Draft Environmental Impact Report

Covering General Waste Discharge Requirements for

Biosolids Land Application

Prepared for:

California State
Water Resources Control Board

Prepared by:

Jones & Stokes Associates
Sacramento, California

June 28, 1999

Draft

Statewide Program EIR Covering General Waste Discharge Requirements for Biosolids Land Application

Prepared for:

California State Water Resources Control Board
Water Quality Division
901 P Street
Sacramento, CA 95814
Contact: Todd Thompson
916/657-0577

Prepared by:

Jones & Stokes Associates, Inc.
2600 V Street, Suite 100
Sacramento, CA 95818-1914
Contact: Mike Rushton
916/737-3000

IN ASSOCIATION WITH:

Carollo Engineers
K.P. Lindstrom, Inc.
The Merriwood Corporation
Quad Knopf Consultants
Questa Engineering Corporation
Harris & Company

June 28, 1999

This document should be cited as:

Jones & Stokes Associates, Inc. 1999. Statewide program EIR covering general waste discharge requirements for biosolids land application. Draft. June 28, 1999. (JSA 98-186.) Sacramento, CA. Prepared for California State Water Resources Control Board, Water Quality Division, Sacramento, CA.

Table of Contents

	Page
Executive Summary	ES-1
Chapter 1. Introduction	1-1
Background on Biosolids Management in California	1-1
Existing Regulations for Land Application of Biosolids	1-2
Purpose of the Statewide Program EIR	1-3
The Scoping Process	1-3
Notice of Preparation	1-4
Other Scoping Activities	1-4
Issues to Be Addressed in the EIR	1-6
Public Involvement	1-6
Terminology	1-7
Report Organization	1-7
Agencies That Will Use This Document	1-8
Anticipated Conditions Following Adoption of the GO	1-9
Chapter 2. Program Description	2-1
Background on Biosolids Generation, Disposal, and Reuse	2-1
Existing and Projected Biosolids Land Application in California	2-1
Existing Regulatory Programs	2-5
State Programs—Role of RWQCBs	2-5
Federal Programs—Part 503 Regulations	2-5
Local Programs—County Ordinances	2-7
General Order Program Objectives	2-8
Comply with California Water Code and Judicial Order	2-8
Provide Regulatory Framework for RWQCB Permit Process	2-9
Provide Flexible Regulatory Framework	2-9
Description of General Order	2-10
Overview	2-10
Applicability	2-10
Relationship of the GO to Part 503 Regulations	2-11
Discharge Prohibitions of the GO	2-13
Discharge Specifications of the GO	2-14
Storage and Transportation	2-14
Provisions	2-15
GO Exclusion Areas	2-16

Chapter 3. Soils, Hydrology, and Water Quality 3-1
Environmental Setting 3-1
Soils 3-1
Hydrology 3-5
Water Quality 3-6
Regulatory Setting 3-20
Key Policies, Laws, and Programs 3-20
Impacts and Mitigation Measures 3-26
Approach and Methods 3-26
Thresholds of Significance 3-26
Impacts of Agricultural Use 3-27
Impacts of Other Activities 3-37

Chapter 4. Land Productivity 4-1
Introduction 4-1
Environmental Setting 4-2
Impacts and Mitigation Measures 4-2
Thresholds of Significance 4-2
Impacts of Agricultural Use 4-3
Impacts of Other Activities 4-15

Chapter 5. Public Health 5-1
Environmental Setting 5-2
Introduction 5-2
Pathogens 5-3
Non-Pathogenic Contaminants 5-7
Routes and Pathways of Contact 5-10
Potential Health Effects from Direct Ingestion or Intake of Foods Related to Biosolids 5-16
Regulatory Setting 5-17
Waste Discharge Requirements 5-17
National Pollutant Discharge Elimination System Permits 5-18
California Hazardous Waste Control Law 5-18
Discharge of Waste to Land 5-18
Regulatory Requirements for Composting Operations 5-19
Source Reduction and Recycling 5-19
Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5) 5-20
Ambient Water Quality Criteria for the Protection of Human Health 5-20
Ambient Air Quality and Air Toxics 5-20
State Health and Safety Code and California Food and Agricultural Code 5-20
California Occupational Safety and Health Act Requirements 5-21
Food Safety 5-21

Impacts and Mitigation Measures 5-23
Approach and Methods 5-23
Thresholds of Significance 5-25
Impacts of Agricultural Use 5-25
Impacts of Other Activities 5-37

Chapter 6. Land Use and Aesthetics 6-1
Environmental Setting 6-1
Regional Settings 6-1
Physical Setting 6-3
Regulatory Setting 6-4
County Land Use Regulations and Ordinances 6-4
Site-Specific Waste Discharge Requirements 6-4
Impacts and Mitigation Measures 6-5
Approach and Methods 6-5
Thresholds of Significance 6-6
Impacts of Agricultural Use 6-6
Impacts of Other Activities 6-9

Chapter 7. Biological Resources 7-1
Environmental Setting 7-1
Agricultural Activities 7-2
Silvicultural Activities 7-3
Horticultural Activities 7-5
Land Reclamation Activities 7-5
Regulatory Setting 7-6
Federal Endangered Species Act 7-6
Federal Migratory Bird Treaty Act 7-7
Bald and Golden Eagle Protection Act 7-7
California Endangered Species Act 7-7
Clean Water Act, Section 404 7-8
Impacts and Mitigation Measures 7-9
Approach and Methods 7-9
Thresholds of Significance 7-9
Impacts of Agricultural and Horticultural Use 7-11
Impacts of Other Activities 7-14

Chapter 8. Fish 8-1
Environmental Setting 8-1
Regions 1-4, 8, and 9: Pacific Coast 8-1
Region 5: Western Sierra Nevada and Central and San Joaquin Valleys 8-2
Regions 6 and 7: Eastern Sierra Nevada, Great Basin, and Colorado River 8-2
Impacts and Mitigation Measures 8-3
Approach and Methods 8-3
Thresholds of Significance 8-4
Impacts of Agricultural Use 8-4
Impacts of Other Activities 8-5

Chapter 9. Traffic 9-1
Environmental Setting 9-1
State Highway System 9-1
Local Roadway System 9-2
Regulatory Setting 9-2
Impacts and Mitigation Measures 9-3
Approach and Methods 9-3
Thresholds of Significance 9-3
Impacts of Agricultural Use 9-4
Impacts of Other Activities 9-5

Chapter 10. Air Quality 10-1
Environmental Setting 10-1
Pollutants of Concern 10-1
California Climate and Meteorology 10-3
Regulatory Setting 10-3
Federal Regulatory Environment 10-3
California Regulatory Environment 10-4
Local Air Quality Regulatory Environment 10-5
Impacts and Mitigation Measures 10-5
Methods 10-5
Thresholds of Significance 10-6
Impacts of Agricultural Use 10-7
Impacts of Other Activities 10-9

Chapter 11. Noise 11-1
Environmental Setting 11-1
Noise-Sensitive Land Uses 11-1
Existing Noise Conditions 11-1
Regulatory Setting 11-2
Impacts and Mitigation Measures 11-3
Approach and Methods 11-3
Thresholds of Significance 11-5
Impacts of Agricultural Use 11-5
Impacts of Other Activities 11-6

Chapter 12. Cultural Resources 12-1
Setting 12-1
Prehistoric Setting 12-1
Ethnographic Setting 12-1
Historic Setting 12-2
Regulatory Setting 12-3
Impacts and Mitigation Measures 12-3
Approach and Methods 12-3
Thresholds of Significance 12-4
Impacts of Agricultural Use 12-4
Impacts of Other Activities 12-6

Chapter 13. Cumulative Impacts 13-1
Overview of Cumulative Impacts Analysis 13-1
Approach 13-1
Impacts 13-2
Groundwater Quality 13-2
Biological Resources 13-5
Air Quality 13-5
Transportation 13-6

Chapter 14. Alternatives Analysis 14-1
Alternatives to the Issuance of the General Order 14-1
No-Project Alternative 14-1
Modified GO Provisions and Specifications Alternative 14-2
Land Application Ban Alternative 14-3
Alternatives Considered but Rejected 14-4
Impact Comparison 14-7
No-Project Alternative 14-7
Modified GO Provisions and Specifications Alternative 14-10
Land Application Ban Alternative 14-13

Chapter 15. Mitigation Monitoring Program 15-1

Chapter 16. Citations 16-1

Chapter 17. Report Preparation 17-1

Appendix A. Draft Text of the General Order

Appendix B. Notice of Preparation and Distribution List

Appendix C. Existing Regulatory Programs for Biosolids Land Application

Appendix D. Soils, Hydrology, and Water Quality Technical Appendix

Appendix E. Public Health Technical Appendix

Appendix F. Information on Special-Status Species

Appendix G. Background Information on Acoustics

List of Figures and Tables

Figure		Follows Page
1-1	Regional Water Quality Control Board Boundaries	1-2
2-1	Typical Biosolids Management Practices	2-2
2-2	Distribution of Biosolids Generated in California (1988, 1991, and 1998)	2-2
2-3	Typical Biosolids Land Application Site	2-4
6-1	California Physiographic Regions	6-2
10-1	California Air Basins	10-2

Table		
ES-1	Summary of Impacts and Mitigation Measures for the California State Water Resources Control Board General Waste Discharge Requirement for Biosolids Land Application	ES-18
2-1	Quantities of Land-Applied Biosolids in California by County in 1998	2-4
2-2	Quantities of Land-Applied Biosolids in California by RWQCB in 1998	2-4
2-3	Regulatory Pollutant Concentrations and Loading Rates under Part 503 Regulations	2-6
2-4	Pollutant Concentration Limits for Biosolids Being Land-Applied	2-14
2-5	Cumulative Loading Limits for Biosolid Land Application Sites	2-14
3-1	Watershed Characteristics of California	3-6
3-2	Major Groundwater Basins of California	3-6
5-1	Pathogenic Bacteria of Concern	5-4
5-2	Pathogenic Viruses of Concern	5-4
5-3	Pathogenic Protozoans of Concern	5-4
5-4	Pathogenic Helminths of Concern	5-4

