% of Total	**0.51**	**0.03**	**3.17**	**11.51**	**84.79**

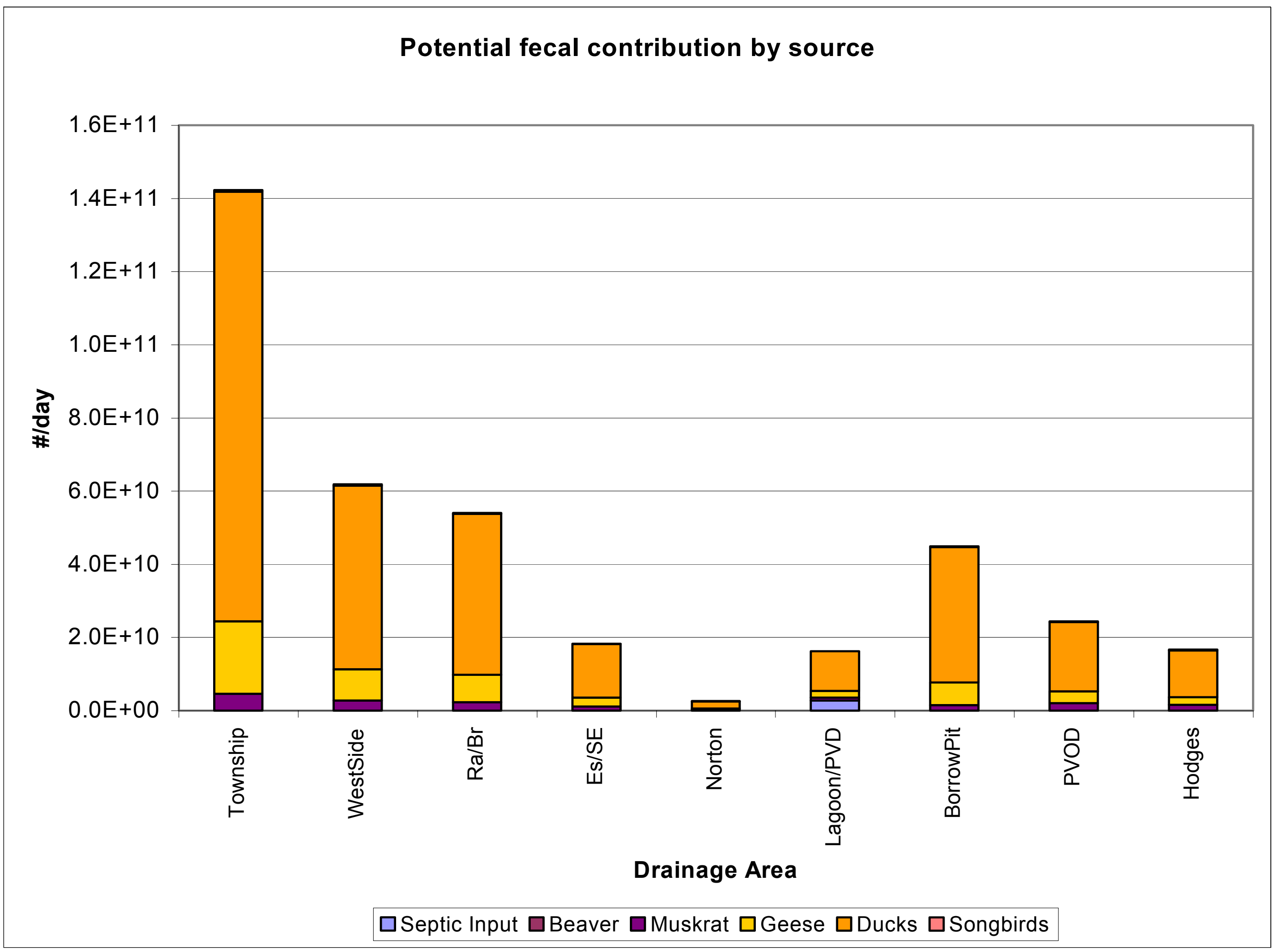


Figure 5.5 Nonpoint Loading by Source (20 per cent Septic Failure Rate)

With an assumed septic system failure rate of 20 per cent, the vast majority of bacteria loading to the entire PVOD appear to originate from waterfowl, with 82.9% coming from ducks and 14 per cent from geese. The next largest input appears to be muskrat (2.3%), followed by septic systems (0.4%), songbirds (0.4%) and beaver (0.02%). Changes in assumed loading rates and/or populations could significantly alter these results.

D. BACTERIA SOURCE TRACKING

The loading estimates provide some insight into possible source loading in Palo Verde Outfall Drain. However, they are based on numerous assumptions regarding septic system failure rates, animal populations in Palo Verde Valley, and bacteria production rates of various animal species. As a result, these estimates are adequate as a general guide in determining the source category breakdown of bacteria loads in PVOD; they are not definitive.

To further investigate the actual sources and the proportion of bacteria they contribute to PVOD, the Regional Water Quality Control Board has commissioned a DNA source tracking study to be completed in 2003-2004. The goal of the study is to assist in determining the sources of inputs by differentiating between the following source categories: human, avian, bovine, canine, and rodent. It is expected that the results of the DNA analysis will help to clarify the source breakdowns determined above. Alternatively, unexpected results may help Regional Board staff to revise assumptions made in the original loading analysis. Any inconsistencies will be further investigated and findings applied to Implementation Phases of the TMDL.

E. MASS BALANCE SPREADSHEET MODEL

To develop necessary load allocations for TMDL development, and to allow for readily incorporating any new data as it is obtained, a mass balance spreadsheet model was created to estimate bacterial concentrations in Palo Verde Outfall Drain (See Appendix A, Model Report). Given the limited availability of water quality observation data, as well as uncertainty regarding sources and behavior of bacteria, Regional Board staff will continue collection of water quality data and development of characterization information. The model was developed so that Regional Board staff can incorporate additional sampling data and loading characterization information.

The mass balance spreadsheet model represents the linkage between source contributions and in-stream response for PVOD and was developed to simulate input and transfer of bacteria in PVOD. The predictive model represents PVOD as a series of plug-flow reactors, each reactor having a constant input of pollutant. A plug-flow reactor can be thought of as an elongated rectangular basin with a constant concentration, in which advection (unidirectional transport) dominates (Figure 5.6). It is assumed to be well mixed both laterally and vertically.

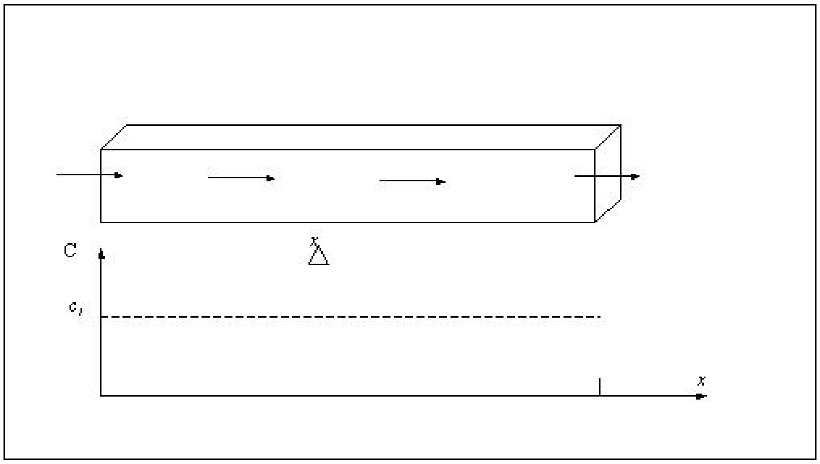


Figure 5.6 Theoretical Plug-flow Reactor

Variations in the longitudinal dimension are what determine any changes in parameters of concern. A "plug" of a substance introduced at one end of the reactor will remain intact as it passes through the reactor. In the case of PVOD, the initial concentration of bacteria can be computed at the injection point; at points further downstream the concentration can be estimated based on first order decay and mass balance. Figure 5.7 shows how the plug-flow reactor concept applies to Palo Verde Outfall Drain.

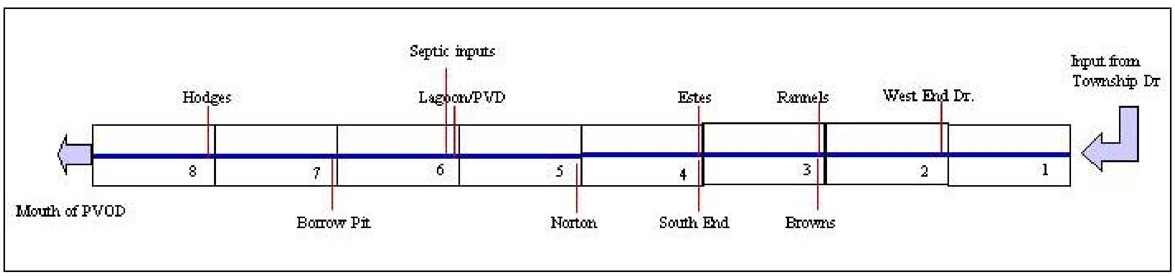


Figure 5.7 Theoretical Plug-Flow Reactor Representation of PVOD with Tributary Drain Inputs

Figure 5.8 depicts the connectivity of drains in Palo Verde Valley and the segmentation of PVOD for modeling purposes. PVOD was segmented at points at which tributaries drain into it. Segment One begins at the mouth of the Township Drain and stretches to the West Side Drain. Segment Two begins at the mouth of the West Side Drain and stretches to the mouth of Rannels Drain, and so on. Two segments (Segments three and four) have two tributaries flowing into them. Segment Six, representing the Lagoon, incorporates Palo Verde Drain, the Lagoon and simulated septic input to the Lagoon. Bacteria concentrations in each segment are calculated using water quality observation data, a first order decay rate, basic channel geometry, and flow. The method assumes water quality observation data are "representative" of existing water quality. As additional data are collected it is possible to plug newly collected tributary flow and concentration observations into the model to obtain an increasingly accurate picture of existing concentrations.