5-5	Summary of Biosolids Land Application in California 1998 (Ranked by Order of Land Applied Biosolids)	5-6
5-6	Summary of Reported Infectious Diseases in California 1993-1998 (Years in which Data Were Available for All Diseases)	5-6
5-7	Summary of Reported Infectious Disease Cases (Bacterial and Viral) by County 1991-1998	5-6
5-8	Summary of Reported Infectious Disease Cases (Parasitic, Protozoan, and Worm) by County 1991-1998	5-6
5-9	Chronic Human Health Effects Associated with Regulated Contaminants found in Biosolids	5-16
6-1	Representative County Ordinance Conditions Pertaining to Land Use or Aesthetic Issues and Land Application of Biosolids	6-4
7-1	Characteristics of Habitat Types Authorized for Treatment under the General Order	7-4
10-1	Ambient Air Quality Standards Applicable in California	10-2
10-2	Air Quality Requirement Attainment Status by Pollutant and Air Basin	10-2
10-3	Vehicle Emissions from Biosolids Operations	on 10-7
11-1	Maximum Allowable Ambient Noise Exposure for Various Land Uses	on 11-2
11-2	Equipment Noise Emissions Levels	on 11-3
11-3	Estimated Project-Related Noise in the Project Area	on 11-4
15-1	Mitigation Monitoring Program	15-1

Acronyms and Abbreviations

ARB	California Air Resources Board
ASA	American Society of Agronomy
Bay-Delta	San Francisco Bay/ Sacramento-San Joaquin River Delta
BMPs	best management practices
B.P.	before present
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
Caltrans	California Department of Transportation
CASA	California Association of Sanitary Agencies
CCA	Certified Crop Adviser
CCAA	California Clean Air Act
CCR	California Code of Regulations
CDFA	California Department of Food and Agriculture
CEC	cation exchange capacity
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CFU	colony forming units
CIWMB	California Integrated Waste Management Board
CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	carbon monoxide
Corps	U.S. Army Corps of Engineers
dBA	decibels above reference noise, A-weighted
DEHP	di-ethylhexyl phthalate
DFA	California Department of Food and Agriculture
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DTSC	California Department of Toxic Substances Control
DWSWAP	Drinking Water Source Water Assessment and Protection
EIR	environmental impact report
EPA	U.S. Environmental Protection Agency
EQ	Exceptional Quality
ESA	Endangered Species Act
FCAA	federal Clean Air Act
FREP	Fertilizer Research and Education Program

GO	General Order
HWCL	California Hazardous Waste Control Law
LEA	local enforcement agency
MAF	million acre-feet
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
MLRA	Major Land Resource Area
MPN/gm	most probable number per gram
NAAQS	National Ambient Air Quality Standard
NDDB	Natural Diversity Data Base
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NO2	nitrogen dioxide
NO3	nitrate
NOA	notice of applicability
NOI	notice of intent
NOx	oxides of nitrogen
NOP	notice of preparation
NPDES	National Pollutant Discharge Elimination System
NRCS	U.S. Natural Resources Conservation Service
NWP	Nationwide Permits
O3	ozone
ORNL	Oak Ridge National Laboratory
PAHs	polynuclear aromatic hydrocarbons
PCAs	possible contaminating activities
PCBs	polychlorinated biphenyls
P.L.	Public Law
PM2.5	inhalable particulate matter less than 2.5 microns in diameter
PM10	inhalable particulate matter less than 10 microns in diameter
POTW	publicly owned treatment works
ppm	parts per million
ROG	reactive organic gases
RWQCB	regional water quality control board
SIP	state implementation plan
SO2	sulfur dioxide
SOCs	synthetic organic compounds
STLC	soluble threshold limit concentration

SWFP	solid waste facilities permit
SWRCB	California State Water Resources Control Board
TAG	technical advisory group
TLC	threshold limit concentration
TPD	tons per day
UC	University of California
USC	U.S. Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
VMT	vehicle miles traveled
WDR	waste discharge requirements
WHPA	Wellhead Protection Area
WWTP	wastewater treatment plant
FG/l	micrograms per liter

Executive Summary

Introduction

The California State Water Resources Control Board (SWRCB) is proposing to adopt a General Order (GO) for General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California. (The entire text of the proposed GO is included in Appendix A.) Biosolids are defined as sewage sludge that has been treated, tested, and shown to be capable of being used beneficially as a soil amendment for agriculture, silviculture, horticulture, and land reclamation. The GO would establish a notification and permit review process applicable to all persons and public entities intending to apply biosolids to land for the purposes stated above. The GO defines discharge prohibitions, discharge and application specifications, transportation and storage requirements, and general procedures and provisions to which all land appliers would be required to adhere.

Purpose of the Statewide Program EIR

The purpose of this statewide program environmental impact report (EIR) is to comply with a Superior Court order by evaluating the environmental impacts of the SWRCB's adoption and implementation of a GO that would allow the issuance of general WDRs for land application of biosolids. The California Environmental Quality Act (CEQA) requires that state and local government agencies consider the environmental consequences of projects over which they have discretionary authority before taking action on those projects (Pub. Res. Code 21000 et seq.). The project analyzed in this document is the SWRCB's discretionary action on the GO; the underlying activity associated with this action is the land application of biosolids. CEQA also requires that each public agency mitigate or avoid, wherever feasible, the significant environmental effects of projects it approves or implements.

An EIR is an informational document used in state, regional, and local planning and decision-making processes to meet the requirements of CEQA. A program EIR is an EIR that is prepared for a series of actions that can be characterized as one large program, in this case the issuance of statewide regulations governing conduct of a continuing program (14 CCR 15168).

Background on Biosolids Generation, Disposal, and Reuse

Treatment of municipal wastewater typically generates two waste streams: a liquid component and a solid or semisolid component. The liquid component, commonly referred to as effluent, usually is discharged to surface waters or percolation ponds or is used as irrigation water on some types of land. The solid or semisolid component, commonly referred to as sewage sludge, is treated to varying degrees and is typically incinerated, stored in drying beds or ponds, disposed of in landfills, or reused as a soil amendment on some types of land. The GO being considered by the SWRCB would apply to sewage sludges treated and tested to meet the definition of biosolids presented above. More than 50% of the biosolids generated in the United States are reused through some form of land application (Goldstein 1998).

Land application of biosolids is currently regulated by the U.S. Environmental Protection Agency (EPA) under Standards for the Use or Disposal of Sewage Sludge (Title 40 Code of Federal Regulations [CFR] Part 503, known as the Part 503 regulations), which were adopted in 1993. Part 503 regulates the final use of biosolids by controlling the permissible levels of various constituents of concern, including the level of pathogen reduction, the degree of vector attraction reduction, and the concentration of pollutants in the biosolids. The Part 503 regulations apply to the generator of the biosolids, however, not the applier. The GO would apply to dischargers of biosolids rather than biosolids generators. The Part 503 regulations establish two pathogen reduction standards for land-applied biosolids: Class A biosolids are treated sufficiently for all pathogens to be essentially eliminated, and Class B biosolids have been treated sufficiently for the level of pathogens to be substantially reduced but not completely removed.

No single state agency regulates land application of biosolids in California; biosolids recycling projects may involve oversight by the SWRCB, the nine regional water quality control boards (RWQCBs), the California Integrated Waste Management Board (IWMB), the California Air Resources Board, and the California Department of Food and Agriculture (DFA). The California Department of Health Services (DHS) acknowledges biosolids recycling efforts in its Manual of Good Practice for Landspreading Sewage Sludge (California Department of Health Services 1983). The IWMB has classified biosolids as a solid waste and thus exercises jurisdiction over biosolids use and disposal. The IWMB is responsible for regulating biosolids composting practices (14 California Code of Regulations [CCR], Division 7, Chapter 5), which requires recycling agencies to submit a permit application through the IWMB tiered permitting program. The IWMB designates a local agency in each county as the local enforcement agency (LEA), which sets standards and enforces solid waste regulations. Some counties have made land application of biosolids exempt from solid waste regulations, and others specify where and how disposal of biosolids can be conducted. Some counties have banned the land application of biosolids entirely.

In an effort to streamline the RWQCB application and permitting process for the use of biosolids, the Central Valley and Lahontan RWQCBs developed separate general waste discharge requirements (WDRs) (also called GOs) for biosolids land application in 1995 and adopted their programs after approving negative declarations under CEQA. Public agencies subsequently petitioned the SWRCB to set aside the RWQCB actions. During the interim before the SWRCB decision, biosolids application projects were permitted for approximately 50,000 acres under the Central Valley GO. The SWRCB remanded the Central Valley RWQCB GO in April 1996 as a result of legal challenges to the negative declaration but allowed for the continued land application of biosolids on sites for which permit coverage had been filed before April 1, 1996. In May 1996, a CEQA-based lawsuit was filed by the Central Delta and South Delta Water Agencies in the Superior Court of California, County of Sacramento, seeking that the SWRCB's interim permission for biosolids land application be rescinded under the GO unless an EIR is prepared. On June 12, 1997, the Superior Court decided that the SWRCB exceeded its authority in allowing the limited number of land application projects to proceed. On September 12, 1997, the Superior Court judge allowed for the continued application of biosolids on the subject sites and ordered the SWRCB to develop this statewide EIR for land application of biosolids within approximately a 3-year timeframe (by October 2000). The Lahontan GO was also subsequently remanded by the SWRCB, but no sites were permitted under this GO at that time.

Existing and Projected Biosolids Land Application in California

The methods available for biosolids management, and particularly land application of biosolids, are determined primarily by the quality of the generated product. Sewage sludges removed in municipal wastewater treatment plants can be treated to produce biosolids of sufficient quality for use as soil amendments or can be disposed of using the alternatives mentioned below. The three primary methods for reuse and disposal of biosolids are land application, surface disposal in a landfill, and incineration.

Quantity of Biosolids Generated in California

The California Association of Sanitary Agencies (CASA), a nonprofit organization of municipal utilities, conducted statewide surveys in 1988, 1991, and 1998 to estimate the quantity of biosolids generated and the uses of those biosolids (California Association of Sanitary Agencies 1991, 1999). The 1988 and 1991 CASA survey results are derived from a database of 120 publicly owned treatment works (POTWs) in California.

CASA concluded that daily sludge disposal was 1,025 dry tons per day (TPD) in 1988; 1,610 dry TPD in 1991; and 1,842 dry TPD in 1998 (not all of the 120 POTWs submitted survey results). More than 70% of this material is generated at 10 POTWs that have wastewater flows in excess of 50 million gallons per day (mgd). The Los Angeles RWQCB region generates the greatest percentage (nearly 50%) of sludge among the nine RWQCB areas, followed in order by the Central Valley, San Francisco Bay, and Santa Ana regions.

Disposal and Reuse Methods

Most of the biosolids being reused in California are generated in the Los Angeles and Orange County areas, as well as in the other large urban centers of the state (San Diego, the San Francisco Bay Area, Sacramento). Much of this material is transported a considerable distance by truck for land application. The counties supporting the largest amounts of biosolids reuse are Kern, Kings, Merced, San Diego, Riverside, and Solano.

Biosolids disposal and reuse methods in California include landfills, land application, composting, onsite storage and incineration. The 1988 CASA survey results estimates that approximately 60% of the biosolids generated in California were disposed of in landfills; the percentage decreased to approximately 45% by 1991. Land application and composting accounted for 18.7% and 21.7%, respectively, of biosolids reuse in 1991, and both uses had increased considerably from what was reported in 1988. The combined onsite storage and incineration of biosolids remained stable from 1988 to 1991 at approximately 14% of the total generated quantities. The 1998 information indicates a huge increase in land application, with nearly 68% of the material reported through the survey going to this reuse option. As a result, the percentage being disposed of in landfills was reduced to 9.1%. Incineration was the selected method of disposal for 5.6%, and 6.9% remained in onsite storage.

The GO regulates the use of biosolids for agriculture, horticulture, silviculture, and land reclamation. In general, the most common land application practice for biosolids is spreading and incorporation into agricultural lands. In California, horticultural use typically involves Class A Exceptional Quality biosolids that have been composted with various types of green waste. The use of biosolids for horticultural activities could include large-scale landscape plantings such as road medians, parks, and golf courses and as a planting or potting medium in large nursery operations.

Currently, no large-scale silvicultural uses (commercial tree farming operations) of biosolids are under way in California. Silvicultural uses are common in other parts of the country, however, including the Pacific Northwest. Additionally, land reclamation is not currently a major biosolids reuse option in California. The major use that would fall into this category is incorporation into final cover material at landfills. This use is not considered a disposal method because it is intended to increase the productivity of the cover soils. Other land reclamation uses could include incorporation into surface materials at mining reclamation sites or soil borrow areas where subsoil material with low growing potential is exposed at the surface.

Future Biosolids Activity in California

Future biosolids production can be estimated based on population projections and per capita generation rates. Statistics were compiled from the California Department of Finance and CASA for use in this EIR. Based on census information, the population in urban areas in 1990(the date for which census data and CASA survey data most closely coincide) was 29.8 million (California Department of Finance 1998a), and this figure is expected to increase by approximately 42.3% to 42.4 million by 2015 (California Department of Finance 1998b). Based on the 1991 CASA estimate of biosolids generation (1,610 dry TPD) and assuming that the rate of per capita biosolids generation remains similar until 2015, the total estimated production of biosolids is expected to increase to 2,329 dry TPD. If the percentage of biosolids that are land applied remains constant in the next 15 years, the amount of material being land applied would be 1,579 dry TPD in 2015, with an annual total of 576,690 dry tons.

General Order Program Objectives

The goal of the GO is to provide a clear and consistent regulatory process that is adequately protective of environmental resources, streamlines the permitting process for land application of biosolids, and includes policies and procedures that ensure continued refinement of biosolids disposal practices and protection of the environment. Therefore, the GO is intended to:

- comply with Section 13274 of the California Water Code and the judicial order by the Superior Court of California for the County of Sacramento by adopting statewide general WDRs for the discharge of dewatered, treated, or chemically fixed sewage sludge (biosolids) for beneficial use as a fertilizer and/or soil amendment;

- provide a regulatory framework for biosolids application to land that can be used by individual RWQCBs to act on Notices of Intent (NOIs) filed by potential dischargers in a manner that avoids or mitigates potentially adverse environmental effects; and

- provide a flexible regulatory framework that allows implementation of a biosolids disposal program for land application operations at the regional level and contains requirements that are based on sound science and best professional judgment.

Description of General Order

Overview

The proposed GO was developed to provide a single regulatory framework for the land application of biosolids in California and to streamline the permitting process that each RWQCB uses for biosolids application projects. Provisions of the GO are based largely on the federal Part 503 regulations to ensure that the state regulation incorporates the extensive health risk assessments and scientific review that went along with developing the federal regulation. Baseline criteria that were established under the Part 503 regulations must be met under the GO and associated general WDRs. This section generally describes the principal permit conditions and procedures of the GO.

Applicability

For the purposes of the GO, biosolids are defined as only those sewage sludges produced at municipal wastewater treatment plants that meet the requirements of the Part 503 regulations. Unstabilized sewage sludge, septage, and wastes that do not meet the Part 503 regulations or are determined to be hazardous under Title 22, Division 4.5, Chapter 11, Article 3 of the CCR would not be regulated under the GO.

Under the GO, the discharger is primarily defined as the landowner but may also include an individual, business, or organization involved in the generation, transportation, and application of biosolids. The discharger would be legally responsible for implementing and complying with the provisions of the general WDRs issued by the RWQCB in accordance with the GO.

A biosolids application project that is permitted under a single NOI must involve less than 2,000 acres of land that receive biosolids, and all application sites must be within 20 miles of each other. In addition, each landowner involved with a biosolids application project must file a separate NOI and pay a separate filing fee. A permitted project for which the GO is applicable may involve a single application of biosolids or repeated applications. The identification of permitted activities under the GO does not preempt or supersede the authority of local agencies to prohibit, restrict, or control biosolids reuse.

The discharger is responsible for making inquiries about permitted uses and obtaining applicable local permits and authorizations.

An important component of the GO is the requirement that each biosolids application project operator, before applying any biosolids, must prepare and submit an NOI for the area in which the biosolids are to be applied. The appropriate RWQCB would then review information contained in the NOI and, if it finds the information to be adequate, issues a Notice of Applicability under the general WDRs of the GO along with discharge monitoring requirements. A complete NOI includes a preapplication report that provides the RWQCB with specific information relating to each field or distinct application area.

An annual filing fee is required for each year that the project is operating and is based on the threat to water quality and complexity of the project as identified in 23 CCR 2200. Biosolids projects encompassing an area of 40-2,000 acres would be designated a Category II threat to water quality and given a Category "b" complexity rating. Biosolids projects of less than 40 acres would be classified a Category III threat to water quality and given a Category "b" complexity rating.

Relationship of the GO to Part 503 Regulations

Some of the minimum standards established under the Part 503 regulations are applicable to the proposed GO program:

- Biosolids must be treated to reduce potential disease-causing pathogens.
- Class A biosolids have been treated sufficiently that pathogens are essentially eliminated; Class A biosolids must be monitored for bacteria growth at the time of use.
- Class B biosolids have been treated sufficiently that pathogens are substantially reduced, but not completely eliminated. Land application of biosolids that meets Class B criteria is restricted by the following conditions:
  - food crops with harvested parts that touch the soil cannot be harvested for 14 months after biosolids application;
  - food crops with harvested parts below the soil cannot be harvested for 20 months after application if biosolids remain on the land surface for 4 months or longer before being incorporated into the soil;

- food crops with harvested parts below the soil cannot be harvested for 38 months after application if biosolids remain on the land surface for less than 4 months before being incorporated into the soil;
- food and fiber crops cannot be harvested for 30 days after biosolids application;
- animals cannot be grazed on the site within 30 days of biosolids application;
- turf cannot be harvested for 12 months after biosolids application if the site is likely to have extensive public exposure (e.g., golf courses, parks);
- public access to land that is likely to have extensive public exposure is not allowed for 12 months after biosolids application;
- grazing of milking animals used for producing unpasteurized milk for human consumption is prevented for at least 12 months if the field is used as pasture; and
- public access to land that is unlikely to have extensive public exposure is not allowed for 30 days after biosolids application.

The Part 503 regulations also outline several alternative chemical and physical treatment processes and management practices that the biosolids must undergo to reduce vector attraction. Biosolids must be treated to meet at least Class B criteria for pathogen reduction and vector reduction levels before they can be applied to land.

The material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations of 10 metals, nine of which are regulated under the Part 503 regulations (see the discussion below in "Discharge Prohibitions of the GO" and "Discharge Specifications of the GO"). Restrictions on pollutant addition levels are described in "Discharge Specifications in the GO".

Discharge Prohibitions of the GO

The GO contains prohibitions that apply to all land application projects that request authorization. In general, biosolids must not be applied under the following conditions:

- the biosolids to be discharged cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste;

- the biosolids cannot be discharged except as allowed at authorized storage, processing, and land application sites;

- no application is permitted until the RWQCB has issued a Notice of Applicability, a set of individual WDRs, or a waiver of WDRs;

- no application is permitted if the discharge would cause or threaten to cause pollution or create a nuisance as defined by Section 13050 of the California Water Code;

- no application is permitted that would cause a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5);

- no application is permitted to areas not specified in the applicant's NOI;

- no application is permitted to surface waters or drainage courses;

- no application is permitted when the application rate would exceed the nitrogen requirements of the vegetation or the rates that would degrade groundwater unless specifically authorized (application in excess of nitrogen requirements may be allowed for land reclamation sites if a certified agronomist, registered agricultural engineer, or registered civil engineer demonstrates that application would not degrade the quality of underlying groundwater);

- no surface water runoff resulting from irrigation of the site is permitted within 30 days of application unless a sufficient buffer of grass (more than 33 feet) is present to prevent biosolids from being carried in runoff from the application site;

- no application is permitted to frozen or water-saturated ground or during periods of rain heavy enough to cause runoff from the site;

- no application or incorporation into the soil is permitted when wind may reasonably be expected to cause airborne particulates to drift from the site;

- no application is permitted in areas subject to erosion or washout offsite; and

- discharge of biosolids with pollutant concentrations greater than specified levels is prohibited.

Discharge Specifications of the GO

The GO contains specifications for the quantity and quality of biosolids that are allowed to be land applied. Most of these specifications are similar to the requirements of the Part 503 regulations and include the following:

- Biosolids must be treated to meet Part 503 standards for vector reduction and be treated to either the Class A or Class B level of pathogen reduction standards.
- Cumulative lifetime metals loading limits for a given application site shall not exceed specified levels (including background soil levels and levels in applied biosolids).
- Biosolids application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed for reclamation sites or biosolids research projects.
- Following incorporation of biosolids into the soil, tilling practices must minimize erosion of the site resulting from wind, stormwater, and irrigation water.
- If the slope of the application site is greater than 10%, an erosion control plan must be prepared by a qualified erosion control specialist.
- For Class B biosolids, the harvesting period for crops is restricted as described in the Part 503 regulations. In addition, the location of application is specified with respect to property lines, municipal and agricultural supply wells, public roads, surface waters, agricultural buildings, and residential buildings.