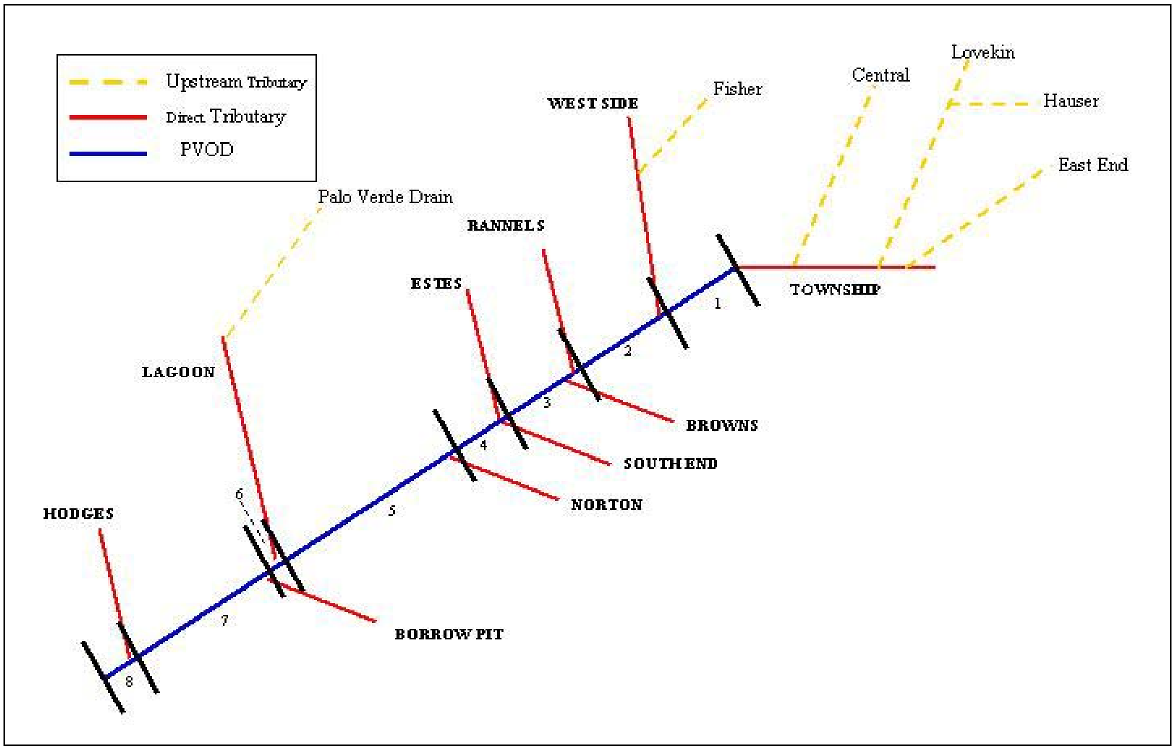


Figure 5.8 Schematic of Tributary Drains to Palo Verde Outfall Drain and Model Segments (not to scale)

Model Results

Model results show that by reducing concentrations entering PVOD through tributary drains, water quality objectives within the Outfall Drain can be met. The model predicts bacteria concentrations in the mainstem of PVOD. Actual data are limited so the model was run for several scenarios in an effort to simulate the most critical concentration/flow combinations (Table 5.10). See Appendix B for all six tested model scenarios. Model results will be confirmed through trend monitoring during the Implementation Phase.

Table 5.10 Various Flow/Concentration Scenarios Tested

Scenario	Concentrations	Flow (cfs)
Calibration	July 2002	Average July flow 2002 (569 cfs)
1	Avg. of all samples per station	Minimum flow (210 cfs)
2	Avg. of all samples per station	Average flow-- (536 cfs)
3	Avg. of all samples per station	Maximum flow (1200 cfs)
4	June 2002 Samples	Minimum measured June flow (426 cfs)
5	JULY 2002 SAMPLES	Minimum measured July flow (444 cfs)
6	August 2002 Samples	Minimum measured August flow (456 cfs)

Since the most comprehensive sampling (for modeling purposes) occurred during June, July, and August 2002, samples taken during that time were used in three of the scenarios. The advantage is since sampling occurred more or less during the same time frame, and the model is a steady state model, the model predictions are expected to be more accurate for those three scenarios. Because the samples only reflect three months they do not represent the extreme conditions that are possible in the watershed. Estimates of loading and subsequent reductions based on the three scenarios using only the 2002 data will most likely not be sensitive enough to make regulatory decisions.

Three additional scenarios were tested using averages of all samples taken at a given location. This has the advantage of being able to evaluate extreme conditions. It is more difficult to pair a concentration with an accurate corresponding flow rate since by definition the average value represents samples that were taken under varying flow conditions. Section 8, TMDL Allocations, shows predicted bacterial concentrations for the selected modeling scenario.

Model results are adequate for predicting in stream concentrations based on known tributary water quality and for determining the relative reduction of tributary concentrations needed to meet water quality objectives in PVOD. The model cannot predict which particular sources should be reduced in order to meet objectives. To understand the relative importance of particular sources to the overall concentrations in PVOD, a source loading analysis was conducted. Source contributions as predicted by the loading analysis indicate that the majority of loading to PVOD is from wildlife (approximately 97.5% from birds, 2.5% from aquatic mammals).

6. CRITICAL CONDITIONS/ SEASONALITY

Palo Verde Valley is located in an arid climate, with hot summers and warm winters. The water in the canal system is diverted from the Colorado River to provide crop irrigation. Irrigation activities are less frequent during the winter months when temperatures and evapotranspiration are lowest; therefore less water is diverted into the canals and flows are lowest during the winter months.

Because contributing sources are assumed to be constant, critical conditions for bacteria loading in the area are assumed to occur during the winter low-flow periods. For this reason, the predictive model was set up to represent flows and water depths that are typical of the lowest flow conditions experienced with respect to the time period in which input concentrations were obtained. Certain high flow scenarios were also simulated for comparison purposes. To represent critical flow conditions, various return flows as measured at the USGS flow gage 09429220 south of Palo Verde Lagoon were used. Source loading analyses were performed using estimates representative of the critical period. For example, wildlife populations are estimated based on winter (January) populations. While it is assumed that the critical period for loading occurs during low flow conditions, monitoring data indicate violations of criteria throughout the year. Given that the sources of bacteria are mostly wildlife, these violations are likely the result of localized loading.

The goal of this TMDL is to determine the assimilative capacity of PVOD and to identify potential allocation scenarios that enable this water body to achieve water quality criteria. The critical condition is the set of environmental conditions for which controls designed to protect water quality will ensure attainment of objectives for all other conditions. This is typically the period of time in which the stream exhibits the most vulnerability.

Review of the available data show year-round violations of bacteria objectives in all areas of PVOD. Flow data was not collected in conjunction with water quality observations. Given the assumption that loading to PVOD is likely the result of contributions from septic systems and wildlife, both relatively constant in nature, it is assumed that critical loading conditions are likely to occur during low flow periods. Low flows in Palo Verde Irrigation system coincide with winter months, January and February in particular, when less water is diverted into the system for irrigation.

7. LINKAGE ANALYSIS

The linkage analysis involves establishing the connection between pollutant load allocations and the protection of beneficial uses. Such information is useful in evaluating the degree and duration of required effort, including mitigation options, to achieve WQOs. For this TMDL, the connection is established on the fact that the Numeric Target and allocations are equal to the water quality objectives of the TMDL. The Numeric Target is protective of all the beneficial uses.

There is a one-to-one relationship between load allocations and numeric targets in this TMDL. For example, a 30-day geometric mean wasteload/load allocation of 200 MPN/100 ml for fecal coliforms at the point of discharge guarantees 200 MPN/100 ml or less in Palo Verde Outfall Drain. The potential for increased concentration downstream due to growth and decay dynamics should be offset by the dilution that occurs in the outfall drain due to agricultural return and base flows.

8. TMDL ALLOCATIONS

A total maximum daily load (TMDL) for a given pollutant and water body is comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for both nonpoint sources and natural background levels. The TMDL must include a margin of safety (MOS), either implicitly or explicitly, to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is represented by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The TMDL is the total amount of pollutant that can be assimilated by the receiving water body while still achieving water quality standards. In TMDL development, allowable loadings from all pollutant sources that cumulatively amount to no more than the TMDL must be established and thereby provide the basis to establish water quality-based controls. For some pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For bacteria, however, TMDLs can be expressed in terms of organism counts (or resulting concentration), in accordance with 40 CFR 130.2(i). Consequently, this TMDL established the existing Basin Plan density-based bacterial objectives as the WLAs for point sources and LAs for nonpoint sources

Discharges from all current and future point sources and nonpoint sources of pollution shall not exceed the following waste load allocations and load allocations, respectively:

Table 8.1 WLAs and LAs

Indicator Parameter	30-Day Geometric Mean	30-Day Log Mean[a]	Maximum
E. coli	126 MPN[b]/100 ml	--	400 MPN/100 ml
Enterococci	33 MPN/100 ml	--	100 MPN/100 ml
Fecal Coliform	--	200 MPN/100ml	c

a. Based on a minimum of no less than 5 samples equally spaced over a 30-day period.
b. Most probable number.
c. No more than 10% of total samples during any 30-day period shall exceed 400 MPN/100 ml.

The allocations are applicable throughout the entire stretch of Palo Verde Agricultural Drain. The numeric target concentrations are based on extensive epidemiological studies conducted by the USEPA and others. By setting the load and waste load allocations equal to the standards, the TMDL approach limits uncertainty about whether attainment of the TMDL and individual allocations will result in attainment of the applicable numeric standards. The TMDL analysis takes a conservative approach in providing load and waste load allocations, even for relatively minor loading sources, which helps ensure the likelihood that the selected source control approach will result in attainment of the numeric objectives. To address uncertainty concerning the bacterial die-off and re-growth dynamics in the Outfall Drain, the TMDL provides a margin of safety by including an aggressive monitoring and review plan which ensures that necessary data are collected and that the TMDL will be reevaluated during Implementation, if necessary.

A. PROPOSED ALLOCATIONS

Based on the source assessment for PVOD, bacterial concentrations originate solely from nonpoint sources. There are no point sources contributing bacteria to PVOD with the possible exception of waste piped illegally from residences to the Lagoon. However, as this TMDL is density-based, the effluent from any future point sources and dischargers are required to meet the bacteriological water quality objectives. If a NPDES permit is issued for a discharger to PVOD, the permit will require the discharger to take necessary actions to ensure compliance with their NPDES permit. The existing WWTPs in Palo Verde Valley discharge to percolation basins, not PVOD and therefore do not have NPDES permits. It is assumed that any future WWTPs in the valley will discharge effluent in the same manner and therefore not be considered a point source discharge.

According to the mass balance spreadsheet model, and assuming 20% septic system failure rate in the community of Palo Verde, the majority of bacteria contributions to PVOD originate from waterfowl, with 82.9% coming from ducks and 14% from geese. The next largest input appears to be muskrat (2.3%), followed by septic systems (0.4%), songbirds (0.4%) and beaver (0.02%). Changes in loading rates and/or populations could significantly alter these results.

B. MARGIN OF SAFETY (MOS)

This TMDL applies an implicit margin of safety through the use of conservative assumptions throughout the modeling process. Such assumptions include using average annual flow for the modeled flow, assuming a 20 per cent septic failure rate, and making conservative assumptions about the proportion of wildlife directly contributing to the drains. By requiring instream water quality to always meet the numeric water quality objectives of 126 counts/100 mL for E. coli, and of 33 counts/100 mL for enterococcus, the TMDL incorporates an additional margin of safety.

9. IMPLEMENTATION PLAN

A. INTRODUCTION

Nonpoint sources are the primary contributors to the bacterial load in Palo Verde Outfall Drain. California controls nonpoint source pollution as specified in the State's "*Plan For California's Nonpoint Source Pollution Control Program*.