Storage and Transportation

The GO specifies conditions for the storage and transportation of biosolids. Major conditions of the GO include the requirement for biosolids to be transported in covered, leakproof vehicles; drivers must carry a copy of an approved spill response plan and be trained with regard to the proper response to accidents or spill events. The GO defines storage as placement of biosolids on the ground or in nonmobile containers for more than 7 consecutive days at an intermediate site other than the place of generation and/or processing. If biosolids are to be stored at the application site, the operator must prepare and implement an RWQCB-approved storage program. Biosolids must not be stored for longer than 7 consecutive days; storage areas must be covered between October 1 and

April 30 during periods of runoff-producing precipitation; public access to storage areas must be restricted; and control measures should be implemented to prevent leachate into the soil, surface runoff, and washout from floods.

Provisions

The GO contains 20 general conditions and procedures that must be followed by the discharger. The general provisions are summarized under the following categories of responsibilities:

- **Obtaining, maintaining, and terminating coverage under the GO:** An NOI must be submitted for each biosolids source and discharge site. Specific agencies, adjacent residents, and adjacent landowners identified in the GO and any local agency with jurisdiction over the application site must be notified. The RWQCB must be notified in advance of any transfer of the project to another party. The RWQCB must be notified of project completion through submittal of a Notice of Termination and a Final Discharge and Monitoring Program report. Provisions of the general WDRs issued by the RWQCB are severable.

- **Chain of responsibility:** Individual property owners and companies responsible for biosolids discharges and site operations are primarily accountable for compliance and enforcement actions under the GO. The discharger is responsible for informing all biosolids haulers using the land application site of the conditions contained in the GO. Individual property owners are responsiblefor applicable crop selection, property access, and harvesting restrictions under the GO.

- **Monitoring, reporting, and record keeping:** The preapplication form that is attached to the GO describes the general reporting requirements and specific groundwater monitoring requirements (if deemed necessary). Groundwater monitoring would generally be required if the depth to groundwater at the disposal site is less than 25 feet and biosolids would be applied to the site more than twice in a 5-year period. If required, one upgradient and two downgradient wells must be monitored annually at each application site to evaluate water level, pH, total dissolved solids, sodium, chloride, nitrate, and total nitrogen levels. The discharger is responsible for implementing the requirements of the GO and for site operations and conducting the required monitoring programs. Sampling must be conducted using approved methods, accurate and properly calibrated equipment, and certified laboratories. Information that must be recorded includes the quantity of biosolids applied at each site along with its nitrogen content, crops grown, and total pollutant loading. The discharger must notify the

RWQCB of any noncompliance with the GO within 24 hours. The discharger must keep monitoring records for at least 3 years. Annual monitoring reports submitted to the RWQCB must be signed and certified by the discharger or a duly authorized representative.

General Order Exclusion Areas

The proposed GO specifies several areas of the state within which biosolids application projects under the GO cannot be permitted. Generally, the exclusion areas are unique or valuable public resources, jurisdictional waters or preserves, or state-designated management areas. The general areas excluded from this GO are the following:

- the Lake Tahoe Basin;
- the Santa Monica Mountains Zone;
- the California Coastal Zone;
- the area within 0.25 mile of a wild and scenic river;
- the jurisdictional Sacramento-San Joaquin River Delta;
- Suisun Marsh;
- the area under the jurisdiction of the San Francisco Bay Conservation and Development Commission; and
- several specific areas within the jurisdiction of the Lahontan RWQCB, including the Antelope Hydrologic Unit above 3,500 feet, areas in the Mojave River Planning Area, the Hilton Creek/Crowley Lake areas, and areas of the Mono-Owens Planning Area.

These areas are not included in the analysis of this EIR.

Alternatives to the Proposed Project

In accordance with State CEQA Guidelines Section 15126.6, an EIR must describe a range of reasonable alternatives to the project, or to the location of the project, that would feasibly attain most of the basic project objectives of the proposed project but would avoid or substantially lessen any of the significant effects of the project, and must evaluate the comparative merits of these alternatives. An EIR does not need to consider every conceivable alternative to a project; rather, it must consider a reasonable range of potentially feasible alternatives that will foster informed decision making and public participation. State CEQA Guidelines Section 15126.6(d) allows for alternatives to be analyzed in lesser detail than the proposed project.

The alternatives to the proposed project were developed to comply with CEQA and are based on input received during the public scoping period. The No-Project Alternative was developed to comply with CEQA. The Modified General Order Alternative is included because it would achieve the project's objectives and would result in reduced impacts compared with the proposed project. Although the Land Application Ban Alternative would not meet the project's basic objectives, it was included in the alternatives analysis to respond to issues identified during the public scoping period.

Impacts of the Proposed General Order

Table ES-1 (at the end of this chapter) presents a summary of project impacts and mitigation measures under the proposed project. Details of the mitigation measures can be found in each relevant technical chapter. Additionally, a mitigation monitoring program is included in Chapter 15, "Mitigation Monitoring Program".

Environmentally Superior Alternative

CEQA requires that the lead agency identify the environmentally superior alternative among those evaluated in the EIR that are within the reasonable range of alternatives. The Modified General Order Alternative is the environmentally superior alternative because it reduces the potential for significant environmental effects when compared to the proposed GO and it is within the reasonable range of alternatives. The Modified GO would include various additional discharge requirements that take into account some of the unusual conditions that exist in regions of California that might receive land-applied biosolids. It also contains the requirements for some additional data and technical analysis to be available to the RWQCB staff when evaluating individual land application permits.

Under the Modified General Order Alternative, potential impacts related to water quality, land productivity (including trace elements and heavy metals in soils), soil erosion, crop contamination, public health risk, land use compatibility, reduced visual quality, potential loss of special-status plant and wildlife species or biologically unique or sensitive natural communities, air quality emissions exceeding significance thresholds for air districts, exposure of sensitive receptors to noise, and disturbance of significant cultural resources would not occur because measures have been incorporated into the design of this alternative to avoid these impacts.

Other CEQA-Required Impact Conclusions

Cumulative Impacts

State CEQA Guidelines Section 15130 requires that an EIR discuss cumulative impacts of a proposed project when the incremental effects of an individual project would be considerable viewed in connection with the effects of past projects, the effects of current projects, and the effects of probable future projects. Additionally, the State CEQA Guidelines state that when a lead agency is examining a project with an incremental effect that is not cumulatively considerable, a lead agency need not consider the effect significant but shall briefly describe its basis for reaching that conclusion. Land application of biosolids could contribute to less-than-significant cumulative impacts for biological resources, air quality, and transportation and a significant cumulative impact for groundwater. Cumulative impacts on these resources are discussed in Chapter 13.

Growth-Inducing Impacts

State CEQA Guidelines Section 15126.6(d) requires an EIR to include a discussion of the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment.

The land application of biosolids would not be growth inducing because it would not foster economic or population growth or remove any obstacles to growth in California. Land application of biosolids is an existing activity in California and would not induce growth as a result of adopting the proposed GO.

Significant and Unavoidable Impacts

CEQA requires that an EIR identify any significant and unavoidable impacts of the proposed project. Implementation of the GO would not result in any significant and unavoidable impacts.

Irreversible Commitment of Resources and Significant Irreversible Environmental Changes

State CEQA Guidelines Section 15126 requires that an EIR include a discussion of any irreversible commitment of resources that would occur as a result of project implementation. Irreversible commitment of resources would occur as a result of implementing the proposed project. These resources include fossil fuels, labor, and energy required for transporting and spreading biosolids.

CEQA also requires that an EIR identify any significant irreversible environmental changes that could result from the project. Although there is the potential for accidental spills of biosolids to occur during transportation of the biosolids to the application site, the GO requires that biosolids be transported in covered, leakproof vehicles; therefore, accidental spills of biosolids resulting from transporting biosolids to a site are unlikely because of the measures incorporated into the GO. If spills did occur, it would be unlikely that an irreversible environmental change would occur. Additionally, land application of biosolids would generally occur on lands that are currently in agricultural production. It is unlikely that significant amounts of land would be converted from nonagricultural to agricultural land use (or to silvicultural, horticultural, or land reclamation use) as a result of this project.

Known Areas of Controversy

State CEQA Guidelines Section 15123(b) requires that an EIR identify areas of controversy known to the lead agency, including issues raised by other agencies and the public. The following are known areas of controversy for regulating the land application of biosolids expressed during the scoping and preparation of this EIR.

Validity of Scientific Data Used during the Formulation of Part 503 Regulations. Numerous comments were received during the scoping process for the draft EIR regarding the validity of the scientific data used by EPA when formulating the

Part 503 regulations. These concerns, including those expressed in the Cornell Waste Management Institute's 1999 working paper (Cornell Waste Management Institute 1999) have been reviewed and taken into consideration in preparing the impact analyses in this EIR. The proposed GO includes land application controls that are more stringent than those included in the Part 503 regulations to account for unusual conditions that may exist in California and differences of opinion that may exist about the adequacy of the Part 503 regulations.

Reduced Property Values where Land Application Occurs. Issues were raised during the scoping process for the draft EIR regarding the potential for reduced property values on and adjacent to sites where land application occurs. Potential property value effects have not been addressed in this EIR, as they would be an economic rather than an environmental effect. Property value effects are considered speculative at this time.

Loss of Crop Value as a Result of Public Perception. Another known area of controversy raised during the scoping process for the draft EIR was the potential for a decrease in crop value resulting from the public perception of biosolids being applied to the soil where these crops were grown. Additionally, concern was raised that crop value would be reduced for land adjacent to parcels where biosolids land application has occurred because the public or food processors could believe that the crops were grown on soil containing biosolids or were contaminated by the adjacent site where biosolids have been used. This issue has been addressed in Chapter 4, "Land Productivity" with regard to the productive value of the land. The potential economic effects are not discussed because they are considered speculative and would not result in a physical change in the environment.

Increase in Operation Costs. Concerns were raised about the GO's effect on operating costs at POTWs. If POTW costs are increased to meet additional treatment and reuse restrictions, the cost to the general public for wastewater treatment might also increase. Although the cost of biosolids treatment and management might increase to meet all of the terms of the GO, the economic effects have not been predicted in this EIR because they are not considered environmental impacts.

Availability of RWQCB Resources to Adequately Monitor and Enforce the GO. Several comments received during the scoping process for the draft EIR related to the availability of the RWQCBs to adequately monitor and enforce the GO. The RWQCBs are the state enforcement agency charged with regulating the land application of biosolids. Members of the public and agency staff indicated that both funds and staffing resources would be needed for the RWQCBs to adequately administer this additional regulatory program. Much of the public concern regarding the viability of the GO has related to its reliance on strong monitoring and enforcement actions.

Significance of Certain High-Profile, Widely Publicized Human Diseases. Several comments also were received regarding certain high-profile, widely publicized human diseases, such as AIDS, hepatitis, “mad cow” disease, hormone inhibitors, and Legionnaire’s disease. Chapter 5, “Public Health”, discusses the potential for these diseases to occur as a result of implementing the proposed GO. Because there is not a large body of research regarding the ability of these diseases to be transmitted specifically in biosolids, the public health risks are considered speculative and the potential for these risks will continue to be studied.

General Public Acceptance of Reusing Human Waste. Another known area of controversy is the public acceptability of reusing human waste. Although human waste has been used as a resource by various cultures worldwide for thousands of years, the potential public health risk and the tendency to remove this material from today’s modern society will continue to make land application a controversial action. The agencies and associations interested in maintaining the resource value of biosolids are attempting to change public perception through education and additional research.

Required Permits and Approvals

State CEQA Guidelines Section 15124 states that an EIR must include a list of the agencies that expect to use the EIR in their decision making and a list of the approvals required to implement the project. In order for the proposed GO to be implemented, the SWRCB would adopt the GO and certify the EIR. With the exception of the RWQCBs, no other agencies would use the EIR for decision making purposes. No other permits or approvals would be required.

Table ES-1.
Summary of Impacts and Mitigation Measures for the California State Water Resources Control Board General Waste Discharge Requirement for Biosolids Land Application

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Soils, Hydrology, and Water Quality			
Changes to existing drainage patterns or increase in surface runoff	Less than significant	None required	Less than significant
Changes in groundwater supply and hydrology	Less than significant	None required	Less than significant
Potential degradation of surface water from nutrients in biosolids	Less than significant	None required	Less than significant
Potential degradation of groundwater from nutrients	Less than significant	None required	Less than significant
Potential degradation of surface water and groundwater from trace elements in biosolids	Less than significant	None required	Less than significant
Potential degradation of surface water and groundwater from synthetic organic compounds in biosolids	Less than significant	None required	Less than significant
Land Productivity			
Changes in physical soil properties and resulting effects on productivity	Less than significant	None required	Less than significant
Changes in soil fertility and salinity and resulting effects on productivity	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report	Less than significant

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Changes in trace elements and heavy metal plant toxicity in soils and resulting effects on productivity	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report	Less than significant
Changes in amount of synthetic organic compounds in soils and resulting effects on agricultural productivity	Less than significant	None required	Less than significant
Changes in grazing-land productivity	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report 4-2: Extend grazing restriction period to allow for SOC biodegradation	Less than significant
Increases in soil erosion rates and resulting effects on production	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report	Less than significant
Changes in farmland classification	Less than significant	None required	Less than significant
Effect on agricultural lands caused by public concerns about crop contamination from biosolids applications	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report 4-2: Extend grazing restriction period to allow for SOC biodegradation 4-3: Track and identify biosolids application sites	Less than significant
Changes in soil nutrient properties and resulting effects on productivity for silvicultural activities	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report	Less than significant

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Potential soil degradation at recreation-area apploication sites	Less than significant	None required	Less than significant
Potential soil degradation	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report 4-2: Extend grazing restriction period to allow for SOC biodegradation	Less than significant
Public Health			
Potential for increased incidence of disease resulting from direct contact with pathogenic organisms at biosolids land application sites	Less than significant	5-1: Review manual of good practices (recommended)	Less than significant
Potential for increased incidence of disease resulting from direct human contact with pathogenic organisms in irrigation runoff from biosolids land application sites	Less than significant	None required	Less than significant
Potential for increased incidence of disease resulting from ingestion of pathogenic organisms in crops grown on land application sites or animals fed with crops grown on land application sites	Potentially significant	5-2: Extended grazing restriction period to allow for pathogen reduction	Less than significant
Potential for increased incidence of chronic human disease resulting from ingestion of biosolids-derived metals in crops grown on land application sites or animals fed with crops grown on land application sites	Less than significant	None required	Less than significant

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Potential for increased risk of chronic disease resulting from ingestion of biosolids-derived organic compounds in food, soils, animals, dairy products, or wildlife	Less than significant	None required	Less than significant
Potential for increased incidence of disease resulting from ingestion of groundwater contaminated by biosolids-derived pollutants or pathogens	Less than significant	None required	Less than significant
Potential for increased incidence of acute or chronic disease resulting from human exposure to aerosols and wind-blown particulates from biosolids stockpiling, composting, or land application	Less than significant	None required	Less than significant
Potential for increased risk of disease resulting from contact with biosolids spilled during transport from point of generation to application site	Less than significant	None required	Less than significant
Land Use and Aesthetics			
Application of biosolids in a manner and/or in locations in conflict with local land use plans and ordinances, including future planned land uses	Less than significant	None required	Less than significant
Application of Class B biosolids at locations that may conflict with existing land uses in urban areas; recreation areas; or other sensitive areas, including schools, hospitals, and recreation/public assembly areas	Potentially significant	6-1: Require setbacks from areas defined as having a high potential for public exposure	Less than significant

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Reduced visual quality resulting from truck transport of biosolids through residential and/or recreational areas	Significant	10-2: Control fugitive dust from unpaved roads 11-1: Avoid the use of haul route near residential lands	Less than significant
Reduced visual quality resulting from land application activities adjacent to schools, hospitals, or recreation/public assembly areas	Potentially significant	10-2: Control fugitive dust from unpaved roads	Less than significant
Reduced visual quality resulting from spillage of biosolids on public roads	Significant	6-2: Require the maintenance of biosolids transport trucks after biosolids are loaded in the trucks	Less than significant
Biological Resources			
Reduction in the number of a special-status plant or wildlife species	Significant	7-1: Modify pre-application report and provide biological information	Less than significant
Substantial disturbance of biologically unique or sensitive natural communities	Significant	7-2: Modify pre-application report and provide information on biologically unique or sensitive natural communities	Less than significant
Potential for physiological effects of biosolids application on wildlife	Less than significant	None required	Less than significant
Fish			
Potential for acute toxicity to fish from leaching of biosolids constituents from application sites to surface waters	Potentially significant	8-1: Increase setback from enclosed water bodies if pupfish are present	Less than significant
Potential for reduced fisheries productivity resulting from runoff and erosion	Potentially significant	4-1: Provide soil- and site-screening information with the pre-application report	Less than significant

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
		Traffic	
Potential increase in traffic resulting from the transport of biosolids	Less than significant	None required	Less than significant
Deterioration of roadway surfaces	Less than significant	None required	Less than significant
Potential for roadway safety hazards resulting from accidental spills	Less than significant	None required	Less than significant
		Air Quality	
Generation of NOx and PM10 from biosolid transport vehicles and biosolids spreaders for vehicle travel exceeding 4,800 VMT per day and/or 67 VMT per day on unpaved roads	Potentially significant	10-1: Properly maintain vehicles in good operating condition and limit truck travel on paved roads to 4,800 VMT 10-2: Control fugitive dust from unpaved roads	Less than significant
Exposure of sensitive receptors to odors	Less than significant	None required	Less than significant
Biosolids drift associated with wind-blown biosolids	Less than significant	None required	Less than significant
		Noise	
Exposure of noise-sensitive land uses to noise resulting from the transport of biosolids	Significant	11-1: Avoid the use of haul routes near residential land uses	Less than significant
Exposure of noise-sensitive land uses to noise from the land application of biosolids	Less than significant	None required	Less than significant

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
		Cultural Resources	
Damage to or destruction of cultural resources on lands not previously disturbed by agricultural activities	Significant	12-1: Conduct a cultural resources investigation	Less than significant
Damage to or destruction of unknown cultural resources on lands currently in agricultural production	Significant	12-2: Comply with state laws regarding disposition of Native American burials, if such remains are found	Less than significant
		Cumulative Impacts	
Cumulative nitrate contamination of groundwater	Potentially significant	13-1: Minimize contribution to groundwater nitrate contamination from land application of biosolids conducted under the GO	Less than significant
		13-2: Reduce Sources of Nitrate Contamination	
Cumulative loss of special-status plant and wildlife species or the loss or disturbance of biologically unique or sensitive natural communities	Less than significant	None required	Less than significant
Cumulative increase in NO_x and PM10 emissions	Less than significant	None required	Less than significant
Cumulative deterioration of roadways	Less than significant	None required	Less than significant

Chapter 1. Introduction

The California State Water Resources Control Board (SWRCB) is proposing to adopt a General Order (GO) for General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California (the entire text of the proposed GO is included in Appendix A). Biosolids are defined as sewage sludge that has been treated, tested, and shown to be capable of being beneficially used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation. The GO would establish a notification and permit review process for all persons and public entities intending to apply biosolids to land for purposes stated above. The GO defines discharge prohibitions, discharge and application specifications, transportation and storage requirements, and general procedures and provisions to which all land appliers would be required to adhere.

This chapter briefly describes the background and existing regulations for land application of biosolids in California. In addition, the chapter describes the purpose of the program environmental impact report (EIR) that is being prepared in accordance with the California Environmental Quality Act (CEQA) and the State CEQA Guidelines, the scope of issues to be addressed, and the organization of the EIR.

Background on Biosolids Management in California

Treatment of municipal wastewater typically generates two waste streams: a liquid component and a solid or semisolid component. The liquid component, commonly referred to as effluent, usually is discharged to surface waters or percolation ponds or is used as irrigation water on some types of land. The solid or semisolid component, commonly referred to as sewage sludge, is treated to varying degrees and is typically incinerated, stored in drying beds or ponds, disposed of in landfills, or reused as a soil amendment on some types of land. The GO being considered by the SWRCB will apply to sewage sludges treated and tested to meet the definition of biosolids as presented above.