B. DESCRIPTION OF PHASED IMPLEMENTATION PLAN

The implementation plan specifies: (1) required actions for responsible parties, and recommended actions for other agencies/organizations; (2) time schedules for actions to be taken; and (3) monitoring and surveillance to be undertaken to determine progress toward attaining deadlines and milestones. The CEQA Checklist and Discussion of Environmental Impacts along with the Natural Environment Study assesses potential environmental impacts of the proposed Basin Plan amendment. The implementation plan, as proposed, identifies the means for TMDL compliance, evaluates economic impacts of TMDL implementation, and identifies potential funding sources for pollution control, pursuant to CWC § 13141 and § 13241.

Spill Pipe, Township Drain

Following USEPA approval, the proposed implementation plan will be in two phases. Phase I consists of actions to be accomplished between 2004 and 2007. Phase I relies on controlling point sources of bacteria to Palo Verde Outfall Drain via voluntary management practices and regulatory compliance with regulations the State Board adopts pursuant to CWC §13291. Phase I also depends on any existing or future point source contributors to comply with the requirements of their NPDES permits.

If water quality targets are not achieved upon conclusion of Phase I in 2007, Phase II actions will begin and the time schedule for implementation will be revised. The phased approach allows for immediate control of major sources while allowing time for monitoring to provide an analytical basis for Phase II planning. Phase II requires further assessment of bacterial contributions from sources not addressed in Phase I and determines the development of implementation actions to control these sources. Phase II will be completed by 2014. In Phase II, plans for a wastewater treatment plant in the community of Palo Verde may be introduced as a method for managing bacteria in Palo Verde Outfall Drain.

C. PHASE I IMPLEMENTATION ACTIONS

Implementation Actions include both voluntary actions and those already required under existing or anticipated regulatory requirements. Voluntary actions will be taken by a variety of implementing parties, while the required actions are to be taken by identified responsible parties.

Phase I Implementation Actions

Implementation Actions in this TMDL include both voluntary actions and those already required under existing or anticipated regulatory requirements. Voluntary actions will be taken by a variety of implementing parties, while the required actions are to be taken by identified responsible parties.

a. Septic System Maintenance and Education

Inform property owners that maintaining septic systems is their personal responsibility and imperative to public health. Public outreach and education on this subject is the responsibility of Riverside and Imperial County Health Departments (Riverside County Ordinance No. 650.4,1988; Imperial County Code Section 91012.00-91012.10; CRWQCB Board Guidelines for Sewage Disposal from Land Developments).

b. Septic System Maintenance Plan

The Regional and State Water Boards, with the cooperation of Riverside and Imperial Counties, will create a plan for the location identification and maintenance of septic systems based on CWC 13291. The Regional Board's existing waiver of waste discharge requirements will end on June 30, 2004. At that time, the Regional Board may adopt a new waiver policy consistent with State Board septic system regulations adopted in accordance with CWC 13291. Alternatively, the Regional Board may consider entering Memoranda of Understanding (MOUs) with the counties for enforcement of septic system requirements, or begin taking enforcement action against individuals who are discharging illegally.

c. DNA Source Tracking Study

Staff will analyze results of on-going DNA source tracking study which will be completed in 2004.

d. Quality Assurance Project Plan and Monitoring Plan

Staff will develop a monitoring plan & Quality Assurance Project Plan (QAPP) within 180 days of USEPA approval.

e. Implementation Tracking Plan

Staff will track activities implemented by dischargers and responsible parties and surveillance conducted for Palo Verde Bacterial Indicators TMDL pursuant to an implementation tracking plan (ITP). The ITP will be developed within 180 days following USEPA approval of the TMDL. The Regional Board's Executive Officer shall approve the ITP after determining that the ITP satisfies the objectives and requirements of this Section. The objectives of Regional Board Surveillance and implementation tracking are:

- Assess/track/account for practices already in place;
- Measure the attainment of Milestones;
- Determine compliance with NPDES permits, WLAs, and LAs; and

Report progress toward implementation of NPS water quality control, in accordance with the SWRCB NPS Program Plan (PROSIP).

Table 9.1 Phase I Actions

PRACTICE	ACTION	SCHEDULE	IMPLEMENTING PARTIES
Septic system inspection and	Inspection and approval of septic	2004-Ongoing	County Health Departments

maintenance education	systems. Educate public on proper maintenance of septic systems		
Septic system maintenance/ upgrade	Inspect and maintain all septic systems in watershed per AB 885	2004-Ongoing	Riverside County, Imperial County
Source tracking	Staff will analyze DNA Source tracking study	2004	Regional Water Quality Control Board
QAPP	Staff will develop a QAPP and Monitoring Plan	180 days after USEPA approval	Regional Water Quality Control Board
Implementation Tracking Plan	Staff will develop a Implementation Tracking Plan	180 days after USEPA approval	Regional Water Quality Control Board

D. PHASE II IMPLEMENTATION ACTIONS

If water quality targets are not achieved upon conclusion of Phase I on December 31, 2007, Phase II actions will begin and the time schedule for implementation will be revised. The phased approach allows for immediate control of major sources while allowing time for monitoring to provide an analytical basis for Phase II planning. Phase II requires Regional Board staff to do the following:

a. Bacterial Source Contribution
Regional Board staff will conduct further assessment of bacterial contributions from sources not addressed in Phase I.

b. Source Control Implementation Plan
Regional Board staff will develop implementation actions to control these sources by 2008.

c. Wastewater Treatment Plan
If the pathogen problem persists, stakeholders may introduce plans for a wastewater treatment plant in the community of Palo Verde as a method for managing pathogens in Palo Verde Outfall Drain.

d. Site Specific Objective/ Use Attainability Analysis
A revision of Water Quality Objectives for Palo Verde Outfall Drain and Lagoon, such as a Site Specific Objective or Use Attainability Analysis will be considered for addressing natural background sources of bacterial by December 31, 2008.

Table 9.2 Phase II Actions

PRACTICE	ACTION	SCHEDULE	IMPLEMENTING PARTIES
Bacterial source Contribution	Assessment of bacterial contributions from sources not addressed in Phase I	2004-Ongoing	Regional Water Quality Control Board
Source Control Implementation Plan	Development of implementation actions to control the sources identified in assessment of	2008	Regional Water Quality Control Board

	bacterial contributions above.		
Wastewater Treatment Plan	Development of a plan for a wastewater treatment plant in the community of Palo Verde	2010	Palo Verde Stakeholders
Designation Revision	Regional Board consideration of a UAA and/or Site Specific Objective for addressing natural background sources of bacteria.	2008	Regional Water Quality Control Board

E. CONDITIONAL PROHIBITION

A conditional prohibition of discharge of bacterial indicator organisms is established in the Basin Plan amendment for Palo Verde Outfall Drain and its tributaries in Palo Verde Valley. The direct or indirect discharge of bacterial indicator organisms to the Palo Verde Outfall Drain and its tributaries is prohibited, unless:

1. The Discharger is:

   a. In compliance with applicable TMDL(s), including implementation provisions; or

   b. Has a monitoring and surveillance program approved by the Executive Officer that demonstrates that discharges of bacterial indicator organisms into the Palo Verde Outfall Drain do not violate or contribute to a violation of the TMDL(s), the anti-degradation policy (State Board Resolution No. 68-16) or WQOs;

   c. Is Covered by Waste Discharge Requirements (WDRs) or a Waiver of WDRs that applies to the discharge; or

   d. Demonstrates compliance with county sewage disposal ordinances.

Individual Dischargers must file a Report of Waste Discharge for general or individual Waste Discharge Requirements. Compliance with the conditional prohibition will be determined with respect to each individual Discharger. The intent of this conditional prohibition is to control, to the degree practicable, bacterial indicator organism discharges in irrigated agriculture runoff water, from publicly owned waste treatment facilities, or from privately owned waste treatment systems in amounts that violate or contribute to a violation of state water quality standards.

F. EXISTING ACTIONS THAT PREVENT BACTERIAL LOADING

1. Ripley Wastewater Treatment Facility (WWTF) Waste Discharge Requirement

Ripley WWTF is currently meeting regulations set forth to control the quality of its discharge. The facility disposes of a maximum of 35,000 gallons per day of domestic sewage to four infiltration basins. Any discharge from the underground tile drainage system beneath the infiltration basins flows to Township Drain, a tributary drain to Palo Verde Outfall Drain. No observed flow to Township Drain has been observed to date. A sample for total coliform and fecal coliform analysis shall be taken at the first observance of flow into Township Drain from the underground tile drainage system.

Ripley WWTF and Township Drain

<u>2.City of Blythe Municipal Wastewater Treatment Plant (WWTP) Waste Discharge Requirement</u>

City of Blythe WWTP is in compliance with regulations controlling the quality of its discharge. The plant disposes of an average of 2.4 MGD into twelve evaporation/percolation ponds and eight sludge beds. Fecal coliform is analyzed for the annual sludge monitoring report.

G. ON-GOING REGIONAL BOARD STAFF WORK

Regional Board staff is conducting a bacteria source tracking study as part of the TMDL Source Analysis. Unexpected results may help staff to revise assumptions made in the original loading analysis. Any inconsistencies will be further investigated and findings applied to Implementation Phases of the TMDL.

Additionally, a Site Specific Objective (SSO) will be considered for addressing natural background sources of bacteria in Palo Verde Outfall Drain and Lagoon by December 31, 2008.

H. TIME SCHEDULE

Regional Board staff estimate a timeframe of ten years to achieve control of bacteria loading in Palo Verde Outfall Drain. The limiting factor on this timeframe is upgrading septic systems in the community of Palo Verde or the subsequent installation of a wastewater treatment plant. All other actions (public outreach and education, implementing management practices) should be in place within ten years. Table 9.4 shows an implementation compliance schedule.

Additionally, a revision of Water Quality Objectives for Palo Verde Outfall Drain and Lagoon, such as a Use Attainability Analysis (UAA) and/or a Site Specific Objective (SSO), will be considered for addressing natural background sources of bacteria by December 31, 2008.

Compliance is achieved initially by demonstrating through reporting mechanisms that implementation measures have been undertaken, and by consequently meeting numeric targets as illustrated through water quality monitoring.

At end of:	IMPLEMENTATION MILESTONE	Monitoring Activity
2004	• Initiate Phase I • RWQCB coordinates with the communities of Palo Verde and Ripley and the counties on public outreach and education topics • RWQCB coordinates with counties on monitoring of septic system maintenance in accordance with AB 885 • Consider revising Water Quality Objectives • Evaluate data collected over the year	fecal coliform E. coli, enterococci, fecal streptococci ↓
2005	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2006	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2007	• Evaluate data collected over the year • Evaluate progress on implementation actions • RWQCB, in coordination with the counties, evaluates the quality of septic systems in the community of Palo Verde • Initiate Phase II, adjust implementation time schedule • RWQCB discusses with stakeholders (community members, BECC, etc.) the option of installing a sewer system and WWTP in Palo Verde	
2008	• Evaluate data collected over the year • Evaluate progress on implementation actions • Revision to Water Quality Objectives must be completed	
2009	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2010	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2011	• Evaluate data collected over the year • Evaluate progress on implementation actions	
2012	• Evaluate data collected over the year • Evaluate progress on implementation actions • RWQCB and stakeholders meet to evaluate TMDL compliance and further actions to be taken	
2013	Load Reductions and Numeric Targets achieved	

Table 9.4 Estimated Implementation Compliance Schedule for the Palo Verde Bacterial Indicators TMDL

10. ECONOMIC ANALYSIS

There are no initial economic impacts as a result of implementing this TMDL (see Attachment 1). Depending on how successful Phase I is in reducing bacterial discharges, subsequent MPs may have significant costs. Phase I has required voluntary implementation actions that will be conducted and evaluated through the year 2007. If water quality goals are not achieved, Phase II will include another assessment of bacterial discharges and subsequent development of additional MPs.

A. PHASE I REQUIRED IMPLEMENTATION ACTIONS

Inspecting and maintaining septic systems is required under this TMDL. Upgrading and maintaining existing septic systems is also mandated under AB 885. Since this is a condition of a septic system permit, the cost of requiring it cannot be attributed to AB 885 or the TMDL being considered.

B. PHASE I VOLUNTARY IMPLEMENTATION ACTIONS

Two practices were considered under this category: septic system maintenance public education and reduction of agriculture runoff.

1. Septic System Maintenance Public Education

Educating septic system owners on proper operation and maintenance is the responsibility of the county agency that issues septic system permits. Insuring that septic systems are being operating according to the permit is also the responsibility of the issuing agency. The cost of these actions is normally included in the cost of the permit. Therefore these costs should not be attributed to this TMDL.

2. Reduction of Agriculture Runoff

Nine agricultural runoff MPs that control surface water runoff were considered for voluntary implementation. Four of the practices directly control bacteria runoff and the remaining five practices are more generally applied in situations to reduce silt or sediment loss from tilling and irrigation activities. Since these activities are voluntary, growers will not implement them unless they expect to benefit either financially or as a public service. Therefore the costs of implementing this section is not attributable to this TMDL.

C. PHASE II

Phase II will be implemented if Phase I water quality goals are not achieved by the year 2007. It is difficult to assess the economic impacts of this section of the TMDL because it is conditional on what the water quality is four years from now. What additional MPs or other measures will be implemented at that time will depend on the re-assessment of bacterial sources contributing to the problem. If needed, an economic analysis can be conducted at that time.

11. MONITORING PLAN

The primary measures of success for implementation of the TMDL are attainment of the numeric targets. Regional Board staff will conduct quarterly water quality monitoring of bacteria to assess the attainment of numeric targets. Staff will also conduct yearly surveillance and tracking of implementation actions such as MPs and public education. All monitoring and data management described in this section is contingent upon the availability of funding.

A. MONITORING FOR REFINEMENT OF SOURCE ANALYSIS AND TMDL IMPLEMENTATON

Trend monitoring will document progress toward achieving the desired water quality conditions. It is important to track TMDL implementation, monitor water quality progress, modify TMDLs, and implementation plans as necessary to:

- Address uncertainty that may exist in aspects of TMDL development;
- Track actions of the TMDL Implementation Plan to ensure that implementation is being carried out; and
- Ensure that the TMDL remains effective, given changes that may occur in the watershed after TMDL development.

Staff will implement two types of trend monitoring: (1) quarterly water quality monitoring, and (2) surveillance and implementation tracking. Both are discussed further in the sections below.

1. Water Quality Monitoring

Palo Verde Bacterial Indicator TMDL Monitoring Program will monitor pathogen indicator organisms, pursuant to the Regional Board Quality Assurance Project Plan for Sampling Pathogen Indicators in Palo Verde Outfall Drain (QAPP). Monitoring will characterize pathogen indicator organisms and track compliance with numeric targets. Monitoring Program objectives include:

- assessment of water quality standards attainment;
- verification of pollution source allocations;
- calibration or modification of selected models (if any);
- evaluation of point and nonpoint source control implementation and effectiveness;
- evaluation of in-stream water quality; and
- evaluation of temporal and spatial trends in water quality.

Quarterly grab samples from sampling stations will be collected and analyzed for the following parameters:

- Fecal coliform organisms
- *E. coli*
- Fecal streptococci
- Enterococci
- Physical parameters (i.e. temperature, pH, dissolved oxygen)

Additionally, WWTP discharges will continue to be monitored for fecal coliform and/or *E. coli* bacteria as part of their NPDES permits. Enterococci monitoring will be required when tests become commercially available in the Region.

2. Surveillance and Tracking

Yearly assessments will be made to the Regional Board by staff on the progress of the actions set forth in the TMDL Implementation Plan. Staff will coordinate with public and private entities in order to ensure likely success of the TMDL Implementation Plan in accordance with the Implementation Compliance Schedule milestones. Yearly reports to the Regional Board staff will include:

- Water quality improvements in terms of pathogen indicator organisms
- If milestones are being met according to the Implementation Compliance Schedule
- What changes, if any, need to be made to the Implementation Compliance Schedule and why

B. DATA MANAGEMENT

Staff will compile Implementation Action Assessments and QA/QC validated monitoring data into an organized spreadsheet. The spreadsheet will be updated quarterly in order to maintain a current public record. The public record will be posted on the Region's website and stored in a Palo Verde Bacterial Indicator Implementation Monitoring File. Staff will evaluate the data to determine when numeric targets are attained.

12. REFERENCES

American Society of Agricultural Engineers. 1998. *ASAE Standards 1998: Standards Engineering Practices Data.* 45th edition. American Society of Agricultural Engineers, St. Joseph, Michigan.

Auer, M.T. and S.L. Niehaus. 1992. Modeling fecal coliform bacteria—I. Field and laboratory determination of loss kinetics. *Water Resources* 27(4): 693-701.

California Department of Health Services. February 1987. Wastewater Disinfection for Health Protection, Sanitary Engineering Branch

California Regional Water Quality Control Board. 2002. Quality Assurance Project Plan for Sampling Pathogen Indicators in Palo Verde Outfall Drain. Colorado River Basin Regional Water Quality Control Board. Palm Desert, CA.

California Regional Water Quality Control Board. As amended to date. Water Quality Control Plan, Colorado River Basin – Region 7. Colorado River Basin Regional Water Quality Control Board. Palm Desert, CA.

California Regional Water Quality Control Board. Guidelines for Sewage Disposal From Land Developments.

Crane, S.R., and J.A. Moore. 1985. Modeling enteric bacterial die-off: A Review. Journal Paper No. 6699. Oregon Agricultural Experiment Station, Corvallis.

Easton, John H., M. Lalor, J. Gauthier, and R. Pitt. 2001. Pathogen Decay in Urban Streams. Submitted. *Journal of the American Waterworks Association.*

Fleming, R. and H. Fraser. 2001. The Impact of Waterfowl on Water Quality: Literature Review. Ridgetown College, University of Guelph.

Hanson, J.H. and P.A. Gruenberg. 1975. Investigation of the Physical, Chemical, and Biological Characteristics of Agricultural return waters in the Imperial and Palo Verde Valleys Winter 1974-75. California Regional Water Quality Control Board Colorado River Basin Region. Palm Desert, CA.

Heath, Ross. 2003. Personal Communication. Riverside County Animal Control, Town Master for the City of Blythe. Blythe, CA.

Horsley and Witten. 1996. Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, Brunswick and Freeport, Maine. Final Report. Casco Bay Estuary Project, Portland, Maine.

Howell, J.M., M.S. Coyne, and P.L. Cornelius. 1996. Effect of sediment particle size and temperature on fecal bacteria mortality rates and the fecal coliform/fecal streptococci ratio. *Journal of Environmental Quality* 25:1216-1220.

Imperial County Code, Chapter 12, Section 91012.00-91012.10.

Johnson, Mark. 2003. Personal Communication. Imperial County Health Department.

Novotny, V., and H. Olem. 1994. Water Quality: Prevention, Identification, and Management of Diffuse Pollution. Van Nostrand Reinhold, New York.

Palo Verde Irrigation District. 1980. Status Report, March 1980. Palo Verde Irrigation District Unit. Blythe, CA.

Palo Verde Irrigation District. 2002. PVID Land Management, Crop Rotation and Water Supply Program Draft EIR CD ROM

Rethwisch. 2003. Personal Communication. University of California Cooperative Extension, Blythe. Blythe, CA.

Riverside County Ordinance No. 650.4. The Board of Supervisors of the County of Riverside. 1988.

Tetra Tech, Inc. January 2003. Draft Total Maximum Daily Load Development for the Rabon Creek Watershed, SC. Prepared for EPA Region 4 and South Carolina Department of Health and Environmental Control. Fairfax, Virginia.

Tetra Tech, Inc. March 2003. Draft Source Analysis, Load Assessment, and Loading Allocations for Palo Verde Outfall Drain Bacteria TMDL. Prepared for California Regional Water quality control Board, Region 7 Colorado River Basin. Fairfax, Virginia.

USDA Soil Conservation Service. 1974. Soil Survey of Palo Verde Area, California. U.S. Government Printing Office, Washington D.C.

United States Environmental Protection Agency. 1985. Rates, Constants, and Kinetics Formulations in Surface Water Quality Modeling. Second Edition. EPA/600/3-85/040. June 1985.

United States Environmental Protection Agency. January 1986. Ambient Water Quality Criteria for Bacteria. EPA 440/5-84-002. USEPA, Washington, D.C.

United States Environmental Protection Agency. May 1986. Quality Criteria for Water. EPA 440/5-86-001. USEPA, Washington, D.C.

United States Environmental Protection Agency. September 1988. Water Quality Standards Criteria Summaries: A Compilation of State/Federal Criteria. EPA 440/5-88-007. USEPA, Washington, D.C.

United States Environmental Protection Agency. May 1998. Bacterial Water Quality Standards Status Report. EPA-823-R-98-003. USEPA, Washington, D.C.

United States Fish and Wildlife Service. 2003. Cibola National Wildlife Refuge. http://southwest.fws.gov/refuges/arizona/cibola.html

Virginia Department of Environmental Quality. 2002. Fecal coliform bacteria TMDL for Blacks Run, Rockingham County, Virginia. In press. Richmond, VA.

APPENDIX A

MASS BALANCE SPREADSHEET MODEL

Excerpt of Draft Source Analysis, Load Assessment, and Loading Allocations for Palo Verde Outfall Drain Bacteria TMDL

Prepared by: Tetra Tech, Inc.
March, 2003

A. MODEL SELECTION

In selecting an appropriate modeling platform for TMDL development, the following criteria were considered and addressed:

- Technical Criteria
- Regulatory Criteria
- User Criteria

Technical criteria refer to the model's simulation of the physical system in question, including watershed and/or stream characteristics/processes and constituents of interest. Regulatory criteria make up the constraints imposed by regulations, such as water quality standards or procedural protocol. User criteria comprise the operational or economical constraints imposed by the end-user and include factors such as hardware/software compatibility and financial resources. The following discussion details considerations within each of these categories specific to Palo Verde Outfall Drain (PVOD).