More than 50% of the biosolids generated in the United States are reused through some form of land application (Goldstein 1998). Land application differs from disposal in that biosolids are applied to condition soil and satisfy or supplement the nutrient requirements of crops or vegetation. Disposal options for biosolids typically include landfilling or incineration. Land application may involve the use of biosolids on traditional agricultural crops, on commercial tree farms, for reclamation of disturbed lands, or in the application of composted or thermally processed materials to public-use areas such as parks and residential landscaping. Certain precautions must be observed to ensure that land application does not endanger public health or adversely affect the environment. The U.S. Environmental Protection Agency (EPA) considers land application a beneficial use because it recycles the nutrients and organic matter contained in biosolids back to the soil (U.S. Environmental Protection Agency 1994).

Existing Regulations for Land Application of Biosolids

Land application of biosolids is currently regulated by EPA under Standards for the Use or Disposal of Sewage Sludge (Title 40 Code of Federal Regulations [CFR] Part 503, known as the Part 503 regulations), adopted in 1993. In designing the Part 503 regulations, EPA used a risk-based approach to develop appropriate treatment, storage, and application procedures for biosolids that are intended to protect human health and the environment from potentially dangerous or toxic constituents that may be present in biosolids. The Part 503 regulations regulate the final use of biosolids according to the constituents of concern, including the level of pathogen reduction, the degree of vector attraction reduction, and the concentration of pollutants in the biosolids. However, the Part 503 regulations apply to the generator of the biosolids, not the applier. Class A biosolids are treated sufficiently for all pathogens to be essentially eliminated, and Class B biosolids have been treated sufficiently for the level of pathogens to be substantially reduced but not completely removed. The regulation was developed through extensive scientific peer review, and public notification and comment were sought before the regulation was adopted. Many state and local agencies now rely on the Part 503 rules for regulatory guidance.

No single state agency regulates biosolids management in California; biosolids recycling projects may involve oversight by the nine regional water quality control boards (RWQCBs) (Figure 1-1), the California Integrated Waste Management Board (IWMB), the California Air Resources Board, and the California Department of Food and Agriculture (DFA). The California Department of Health Services (DHS) acknowledges biosolids recycling efforts in its Manual of Good Practice for Landspreading Sewage Sludge (California Department of Health Services 1983). The IWMB has classified biosolids as a solid waste and thus exercises jurisdiction over the use and disposal of biosolids. The IWMB is responsible for regulating biosolids composting practices (14 California Code of Regulations [CCR], Division 7, Chapter 5), which requires recycling agencies to submit a permit application under the IWMB tiered permitting program. The IWMB designates a local agency in each county as the local enforcement agency (LEA), which sets standards and enforces solid waste regulations. Some counties have made land application of biosolids exempt from solid waste regulations, and others specify where and how disposal of biosolids can be conducted. Some counties have banned the use of biosolids.

In an effort to streamline the RWQCB application and permitting process for the use of biosolids, the Central Valley and Lahontan RWQCBs developed separate general waste discharge requirements (WDRs) (also called GOs) for biosolids land application in 1995 and adopted their programs after adopting negative declarations under CEQA. Public

Jones & Stokes Associates, Inc.

Figure 1-1
Regional Water Quality Control Board Boundaries

agencies subsequently petitioned the SWRCB to set aside both RWQCB actions. However, biosolids application projects were permitted for approximately 50,000 acres under the Central Valley GO. The SWRCB remanded the Central Valley RWQCB GO in April 1996 as a result of CEQA challenges of the negative declaration but allowed for the continued land application of biosolids on sites for which permit coverage had been filed before April 1. 1996. In May 1996, a CEQA-based lawsuit was filed by the Central Delta and South Delta Water Agencies in the Superior Court of California, County of Sacramento, seeking that the SWRCB's interim permission for biosolids land application be rescinded under the GO unless an EIR is prepared. On June 12, 1997, the Superior Court decided that the SWRCB exceeded its authority in allowing the limited number of land application projects to proceed. On September 12, 1997, the Superior Court judge allowed for the continued application of biosolids on the subject sites and ordered the SWRCB to develop this statewide EIR for land application of biosolids within approximately a 3-year timeframe (by October 2000). The Lahontan GO was also subsequently remanded by the SWRCB, but no sites were permitted under this GO at that time.

Purpose of the Statewide Program EIR

The purpose of this statewide program EIR is to comply with the Superior Court order by evaluating the environmental impacts of the SWRCB's adoption and RWQCB implementation of a GO that would allow the issuance of general WDRs for the land application of biosolids. CEQA requires that state and local government agencies consider the environmental consequences of projects over which they have discretionary authority before taking action on those projects (Pub. Res. Code 21000 et seq.). The project analyzed in this document is the SWRCB's discretionary action on the GO; the underlying activity associated with this action is the land application of biosolids. CEQA also requires that each public agency mitigate or avoid, wherever feasible, the significant environmental effects of projects it approves or implements.

An EIR is an informational document used in state, regional, and local planning and decision-making processes to meet the requirements of CEQA. A program EIR is an EIR that is prepared for a series of actions that can be characterized as one large program, in this case the issuance of statewide regulations governing conduct of a continuing program (14 CCR 15168).

The Scoping Process

Section 15083 of the State CEQA Guidelines authorizes and encourages an early consultation or scoping process to help identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in an EIR and to help resolve concerns of affected agencies and individuals. The intent of the scoping process is to identify the significant issues for study in the EIR and to determine the scope of the analysis of each issue. Scoping is designed to explore issues for environmental assessment to ensure that important considerations are not overlooked and to uncover concerns that might otherwise go unrecognized. Scoping has allowed the SWRCB to make the program EIR as complete and informative as possible for decision makers and those affected by the proposed action and its alternatives. This section describes the scoping activities sponsored by the SWRCB.

Notice of Preparation

A notice of preparation (NOP), which is required by CEQA, is the first effort to involve the public and interested agencies in the scoping process. The NOP describes the proposed project or program, indicates the types of environmental effects that could result from implementation of the program, and announces the start of an EIR review process under CEQA. The NOP encourages public participation in the environmental evaluation.

On October 21, 1998, the SWRCB sent an NOP of the statewide program EIR to more than 200 agencies and persons with potential interest in the program. Copies of the NOP were available for review at the SWRCB and each RWQCB office. Additionally, the NOP was posted at the SWRCB home page (http://www.swrcb.ca.go) and an announcement of its availability was forwarded to more than 300 individuals. The SWRCB developed a mailing list of agencies, organizations, and individuals interested in receiving the NOP and scoping meeting announcements. The list also was used for distribution of this EIR. The NOP and the distribution list for the NOP are included in Appendix B.

Other Scoping Activities

Scoping Meetings

The SWRCB staff held scoping meetings on the following dates and at the following locations:

- November 9, 1998 - Bakersfield
- November 10, 1998 - Palmdale
- November 16, 1998 - Davis

The scoping meetings were held to solicit input from agencies and interested parties on issues to be addressed in the program EIR. The scoping meetings included a description of the meeting's purpose, a description of the proposed GO regulatory program, a presentation of the conceptual environmental effects and program alternatives, an overview of the environmental review process and preparation of the EIR, and a public comment period. Those in attendance made comments on issues related to the GO program and on the alternatives proposed for the EIR. The scoping meetings were advertised in five publications throughout California, including a Spanish-language publication. In addition, a press release in Spanish about the scoping activities was distributed to several Spanish-language radio stations. A Spanish-speaking interpreter attended each scoping meeting to solicit input.

Technical Advisory Group

In addition to holding public scoping meetings and distributing the NOP, the SWRCB formed a technical advisory group (TAG) to provide input during preparation of the EIR and the GO. Meetings of the TAG have been held intermittently since August 1998. The TAG includes staff members of state and federal agencies (SWRCB, RWQCBs, California Department of Toxic Substances Control [DTSC], DHS, DFA, California Department of Fish and Game [DFG], IWMB, California Air Resources Board, Delta Protection Commission, EPA, U.S. Fish and Wildlife Service, and Natural Resources Conservation Service), representatives of publicly owned treatment works (POTWs) and land appliers, and representatives of special interest groups (California Farm Bureau Federation, Planning and Conservation League, California Communities Against Toxics, Association of California Water Agencies, Sierra Club, and California Environmental Health Associations).

RWQCB Roundtable Meeting

On September 16, 1998, the SWRCB staff sponsored a roundtable meeting in Sacramento to receive direct scoping input from staff members of each of the RWQCBs. The SWRCB solicited input from the RWQCBs on the GO, alternatives to the GO, and the scope of the program EIR. The RWQCBs also were informed of their role as "responsible agencies" under CEQA and their involvement in the EIR review process. Modifications to the GO proposed by the RWQCBs were included in the revised GO. The RWQCBs also indicated how they expected to use the GO after it is adopted by the SWRCB. In addition, the location and format of the public scoping meetings were reviewed and confirmed by the RWQCBs and the SWRCB.

Scoping Report

The NOP requested that recipients send comments on the scope of the EIR to the SWRCB to further identify issues for the EIR. The SWRCB received verbal comments from 67 individuals and letters of comment from 59 individuals or agencies. All of these comments were reviewed and a scoping report was prepared in December 1998 that summarized the proposed program, the scoping process, and issues raised during the scoping process. The report also contains all letters received and a summary of oral testimony received at the scoping meetings. A copy of the report is available for public review at the SWRCB offices in Sacramento (contact Todd Thompson at 916/657-0577) and each RWQCB office.

Issues to Be Addressed in the EIR

Based on input received during the scoping process, the SWRCB staff determined that the following issues are of concern and should be addressed in the program EIR:

- soils, hydrology and water quality,
- land productivity,
- public health,
- land use and aesthetics,
- biological resources,
- traffic,
- air quality,
- noise, and
- cultural resources.

Potential effects on public utilities and infrastructure (other than roads), energy, geology and seismicity were not raised as concerns in the scoping process. A significant number of comments were received on the GO itself, and a number of parties recommended adding project alternatives. All comments were considered in the development of the contents of this program EIR.

Public Involvement

The public is encouraged to continue to be involved in the CEQA process beyond the scoping efforts. This draft program EIR is being circulated for public review and comment. In addition, the SWRCB will be conducting public hearings on the draft document. Comments received at the hearings or received in written form will be considered in the development of a final program EIR. Once the final EIR has been circulated, the SWRCB will receive public testimony on the GO before an official action is taken on its adoption or denial.

Terminology

This report identifies the following levels of impacts:

- a *less-than-significant* impact is an impact that is considered to cause no substantial adverse change in the environment and for which no mitigation measures are required;
- a *significant* impact is an impact that is considered to have a substantial adverse effect on the environment but for which feasible mitigation measures are available to reduce it to a less-than-significant level; and
- a *significant and unavoidable* impact is an impact that is considered to cause a substantial adverse effect on the environment and for which no feasible mitigation measures are available to reduce it to a less-than-significant level.

The program EIR also recommends mitigation measures. The State CEQA Guidelines (Section 15370) define mitigation as:

(a) Avoiding the impact altogether by not taking a certain action or parts of an action.

(b) Minimizing impacts by limiting the degree or magnitude of the action and its implementation.

(c) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.

(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action.

(e) Compensating for the impact by replacing and providing substitute resources or environments.

Mitigation measures proposed in this EIR were developed to meet these requirements.

Report Organization

The content and format of this program EIR are designed to meet the requirements of CEQA and the State CEQA Guidelines. The report is organized into the following chapters so that the reader can easily obtain information about the program and its specific environmental issues.

- The Executive Summary presents a summary of the proposed GO program and its impacts; a description of impacts and mitigation measures, presented in a table format; and impact conclusions regarding growth inducement, irreversible environmental changes, and known areas of controversy.
- Chapter 1, "Introduction", provides a brief overview of the draft EIR.
- Chapter 2, "Program Description", describes the proposed GO program.
- Chapters 3-12 are devoted to the particular issue areas identified above under "Scope of Issues to Be Addressed". Each of these chapters describes for a particular issue area the existing conditions, or setting, before project implementation, specific impacts that would result from the proposed GO program, and mitigation measures that would eliminate or reduce significant impacts.
- Chapter 13, "Cumulative Impacts", summarizes the cumulative impacts of the GO.
- Chapter 14, "Alternatives Analysis", presents the alternatives to the proposed GO (including the No-Project Alternative) and provides an evaluation of each alternative in comparison with the GO.
- Chapter 15, "Draft Mitigation Monitoring and Reporting Program", presents the CEQA-required monitoring program.
- Chapter 16, "Citations", identifies the documents used (printed references) and individuals consulted (personal communications) in the preparation of this EIR.
- Chapter 17, "Report Preparation", lists the individuals involved in preparing this EIR.

Technical appendices are included at the end of the report.

Agencies That Will Use This Document

The SWRCB and each of the RWQCBs will use this EIR in considering their discretionary actions related to the GO program. These actions are as follows:

- The SWRCB must review the EIR before certifying it as an adequate environmental evaluation under CEQA; once the EIR is certified, it will be one of the factors considered by the SWRCB in making a decision regarding the adoption of the proposed GO.

- As responsible agencies under CEQA, the RWQCBs must ensure that the EIR addresses their environmental issues of concern; once the document is certified by the SWRCB and if the GO is approved for implementation, the RWQCBs will use the EIR as an element of the decision-making process when considering a notice of intent (NOI) filed by an individual requesting authorization for land application of biosolids under the adopted GO. If the RWQCBs find that the land application project falls within the scope of the program EIR, it can act as the CEQA compliance document for the new land application project, and mitigation measures in the program EIR will be applied to the project. If the RWQCB finds that the land application program does not fall under the scope of the program EIR, then a new initial study would need to be prepared, leading to either a project-specific negative declaration or a project-specific EIR.

Anticipated Conditions Following Adoption of the GO

The environmental impact discussions contained in Chapters 3-12 are based on an assumed set of conditions that would follow adoption of the proposed GO. POTWs would continue to generate and treat sewage sludges in compliance with waste discharge requirements. Much of this material would be treated to meet the minimum requirements of the EPA Part 503 Regulations and the conditions of the new GO so that it could be reused in agricultural, horticultural, silvicultural or land reclamation activities as biosolids.

Biosolids would be transported to land application sites by truck and then spread on the surface of the soil or injected into the soil; most of this material would be incorporated into the soil within 48 hours of spreading onto the land. The biosolids would be used as a source of nutrients and as a soil conditioner with the intention of growing either a crop or a vegetation cover. The material would not be spread onto the land as a method of disposal, with no intention of supporting vegetation. Limitations on the frequency and volume of biosolids application on any given parcel of land would be determined by the nitrogen and metals loading limits and other restrictions contained in the GO.

The impact analysis assumed a 15-year time frame for this land application process, knowing that the SWRCB would be evaluating the success of the program over the next five years. If necessary, adjustments could be made in the regulation at any time to address longer-term impact issues.

The programmatic impact analysis is intended to address potential environmental impacts at any location in the state that is not implicitly (wetlands, waterways, urbanized areas) or explicitly (exclusion areas) exempted from the GO. Therefore, this EIR also provides programmatic analysis for the existing biosolids land application operations in the state, including the 50,000+ acres permitted under the general waste discharge requirements of the Central Valley and Lahontan RWQCBs prior to initiation of this statewide GO effort.

Chapter 2. Program Description

This chapter provides a description of the SWRCB's proposed GO for regulation of land application of biosolids. It also provides the reader with the setting from which the GO has been developed. The GO objectives and program description are preceded by background information on current biosolids land application in California and the regulatory framework for this activity. The full text of the proposed GO is contained in Appendix A.

Background on Biosolids Generation, Disposal, and Reuse

Existing and Projected Biosolids Land Application in California

The methods available for biosolids management, and particularly land application of biosolids, are largely determined by the quality of the generated product. Sewage sludges removed in municipal wastewater treatment plants can be treated to produce biosolids of sufficient quality for use as soil amendments or can be disposed of. The three primary methods for reuse and disposal of biosolids are land application, surface disposal in a landfill, and incineration. This section describes the existing quantity of biosolids generated at municipal POTWs in California and the distribution of those biosolids to different reuse and disposal options. The projected quantity and distribution of biosolids are discussed with respect to a long-term planning horizon suitable for evaluation in this program EIR.

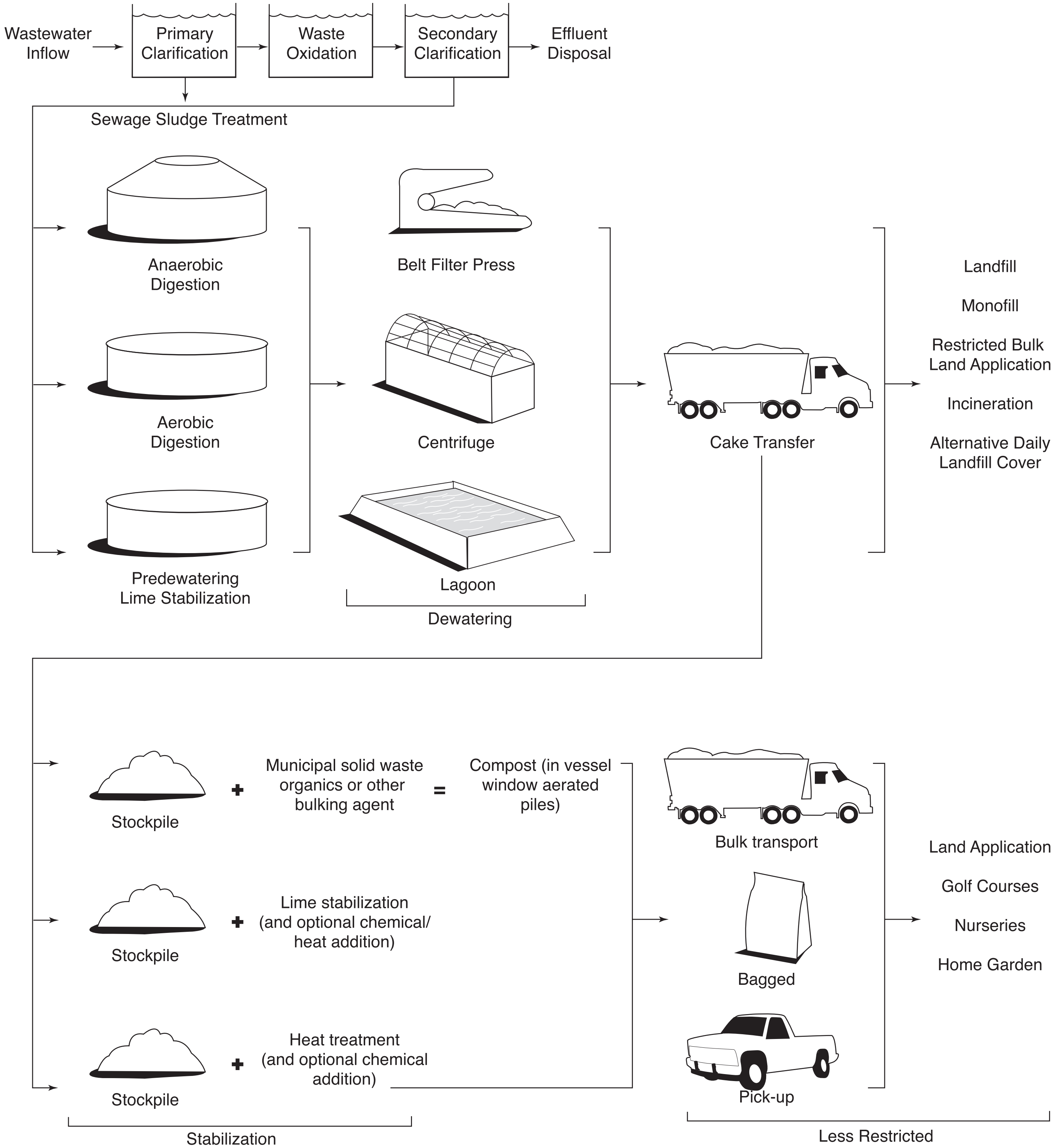
Current Biosolids Activity in California

Typical Biosolids Treatment. The quantity of biosolids generated at a municipal POTW depends on the specific processes for waste treatment and solids thickening that are used and the volume of wastewater received. The water content and appearance of the biosolids can differ depending on the ultimate disposal or reuse option used. Figure 2-1 shows treatment processes used to treat sewage sludge to produce biosolids at a POTW. Biosolids are separated from the liquid fraction of the waste stream at a typical POTW by primary and secondary clarification following waste oxidation processes. Following clarification, biosolids are commonly stabilized by anaerobic digestion, aerobic digestion, or pre-dewatering lime stabilization to reduce the level of pathogens and attraction to disease vectors such as flies, rodents, and mosquitos. Once stabilized, the moisture level of the biosolids may be reduced by mechanical filter presses or centrifuges, gravity dewatering, heat treatment, solar drying, or long-term lagoon storage. After this initial treatment, biosolids can be disposed of in landfills. If pathogen levels and vector attraction have been sufficiently reduced following stabilization and drying, biosolids may then be used as daily cover at landfills; incinerated; or applied in bulk for certain types of agriculture, silviculture, or land reclamation. Alternatively, additional biosolids treatment may be employed (e.g., composting, lime stabilization, heat treatment, and thermophilic digestion) to further reduce pathogen levels and vector attraction. This additional treatment allows for more limited horticultural uses, such as bulk and bagged sales to the public as a garden soil amendment, bulk land application to public areas (e.g., golf courses and parks), and land application for certain agricultural crops.