B. TECHNICAL CRITERIA

Physical Domain

Representation of the physical domain is perhaps the most important consideration in model selection. The physical domain refers to the focus of the modeling effort - typically either the receiving water itself or a combination of the contributing watershed and the receiving water. Selection of the appropriate modeling domain depends on the constituents of interest and the conditions under which the stream exhibits impairment. For a stream dominated by point source inputs that exhibits impairments under only low-flow conditions, a steady-state approach is typically undertaken. This type of modeling approach focuses only on in-stream (receiving water) processes during a user-specified condition. For streams impacted additionally or solely by nonpoint sources or primarily rainfall-driven flow and pollutant contributions, a dynamic approach is recommended. Dynamic watershed models consider time-variable nonpoint source contributions from a watershed surface or subsurface. Some models consider monthly or seasonal variability while others enable assessment of conditions immediately before, during, and after individual rainfall events. Dynamic models require a substantial amount of information regarding input parameters and data for calibration purposes. It is assumed that PVOD is dominated by nonpoint sources that are generally constant on a daily time step and are depositing directly to drains. While the sources are nonpoint in nature, their behavior in the stream is more like that of a point source.

Source Contributions

Primary sources of pollution to a water body must be considered in the model selection process. Accurately representing contributions from permitted point sources and nonpoint source contributions from urban, agricultural, and natural areas is critical in properly representing the system and ultimately evaluating potential load reduction scenarios.

Available water quality monitoring data are not sufficient to fully characterize all sources of pollution resulting in high bacterial concentrations for PVOD. There are two wastewater treatment facilities in Palo Verde Valley; however, neither is permitted to discharge to surface waters. Palo Verde Valley is located in an arid climate; runoff driven loading is assumed not to be a problem. Land use in the Valley is about 85 per cent crop land. Manure has not been applied to crop fields for the past two years. This time period has included the same period for which water quality data have been collected. It is assumed that manure application is not a component of the source loading to the drains in the irrigation system.

The community of Palo Verde is located directly adjacent to Palo Verde Lagoon and is served entirely by individual septic systems. Wildlife and birds are present in relative abundance in and adjacent to the drains. As a result, the high bacterial concentrations observed in PVOD are likely the result of septic inputs and nonpoint source pollution delivered directly to drains by wildlife and birds. It is most likely not a function of surface and or subsurface buildup and washoff. Additional DNA bacterial source analysis will play a critical role in supporting or contradicting these preliminary conclusions.

Critical Conditions

The goal of the TMDL is to determine the assimilative capacity of a water body and to identify potential allocation scenarios that enable the water body to achieve water quality criteria under all conditions. The critical condition is the set of environmental conditions for which controls designed to protect water quality will ensure attainment of objectives for all other conditions. This is typically the period of time in which the stream exhibits the most vulnerability.

Review of the limited available data show year-round violations of bacteria objectives in all areas of PVOD. Flow data have not been collected in conjunction with water quality observations. Given the assumption that loading to PVOD is likely the result of contributions from septic systems and wildlife, both relatively constant in nature, it is assumed that critical loading conditions are likely to occur during low flow periods. Low flows in Palo Verde Irrigation system coincide with winter months, January and February in particular, when less water is diverted into the system for irrigation.

Constituents

The focus of TMDL development for PVOD is on bacteria. Factors affecting bacterial survival include soil moisture content, pH, solar radiation, and available nutrients. In-stream bacteria dynamics can be extremely complex, and accurate estimation of bacteria concentrations relies on a host of interrelated environmental factors. Bacterial concentrations in the water column are influenced by die-off, re-growth, partitioning of bacteria between water and sediment during transport, settling, and resuspension of bottom materials. First order decay is probably the most important dynamic to simulate in PVOD. The limited available data provide few insights into which of the other factors listed above may be most influential on bacterial behavior in PVOD. Again, additional monitoring will play a critical role in determining for example, whether re-growth or re-suspension of bacteria influence concentrations in PVOD.

C. REGULATORY CRITERIA

A properly designed and applied model provides the source-response linkage component of the TMDL and enables accurate assimilative capacity assessment and allocation distribution. A stream's assimilative capacity is determined through adherence to predefined water quality criteria. The California Regional Water Quality Control Board Water Quality Control Plan for the

Colorado River Basin-Region 7, defines applicable bacteria objectives for PVOD, which is classified as a REC I water body (Table 1.1).

Table 1.1 Numeric Criteria for Bacteria in PVOD

Organism	**REC I**	**REC II**
Geometric mean shall not exceed		
E. coli Enterococci	126 per 100 ml 33 per 100 ml	630 per 100 ml 165 per 100 ml
Instantaneous Maximum Allowable concentrations		
E. coli Enterococci	400 per 100 ml 100 per 100 ml	2000 per 100 ml 500 per 100 ml

*Based on not less than five samples equally spaced over a 30-day period.
**Additionally, for REC I waters, Fecal Coliform concentrations shall not exceed a log mean of 200 MPN per 100 ml, nor shall more than ten percent of total samples during any 30-day period exceed 400 MPN per 100 ml

These criteria are the target for TMDL modeling exercises. Therefore, the modeling platform must enable direct comparison of model results to both geometric mean and instantaneous maximum allowable concentrations.

D. USER CRITERIA

The needs, expectations, and resources of the Region 7 Water Quality Control Board determine user criteria. Modeling software must be compatible with existing Regional Board staff hardware platforms, available software, and due to future use needs for planning and implementation decisions, the model should be well documented. From a resource perspective, the level of effort required to apply and update the model must be commensurate with available staffing and expertise, without compromising the ability to meet technical criteria. In addition to these primary criteria, the required time-frame for model development, application, and completion is important, as well as the level of concern or priority of the impaired stream.

E. MASS BALANCE SPREADSHEET MODEL

To develop necessary load allocations for TMDL development, and to allow for readily incorporating any new data as it is obtained, a mass balance spreadsheet model was created to estimate bacterial concentrations in Palo Verde Outfall Drain. Given the limited availability of water quality observation data, as well as uncertainty regarding sources and behavior of bacteria, it is understood that the Regional Board staff plans continued collection of water quality data and development of characterization information for PVOD to verify the estimations derived from the model. The model was developed so that Regional Board staff may easily incorporate additional sampling data and loading characterization information.

To represent the linkage between source contributions and in-stream response for PVOD, a mass balance spreadsheet model was developed to simulate input and transfer of bacteria in PVOD. The predictive model represents PVOD as a series of plug-flow reactors, each reactor having a constant input of pollutant. A plug-flow reactor can be thought of as an elongated rectangular basin with a constant concentration, in which advection (unidirectional transport) dominates (Figure 1.1).

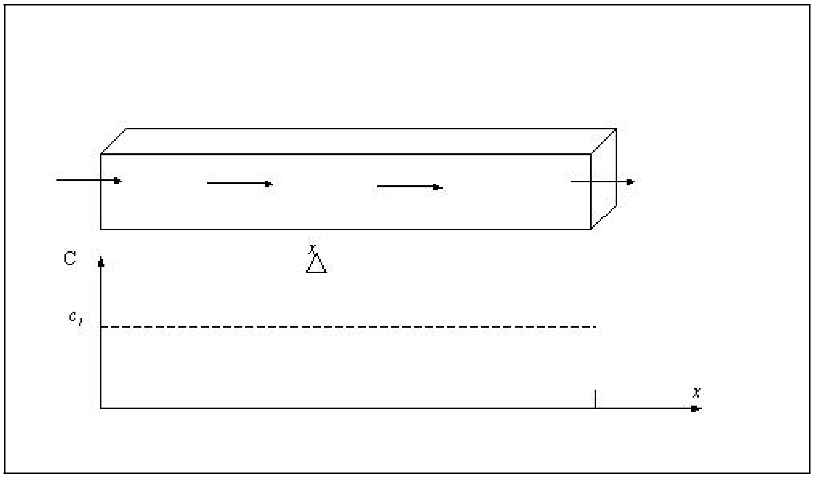


Figure 1.1 Theoretical Plug-flow Reactor

It is assumed to be well mixed both laterally and vertically. Variations in the longitudinal dimension are what determine any changes in parameters of concern. A “plug” of a conservative substance introduced at one end of the reactor will remain intact as it passes through the reactor. In the case of PVOD, the initial concentration of bacteria can be computed at the injection point; at points further downstream the concentration can be estimated based on first order decay and mass balance.

F. MODEL SETUP

Conceptually, PVOD is segmented into a series of plug-flow reactors defined along the entire length of the impaired segment to simulate the steady state (constant flow and constant input) distribution of bacteria along its length. Segmentation locations are determined based on the location of discrete flow inputs to the system (tributary drains). This is necessary to account for water balance between each segment and the impact of the tributary drains to the impaired segment being modeled. Multiple source contributions in a reactor are lumped and represented as a single input based on observed water quality data. In other words, the measured water quality concentration is assumed to be representative of all sources in the reactor. The model is one dimensional (longitudinal) under a steady-state condition. Each reactor defines the mass balance for bacteria and water. First-order decay is used to represent bacteria die-off, which can be attributed to solar radiation, temperature, and other environmental conditions (Crane and Moore, 1985). Bacterial re-growth is not simulated. Resuspension is not simulated.

Using an upstream boundary condition of $C = C_0$ near the Township Drain, the water column concentration can be calculated using the equation given below:

(Equation 1) $\frac{dc}{dt} = -kc$ <u>or</u> *(Equation 2)* $C = C_0 e^{-kt} = C_0 e^{-\left(k\frac{x}{u}\right)}$

Where:

C_0 = *Initial concentration (# organisms/100 mL)*

C = *Final concentration (# organisms/100 mL)*

k = *Die-off rate 1/day*

x = *Segment length*

u = *Stream velocity*

At each confluence where there is a tributary, a mass balance of the load just upstream and the load from the tributary is performed to determine the change in concentration.

$$\text{(Equation 3):} \quad C_0 = \frac{Q_r \cdot C_r + Q_{t_1} \cdot C_{t_1}}{Q_r + Q_{t_1}}$$

Where Q_r and C_r refer to the flow and concentration of the receiving water (i.e. PVOD) and Q_t and C_t refer to the flow and concentration from tributary. Equation 3 represents the mass balance for one tributary feeding into PVOD; however, if more than one tributary feeds into the system, additional terms can be added to equation 3 (i.e. Q_{t2} and C_{t2}). The concentration calculated from equation 3 is then used as the initial concentration C_0 in equation 2 for the next segment. Analysis was performed for low flow conditions representing minimum dilution. Figure 1.2 depicts the connectivity of drains in Palo Verde Valley and the segmentation of PVOD for modeling purposes.

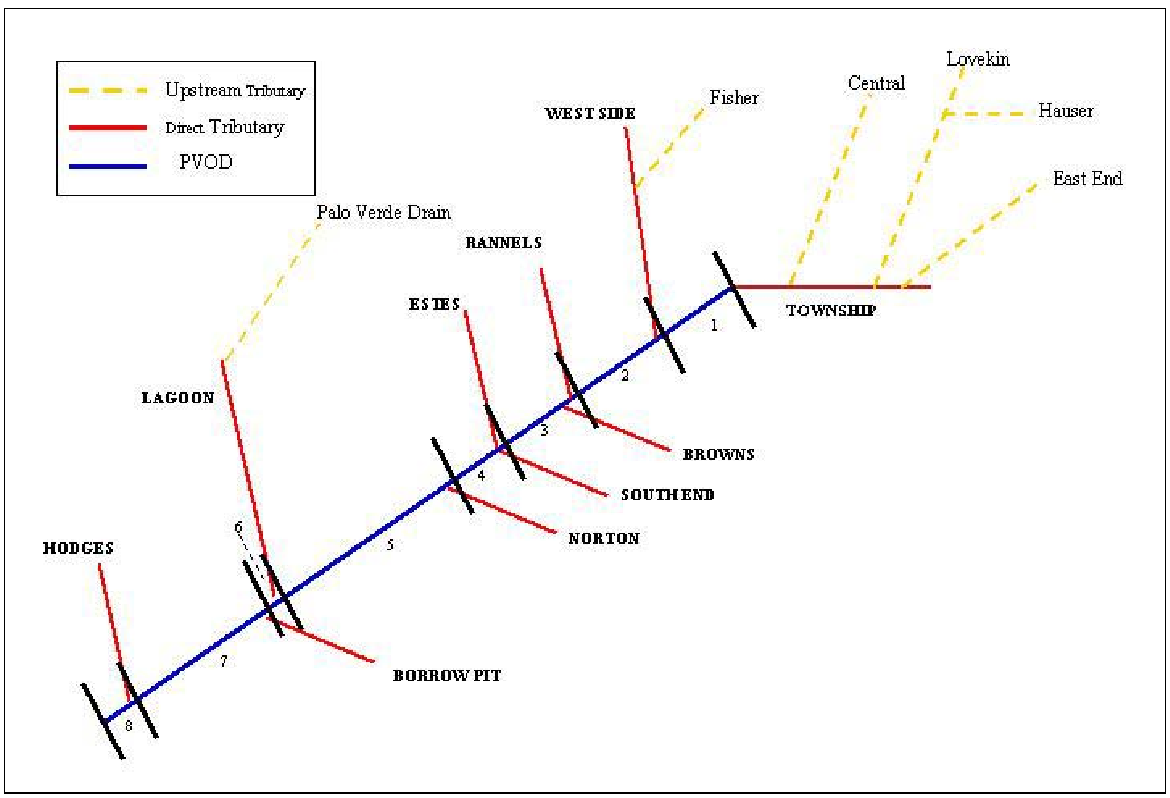


Figure 1.2 Schematic of Tributary Drains to Palo Verde Outfall Drain and Model Segments (not to scale)

PVOD was segmented at points at which tributaries drain into it. Segment One begins at the mouth of the Township Drain and stretches to the West Side Drain. Segment Two begins at the mouth of the West Side Drain and stretches to the mouth of Rannels Drain, and so on. Two segments (Segments three and four), have two tributaries flowing into them. Segment Six, representing the Lagoon, incorporates Palo Verde Drain, the Lagoon and simulated septic input to the Lagoon. Bacteria concentrations in each segment are calculated using water quality observation data, a first order decay rate, basic channel geometry, and flow. The method assumes water quality observation data are "representative" of existing water quality. As additional data are collected it is possible to plug newly collected tributary flow and concentration observations into the model to obtain an increasingly accurate picture of existing concentrations. Figure 1.3 shows how the plug-flow reactor concept applies to Palo Verde Outfall Drain.

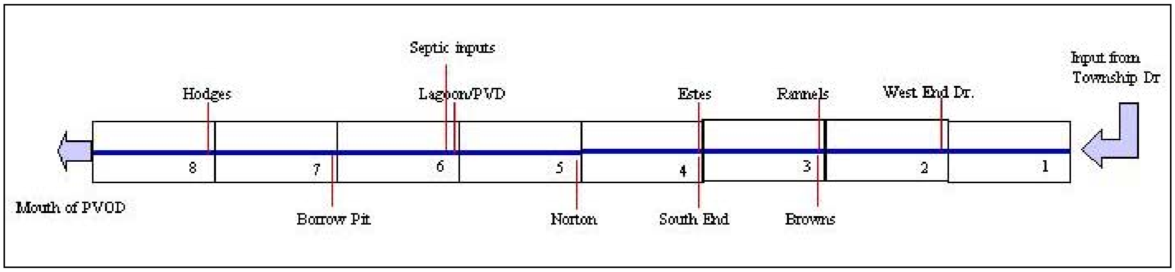


Figure 1.3 Theoretical Plug-Flow Reactor Representation of PVOD with Tributary Drain Inputs

Key data needs for this methodology include the following:

- Channel geometry for each model segment (volumes, cross sections, water depth.)
- Flow information for PVOD as well as tributary drains
- Representative bacteria concentration values from inputs

Since precise channel geometry data are not available, they were estimated with the guidance of Palo Verde Irrigation District (Roger Henning, PVID engineer). Flow is not measured in the drains; therefore annual measured outflow at the USGS gage station south of the Lagoon was used to represent flow in tributary drains. The flow value used depended on the specific time period being modeled. (i.e., for June observations, average June flows were used.) Total flow was distributed to individual drains proportionally to the estimated drainage area of the individual drain. Drainage areas were estimated through GIS analysis by overlaying the tributary drain network with USGS quadrangle maps of Palo Verde Valley and the MRLC land use coverage. Farm field boundaries were identified and drainage areas were delineated based on the location of drains with respect to field boundaries. Water depths in individual segments were calculated based on flow using Manning's equation.

Table 1.2 shows the values used to represent physical characteristics of the model segments for the calibration condition (July 2002 sample data with average flows measured at the gage station during July 2002 –569 cfs). These dimensions change with changing flow. From the Norton Drain segment (Segment Five) 25 percent of flow is diverted into Segment Six and 75% of flow is diverted to Segment Seven.

Table 1.2 Estimated Channel Dimensions, Calibration Condition

Channel Segment	Avg. Bottom Width of Drain Segment (ft)	Avg. Depth (ft)	Side Slope n (1:n)	Length (miles)	Cross Sect. area A (sqft)	Avg. Flow Q (cfs)
1	15.00	5.10	1	0.45	102.51	0.00
2	15.00	5.10	1	2.13	102.51	0.00
3	15.00	5.10	1	2.50	102.51	0.00
4	15.00	5.10	1	0.85	102.51	0.00
5	20.00	4.30	1	1.47	104.49	0.00
6	30.00	3.40	1	1.22	113.56	0.00
7	25.00	3.80	1	0.40	109.44	0.00
8	25.00	3.80	1	8.60	109.44	0.00

This modeling approach relies upon basic channel geometry measurements. These include bottom width of drain segment, depth of water, and side slope of channels. The method also relies upon having flow information for each tributary. It is important to note that each of these model parameters has been estimated. The accuracy of the model is therefore, subject to the accuracy of these estimations.

G. MODEL CALIBRATION

The calibration was completed by adjusting channel width, water depth, and other physical parameters to reflect designated flow conditions as closely as possible. The calibration condition consisted of the set of observed concentrations obtained during the July 2002 sampling trip and the average flow for July 2002 as measured at the USGS Gage station.

The model decay rate reflects bacterial mortality due to various environmental conditions and may be used as a calibration parameter. Decay rates are the same for each segment. A lower decay rate was assumed for enterococcus (1.15/day) than for E. coli and fecal coliform (.7/day) to reflect the higher resistance of enterococcus relative to E. coli (Easton et.al, 2001). These values are deemed appropriate as they are within the range of decay rates used in various modeling studies as reported in the Rates, Constants and Kinetics Formulations in Surface Water Quality Modeling (EPA, 1985.) These decay rates were verified by comparing the model predictions to July 2002 observations. While there is a lack of instream data available to thoroughly verify the appropriateness of the assumed die-off rates, the model assumptions seem reasonable given that most predicted concentrations fall within at least the same order of magnitude as observations. The observed tributary concentrations are based on actual water quality observations and are not considered a calibration parameter

H. MODEL RESULTS

Model results show that by reducing concentrations entering PVOD through tributary drains, water quality objectives within the Outfall Drain can be met. The model predicts bacteria concentrations in the mainstem of PVOD. Actual data are limited so the model was run for several scenarios in an effort to simulate the most critical concentration/flow combinations (Table 1.3). Model results will be confirmed through trend monitoring during the Implementation Phase.

Table 1.3 Various Flow/Concentration Scenarios Tested

Scenario	Concentrations	Flow (cfs)
Calibration	July 2002	Average July flow 2002 (569 cfs)
1	Avg. of all samples per station	Minimum flow (210 cfs)

2	Avg. of all samples per station	Average flow-- (536 cfs)
3	Avg. of all samples per station	Maximum flow (1200 cfs)
4	June 2002 Samples	Minimum measured June flow (426 cfs)
5	July 2002 Samples	Minimum measured July flow (444 cfs)
6	August 2002 Samples	Minimum measured August flow (456 cfs)

Since the most comprehensive sampling (for modeling purposes) occurred during June, July, and August 2002, samples taken during that time were used in three of the scenarios. The advantage in this is that since sampling occurred more or less during the same time frame and the model is a steady state model, the model predictions are expected to be more accurate. Because the samples only reflect three months however, they do not represent the extreme conditions that are possible in the watershed. Therefore any estimates of loading and subsequent reductions based on the 2002 data will most likely not be protective enough of regulatory criteria.

Three additional scenarios were tested using averages of all samples taken at a given location. This has the advantage of being able to consider extreme conditions. However, it is more difficult to pair a concentration with an accurate corresponding flow rate since by definition the average value represents samples that were taken at varying flow conditions. The TMDL Allocations Section of the Project Report shows predicted bacterial concentrations for each different modeling scenario. Depending on the scenario, required reductions for E. coli range from 0 per cent to 99 per cent; for enterococcus reductions range from 0 per cent to 99 percent; for fecal coliform reductions range from 0 per cent to 100 per cent.

Model results are adequate for predicting in stream concentrations based on known tributary water quality and for determining the relative reduction of tributary concentrations needed to meet water quality objectives in PVOD. The model cannot predict which particular sources should be reduced in order to meet objectives. To understand the relative importance of particular sources to the overall concentrations in PVOD, a source loading estimation was conducted. Source contributions as predicted by the loading analysis indicate that the majority of loading to PVOD is from wildlife (96% from birds, 3% from aquatic rodents.)

APPENDIX B

ALLOCATION SCENARIOS

Excerpt of Draft Source Analysis, Load Assessment, and Loading Allocations for Palo Verde Outfall Drain Bacteria TMDL

Prepared by: Tetra Tech, Inc.
March, 2003

A. ALLOCATIONS

Allocations are expressed as concentrations (# organisms/ 100 mL). Based on the source assessment for PVOD, bacterial concentrations are assumed to originate solely from nonpoint sources. There are no point sources contributing bacteria to PVOD. Waste Load Allocations have been set at zero. Reductions were established for E. coli, enterococcus, and Fecal coliform. The septic loading analysis was performed using literature values based on fecal coliform concentrations. Fecal coliform bacteria in PVOD were therefore modeled to present a direct comparison between the loading analysis and the predictive model and should therefore be viewed cautiously.

B. ALLOCATION METHODOLOGY

Necessary reductions were determined by addressing each model segment sequentially. Concentrations incoming to Segment One were reduced until the predicted concentration in model Segment One met water quality objectives. Concentrations of water in tributaries to Segment Two were then reduced until the concentration in Segment Two met objectives, and so on. If two tributaries entered a segment, both were reduced so as not to place a higher reduction burden on one drainage area than another. Objectives include 126 / 100 mL for E. coli, and 33 / 100 mL for enterococcus. The target of 200 / 100 mL was chosen for fecal coliform as it is consistent with numeric objectives stated in the Control Plan for REC I waters.

Allocation and TMDL Tables
This section presents the TMDLs and Allocations based on the six scenarios tested. For each scenario there are six tables. The first table presented includes modeled E. coli concentrations for each segment, modeled reduced concentrations in each segment, and the percent reduction required from incoming tributaries to meet the required reductions. The second table shows the LA, WLA and TMDL for each model segment based on that scenario. The following four tables present the same information for Enterococcus and for fecal coliform. Septic inputs are only modeled using the fecal coliform parameter. All septic inputs are reduced 100 percent to zero contibution.

Scenario One

June 2002 samples, Minimum recorded June flow (426 cfs)

Table 1.1 Modeled Existing and Reduced E. coli Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to

				Tributary
1	Township Drain	226	124	4
2	West Side	182	114	0
3	Rannels Drain	173	122	0
4	Estes Drain	170	122	0
	South End Drain			0
5	Norton Drain	163	118	0
6	Palo Verde Drain/Lagoon	143	103	0
7	Borrow Pit Drain	137	112	0
8	Hodges Drain	120	99	0

Table 1.2 TMDL Table for E. coli

Model Segment	**Tributary Feeding into the Model Segment**	**LA #/100 mL**	**WLA #/100 mL**	**TMDL #/100 mL**
1	Township Drain	124	0	124
2	West Side	114	0	114
3	Rannels Drain	122	0	122
4	Estes Drain	122	0	122
	South End Drain		0	
5	Norton Drain	1	0	1
6	Palo Verde Drain/Lagoon	103	0	103
7	Borrow Pit Drain	112	0	112
8	Hodges Drain	99	0	99

Table 1.3 Modeled Existing and Reduced enterococcus Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	1287	26	98
2	West Side	1106	18	100
3	Rannels Drain	1656		98
	B			98
4	Estes Drain	1666	32	97
	South End Drain			96
5	Norton Drain	1643	32	96
6	Palo Verde Drain/Lagoon	1543	32	95
7	Borrow Pit Drain		31	99
8	Hodges Drain	2409	29	0

Table 1.4 TMDL Table for Enterococcus

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	26	0	26
2	West Side	18	0	18
3	Rannels Drain	30		30
	B		0	
4	Estes Drain	32	0	32
	South End Drain		0	
5		32	0	32
6	Palo Verde Drain/Lagoon	32	0	32
7	Borrow Pit Drain		0	31
8	Hodges Drain	29	0	29

Table 1.5 Modeled Existing and Reduced Fecal coliform Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	226	199	12
2	West Side	235	199	21
3	Rannels Drain	203	176	
	B			0
4	Estes Drain	210	185	0
	South End Drain			0
5		202	178	0
6	Palo Verde Drain/Lagoon	190	169	0
	Failing Septic Systems	10000	0	100
7	Borrow Pit Drain		189	0
8	Hodges Drain	178	167	0

Table 1.6 TMDL Table for Fecal coliform

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	199	0	199
2	West Side	199	0	199
3	Rannels Drain	176		176
	B		0	
4	Estes Drain	185	0	185
	South End Drain		0	
5	Norton Drain	178	0	178
6	Palo Verde Drain/Lagoon	169	0	169
7	Borrow Pit Drain		0	189
8	Hodges Drain	167	0	167

Scenario Two

July 2002 samples; Minimum recorded July flow (444 cfs)

Table 1.7 Modeled Existing and Reduced E. coli Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduce d Conc. #/100 mL	% Reductio n Required to Tributary
1	To in	167	125	25
2	West Side	174	126	32
3	Rannels Drain	159	123	
	B			0
4	Estes Drain	151	118	0
	South End Drain			0
5	Norton Drain	146	114	0
6	Palo Verde Drain/Lagoon	135	107	0
7	Borrow Pit Drain		107	0
8	Hodges Drain	105	90	0

Table 1.8 TMDL Table for E. coli

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	125	0	125
2	West Side	126	0	126
3	Rannels Drain	123		123
	B		0	
4	Estes Drain	118	0	118
	South End Drain		0	
5		114	0	114
6	Palo Verde Drain/Lagoon	107	0	107
7	Borrow Pit Drain		0	107
8	Hodges Drain	90	0	90

Table 1.9 Modeled Existing and Reduced enterococcus Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	1684	17	99
2	West Side	2584	13	100
3	Rannels Drain	2511		98
	B			98
4	Estes Drain	2499	24	97
	South End Drain			97
5	Norton Drain	2455	33	55
6	Palo Verde Drain/Lagoon	2352	32	98
7	Borrow Pit Drain		29	99
8	Hodges Drain	2058	27	0

Table 1.10 TMDL Table for Enterococcus

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	17	0	17
2	West Side	13	0	13
3	Rannels Drain	20		20
	B		0	
4	Estes Drain	24	0	24
	South End Drain		0	
5		33	0	33
6	Palo Verde Drain/Lagoon	32	0	32
7	Borrow Pit Drain		0	29
8	Hodges Drain	27	0	27

Table 1.11 Modeled Existing and Reduced Fecal coliform Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	295	198	33
2	West Side	338	200	52
3	Rannels Drain	298	194	
	B			0
4	Estes Drain	292	196	0
	South End Drain			0
5		283	190	0
6	Palo Verde Drain/Lagoon	260	179	0
	Failing Septic Systems	10000	0	100
7	Borrow Pit Drain		153	0
8	Hodges Drain	180	137	0

Table 1.12 TMDL Table for Fecal coliform

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	198	0	198
2	West Side	200	0	200
3	Rannels Drain	194		194
	B		0	
4	Estes Drain	196	0	196
	South End Drain		0	
5	Norton Drain	190	0	190
6	Palo Verde Drain/Lagoon	179	0	179
7	Borrow Pit Drain		0	153
8	Hodges Drain	137	0	137

Scenario Three

August 2002 samples, Minimum recorded August flow (426 cfs)

Table 1.13 Modeled Existing and Reduced E. coli Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1		167	125	25
2	West Side	420	114	90
3	R	331	101	0
	Brown's Drain			0
4	Estes Drain	317	105	0
	South End Drain			0
5	Norton Drain	306	102	0
6	Palo Verde Drain/Lagoon	280	102	0
7	Borrow Pit Drain	223	109	0
8	Hodges Drain	190	96	0

Table 1.14 TMDL Table for E. coli

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1		125	0	125
2	West Side	114	0	114
3	R	101	0	101
	Brown's Drain		0	
4	Estes Drain	105	0	105
	South End Drain		0	
5	Norton Drain	102	0	102
6	Palo Verde Drain/Lagoon	102	0	102
7	Borrow Pit Drain	109	0	109
8	Hodges Drain	96	0	96

Table 1.15 Modeled Existing and Reduced enterococcus Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduce d Conc. #/100 mL	% Reductio n Required to Tributary
1	To in	2969	30	99
2	West Side	3451	22	100
3	Rannels Drain	2869		93
	B			93
4	Estes Drain	2764	33	97
	South End Drain			97
5	Norton Drain	2702	33	91
6	Palo Verde Drain/Lagoon	2914	30	100
7	Borrow Pit Drain		28	99
8	Hodges Drain	2356	26	0

Table 1.16 TMDL Table for Enterococcus

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	30	0	30
2	West Side	22	0	22
3	Rannels Drain	32		32
	B		0	
4	Estes Drain	33	0	33
	South End Drain		0	
5	Norton Drain	33	0	33
6	Palo Verde Drain/Lagoon	30	0	30
7	Borrow Pit Drain		0	28
8	Hodges Drain	26	0	26

Table 1.17 Modeled Existing and Reduced Fecal coliform Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduce d Conc. #/100 mL	% Reductio n Required to Tributary
1	To in	295	198	33
2	West Side	505	196	79
3	Rannels Drain	406	173	
	B			0
4	Estes Drain	385	171	0
	South End Drain			0
5		372	166	0
6	Palo Verde Drain/Lagoon	346	166	0
	Failing Septic Systems	10000	0	100
7	Borrow Pit Drain		144	0
8	Hodges Drain	223	129	0

Table 1.18 TMDL Table for Fecal coliform

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	198	0	198
2	West Side	196	0	196
3	Rannels Drain	173		173
	B		0	
4	Estes Drain	171	0	171
	South End Drain		0	
5		166	0	166
6	Palo Verde Drain/Lagoon	166	0	166
7	Borrow Pit Drain		0	144
8	Hodges Drain	129	0	129

Scenario Four

Averaged concentrations; Minimum flow (210 cfs)

Table 1.19 Modeled Existing and Reduced E. coli Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduce d Conc. #/100 mL	% Reductio n Required to Tributary
1	To in	186	125	33
2	West Side	290	124	75
3	Rannels Drain	277	119	
	B			30
4	Estes Drain	270	120	30
	South End Drain			30
5	Norton Drain	259	116	0
6	Palo Verde Drain/Lagoon	227	104	0
7	Borrow Pit Drain		118	100
8	Hodges Drain	41905	101	0

Table 1.20 TMDL Table for E. coli

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	125	0	125
2	West Side	124	0	124
3	Rannels Drain	119		119
	B		0	
4	Estes Drain	120	0	120
	South End Drain		0	
5	Norton Drain	116	0	116
6	Palo Verde Drain/Lagoon	104	0	104
7	Borrow Pit Drain		0	118
8	Hodges Drain	101	0	101

Table 1.21 Modeled Existing and Reduced enterococcus Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	1976	30	99
2	West Side	2203	29	99
3	Rannels Drain	2063		98
	B			98
4	Estes Drain	2044	31	97
	South End Drain			97
5	Norton Drain	2000	33	86
6	Palo Verde Drain/Lagoon	1902	33	97
7	Borrow Pit Drain		29	100
8	Hodges Drain	7504	26	0

Table 1.22 TMDL Table for Enterococcus

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	30	0	30
2	West Side	29	0	29
3	Rannels Drain	30		30
	B		0	
4	Estes Drain	31	0	31
	South End Drain		0	
5	Norton Drain	33	0	33
6	Palo Verde Drain/Lagoon	33	0	33
7	Borrow Pit Drain		0	29
8	Hodges Drain	26	0	26

Table 1.23 Modeled Existing and Reduced Fecal coliform Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	271	198	27
2	West Side	389	200	67
3	Rannels Drain	354	200	
	B			20
4	Estes Drain	342	200	6
	South End Drain			6
5		328	192	0
6	Palo Verde Drain/Lagoon	289	172	0
	Failing Septic Systems	10000	0	100
7	Borrow Pit Drain		167	100
8	Hodges Drain	46017	143	0

Table 1.24 TMDL Table for Fecal coliform

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	198	0	198
2	West Side	200	0	200
3	Rannels Drain	200		200
	B		0	
4	Estes Drain	200	0	200
	South End Drain		0	
5	Norton Drain	192	0	192
6	Palo Verde Drain/Lagoon	172	0	172
7	Borrow Pit Drain		0	167
8	Hodges Drain	143	0	143

Scenario Five

Averaged concentrations; Average flow (569 cfs)

Table 1.25 Modeled Existing and Reduced E. coli Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	187	125	33
2	West Side	295	125	76
3	Rannels Drain	285	125	
	B			50
4	Estes Drain	279	126	35
	South End Drain			35
5	Norton Drain	269	122	0
6	Palo Verde Drain/Lagoon	243	113	0
7	Borrow Pit Drain		125	100
8	Hodges Drain	43934	111	0

Table 1.26 TMDL Table for E. coli

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	125	0	125
2	West Side	125	0	125
3	Rannels Drain	125		125
	B		0	
4	Estes Drain	126	0	126
	South End Drain		0	
5	Norton Drain	122	0	122
6	Palo Verde Drain/Lagoon	113	0	113
7	Borrow Pit Drain		0	125
8	Hodges Drain	111	0	111

Table 1.27 Modeled Existing and Reduced enterococcus Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	1982	22	99
2	West Side	2228	32	98
3	Rannels Drain	2100		98
	B			98
4	Estes Drain	2084	33	98
	South End Drain			98
5	Norton Drain	2050	33	96
6	Palo Verde Drain/Lagoon	1985	32	98
7	Borrow Pit Drain		28	100
8	Hodges Drain	7769	27	0

Table 1.28 TMDL Table for Enterococcus

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	22	0	22
2	West Side	32	0	32
3	Rannels Drain	33		33
	B		0	
4	Estes Drain	33	0	33
	South End Drain		0	
5	Norton Drain	33	0	33
6	Palo Verde Drain/Lagoon	32	0	32
7	Borrow Pit Drain		0	28
8	Hodges Drain	27	0	27

Table 1.29 Modeled Existing and Reduced Fecal coliform Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	272	198	27
2	West Side	396	199	69
3	Rannels Drain	364	199	
	B			25
4	Estes Drain	353	197	25
	South End Drain			25
5		342	191	0
6	Palo Verde Drain/Lagoon	310	176	0
	Failing Septic Systems	10000	0	100
7	Borrow Pit Drain		170	100
8	Hodges Drain	48247	152	0

Table 1.30 TMDL Table for Fecal coliform

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	198	0	198
2	West Side	199	0	199
3	Rannels Drain	199		199
	B		0	
4	Estes Drain	197	0	197
	South End Drain		0	
5		191	0	191
6	Palo Verde Drain/Lagoon	176	0	176
7	Borrow Pit Drain		0	170
8	Hodges Drain	152	0	152

Scenario Six

Averaged concentrations; Maximum flow (1200 cfs)

Table 1.31 Modeled Existing and Reduced E. coli Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	188	126	33
2	West Side	299	125	77
3	Rannels Drain	290	126	
				51
4	Estes Drain	284	126	50
	South End Drain			40
5	Norton Drain	276	123	0
6	Palo Verde Drain/Lagoon	254	115	20
7	Borrow Pit Drain		126	100
8	Hodges Drain	45271	115	0

Table 1.32 TMDL Table for E. coli

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	126	0	126
2	West Side	125	0	125
3	Rannels Drain	126		126
	B		0	
4	Estes Drain	126	0	126
	South End Drain		0	
5	Norton Drain	123	0	123
6	Palo Verde Drain/Lagoon	115	0	115
7	Borrow Pit Drain		0	126
8	Hodges Drain	115	0	115

Table 1.33 Modeled Existing and Reduced enterococcus Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	1985	30	99
2	West Side	2244	29	99
3	Rannels Drain	2124		98
				98
4	Estes Drain	2110	33	98
	South End Drain			98
5	Norton Drain	2083	33	95
6	Palo Verde Drain/Lagoon	2039	33	98
7	Borrow Pit Drain		29	100
8	Hodges Drain	7942	27	0

Table 1.34 TMDL Table for Enterococcus

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To in	30	0	30
2	West Side	29	0	29
3	Rannels Drain	32	0	32
	B		0	
4	Estes Drain	33	0	33
	South End Drain		0	
5	Norton Drain	33	0	33
6	Palo Verde Drain/Lagoon	33	0	33
7	Borrow Pit Drain		0	29
8	Hodges Drain	27	0	27

Table 1.35 Modeled Existing and Reduced Fecal coliform Concentrations and % Reduction Required

Model Segment	Tributary Feeding into the Model Segment	Sampled Conc. #/100 mL	Reduced Conc. #/100 mL	% Reduction Required to Tributary
1	To in	273	199	27
2	West Side	400	199	70
3	Rannels Drain	371	197	
				0
4	Estes Drain	361	200	0
	South End Drain			0
5		351	195	0
6	Palo Verde Drain/Lagoon	324	183	0
	Failing Septic Systems	10000	0	100
7	Borrow Pit Drain		175	100
8	Hodges Drain	49716	161	0

Table 1.36 TMDL Table for Fecal coliform

Model Segment	Tributary Feeding into the Model Segment	LA #/100 mL	WLA #/100 mL	TMDL #/100 mL
1	To n	199	0	199
2	West Side	199	0	199
3	Rannels Drain	197		197
	B		0	
4	Estes Drain	200	0	200
	South End Drain		0	
5		195	0	195
6	Palo Verde Drain/Lagoon	183	0	183
7	Borrow Pit Drain		0	175
8	Hodges Drain	161	0	161

Scenario Comparison

Tables 1.37 through 1.39 provide a comparison of the reductions required for each parameter based on the six scenarios tested. Since the sources are the same for all parameters, reductions will be driven by those which are most stringent—Enterococcus.

Table 1.37 Comparison of Reductions Required by Different Scenarios (E. coli)

Model Segment	Tributary Feeding into the Model Segment	%Required Avg. Conc./ Low Flow (210 cfs)	%Required Avg. Conc./ Avg. Flow (536 cfs)	% Required Avg. Conc./ Max. Flow (1200 cfs)	% Required June (426 cfs)	% Required July (444 cfs)	% Required August (456 cfs)
1		33	33		45	25	25
2	West Side	75	76	77	0	32	90
3	Rannels Drain	60	50	51	0	0	0
	Brown's Drain	30	50	51	0	0	
4	Estes Drain	30	35	50	0	0	0
	South End Drain	30	35	40	0	0	0
5	Norton Drain	0	0	0	0	0	0
6	Palo Verde Drain/Lagoon	0	0	20	0	0	0
7	Borrow Pit Drain	100	100	100	0	0	0
8	Hodges Drain	0	0	0	0	0	0

Table 1.38 Comparison of Reductions Required by Different Scenarios (Enterococci)

Model Segment	Tributary Feeding into the Model Segment	%Required Avg. Conc./ Low Flow (210 cfs)	%Required Avg. Conc./ Avg. Flow (536 cfs)	% Required Avg. Conc./ Max. Flow (1200 cfs)	% Required June (426 cfs)	% Required July (444 cfs)	% Required August (456 cfs)
1	Township Drain	99	99	99	98	99	99
2	West Side	99	98	99	100	100	100
3	Rannels Drain	98	98	98	98	98	93
	Brown's Drain	98	98	98	98	98	93
4	Estes Drain	97	98	98	97	97	97
	South End Drain	97	98	98	96	97	97
5	Norton Drain	86	96	95	96	55	91
6	Palo Verde Drain/Lagoon	97	98	98	95	98	100
7	Borrow Pit Drain	100	100	100	99	99	99
8	Hodges Drain	0	0	0	0	0	0

Table 1.39 Comparison of Reductions Required by Different Scenarios (Fecal coliform)

Model Segment	Tributary Feeding into the Model Segment	%Required Avg. Conc./ Low Flow (210 cfs)	%Required Avg. Conc./ Avg. Flow (536 cfs)	% Required Avg. Conc./ Max. Flow (1200 cfs)	% Required June (426 cfs)	% Required July (444 cfs)	% Required August (456 cfs)
1	Township Drain	27	27	27	12	33	33
2	West Side	67	69	70	21	52	79
3	Rannels Drain	20	25	36	0	0	5
	Brown's Drain		25	0	0	0	0
4	Estes Drain	6	25	0	0	0	0
	South End Drain	6	25	0	0	0	0
5	Norton Drain		0	0	0	0	0
6	Palo Verde Drain/Lagoon	0	0	0	0	0	0
	Failing Septic Systems	100	100	100	100	100	100
7	Borrow Pit Drain	100	100	100	0	0	0
8	Hodges Drain	0	0	0	0	0	0

ATTACHMENT 1

ECONOMIC IMPACT ASSESSMENT

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Secretary for Environmental Protection

State Water Resources Control Board

Office of Statewide Initiatives
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TO: (1) John Norton
Chief, Office of Statewide Initiatives

(2) Teresa Gonzales
Unit Chief, TMDL Development
Colorado River Basin Regional Water Quality Control Board

FROM: Gerald Horner, Ph.D.
Senior Economist (RPS II)
Economics and Effectiveness Unit
Office of Statewide Initiatives

DATE: May 6, 2003

SUBJECT: **PALO VERDE OUTFALL DRAIN PATHOGEN TMDL: ECONOMIC IMPACT ASSESSMENT**

The staff of the TMDL (Total Maximum Daily Load) Coordination Unit, of the Colorado River Basin Regional Water Quality Control Board, has requested that the Economics Unit of the State Water Resources Control Board estimate the economic impacts of implementing the proposed pathogen TMDL for Palo Verde outfall drain flowing directly into the Colorado River.

The implementation of this TMDL will not cause significant economic impacts since the proposed Management Practices (MP) are currently regulations or will be required under future regulations. Depending on the initial success of the TMDL in achieving water quality goals, subsequent actions could impact growers and residents of the area. A section presenting the reasons for this conclusion has been prepared and attached for your use.

If our office can be of further assistance on this matter, please contact us at 916-341-5279.

Attachment: Section 10 Economic Analysis

cc: Lori Okun, OCC