Quantity of Biosolids Generated. The California Association of Sanitary Agencies (CASA), a nonprofit organization of municipal utilities, conducted statewide surveys in 1988, 1991, and 1999 to estimate the quantity of biosolids currently generated and the uses of those biosolids (California Association of Sanitary Agencies 1991, 1999). The 1988 and 1991 CASA survey results are derived from a database of 120 POTWs in California. CASA received responses from 86% of the POTWs in the 1988 survey and received updated responses from 45% of the POTWs in 1991. Information from the 1998 survey is still being compiled, but it is derived from a 66% response. If complete information was not submitted with the survey response forms, CASA did not include the results in the summary analyses and quantitative estimates of biosolids management practices.

Based on the positive responses, CASA concluded that daily sludge generation was 1,025 dry tons per day (TPD) in 1988; 1,610 dry TPD in 1991; and 1,842 dry TPD in 1998. More than 70% of this material is generated at 10 POTWs that have daily wastewater flows in excess of 50 million gallons per day (mgd). Figure 2-2 shows the regional distribution of sludge production within each RWQCB region, which is generally similar in all three surveys. As shown in Figure 2-2, the Los Angeles region generates the greatest percentage (nearly 50%) of sludge among the nine RWQCB areas, followed in order by the Central Valley, San Francisco Bay, and Santa Ana regions.

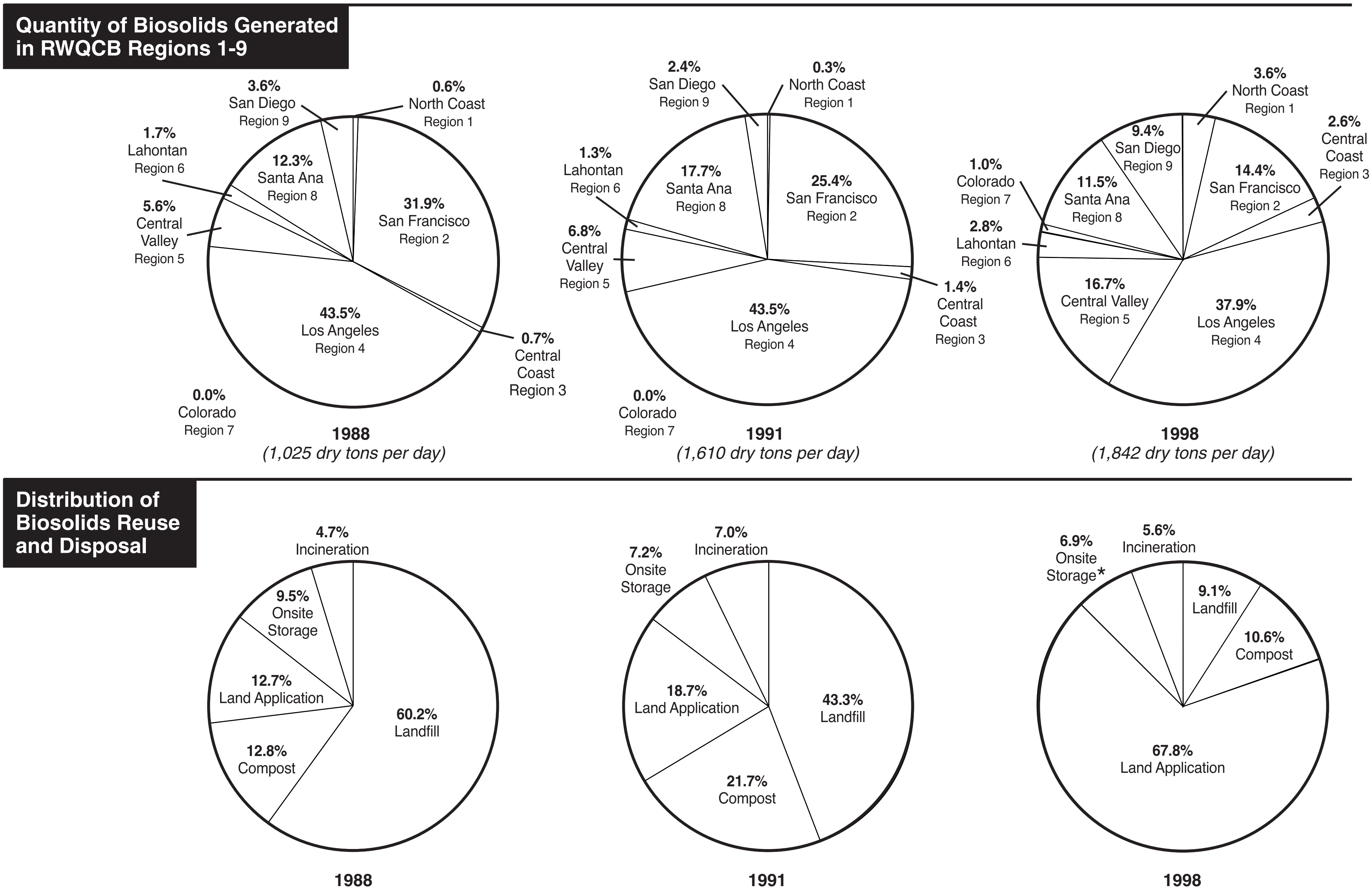
Disposal and Reuse Methods. Biosolids reuse and disposal options as a percentage of total biosolids generated in California are shown in Figure 2-2. The 1988 estimates indicated that approximately 60% of the biosolids generated in California were disposed of in landfills; the percentage decreased to approximately 45% by 1991. Land application and composting accounted for 18.7% and 21.7%, respectively, of the biosolids reuse in 1991, and both uses had increased considerably from what was reported in 1988. The combined onsite storage and incineration of biosolids remained stable from 1988 to 1991 at approximately 14% of the total generated quantities. The 1998 information indicates a huge increase in land application, with nearly 68% of the material reported through the survey going to this reuse option. As a result, the percentage being disposed of in landfills was reduced to 9.1%. Incineration was the selected method of disposal for 5.6%, and 6.9% remained in onsite storage.



SOURCE:
Modified from Carollo Engineers 1997.

Jones & Stokes Associates, Inc.

Figure 2-1
Typical Biosolids Management Practices



SOURCE:
California Association of Sanitation Agencies 1999.

* Onsite storage for this year only combines onsite and offsite storage and surface disposal.

Jones & Stokes Associates, Inc.

Figure 2-2
Distribution of Biosolids Generated in California (1988, 1991, and 1998)

Most of the biosolids being reused in California are generated in the Los Angeles and Orange County areas, as well as in the other large urban centers of the state (San Diego, the San Francisco Bay Area, Sacramento). Much of this material is transported a considerable distance by truck for land application. Table 2-1 identifies the location and volume of biosolids applied to land in 1998 by county, and Table 2-2 identifies the distribution by RWQCB region. The counties supporting the largest amounts of biosolids reuse are Kern, Kings, Merced, San Diego, Riverside, and Solano.

The CASA biosolids surveys did not ask the POTWs to specify whether their land application practices included agriculture, horticulture, silviculture, land reclamation, or home garden uses. In general, however, the most common land application practice is spreading and incorporation into agricultural land (California Water Environment Association 1996). Much smaller quantities are used in composting operations for eventual horticultural use and in land reclamation. Little or no material is currently being used to support silvicultural practices in California.

Agricultural Use. Figure 2-3 shows an example of a land application site for agricultural crop production, including staging (or temporary stockpiling of biosolids) at the farm, loading and spreading of biosolids, and incorporation practices. In agricultural use situations, biosolids are usually transported from the POTW of origin to the agricultural site in bottom-dumping trailers. When the material is received at the agricultural site, it may be dumped directly in long windrows on the fields, bottom-dumped into spreaders for immediate application, or placed in stockpiles for later transfer into spreaders. The biosolids are spread evenly across the fields and subsequently incorporated into the bare soil through disking or harrowing. In some instances, biosolids with a high moisture content may be transferred to liquid tank vehicles and injected into the soil (see Figure 2-3). Individual fields may receive one or several loads of biosolids before a crop is planted.

Horticultural Use. In California, horticultural use typically involves Class A Exceptional Quality biosolids (defined below in "Discharge Specifications") that have been composted with various types of green waste. Following the composting process, the biosolids may be packaged or made available to the public in bulk for home garden use. The GO is not intended to regulate these small-scale uses. The material is also used by various state and local entities and private businesses for large-scale landscape plantings such as road medians, parks, ornamental flower production, landscape and turfgrass production, and golf courses. It may also be used as a planting or potting medium in large nursery operations. Horticultural use areas are generally much more accessible to the public and involve a larger work force than do agricultural operations.

Silvicultural Use. Currently, no large-scale silvicultural uses of biosolids are under way in California. Silvicultural uses are common in other parts of the country, however, including the Pacific Northwest. A typical silvicultural operation would include transfer of biosolids by truck from the POTW to a commercial tree-growing operation. The material would be transferred to a hopper vehicle equipped with an impeller spreader for application. The land itself may be totally cleared or it may have trees already growing. The biosolids may or may not be mechanically incorporated into the soil**,** depending on the existing groundcover and site slopes. In some instances, liquid biosolids have been sprayed onto silvicultural sites.

Land Reclamation. Land reclamation is not currently a major biosolids reuse option in California. The major use that would fall into this category is incorporation into final cover material at landfills. This use is not considered a disposal method because it is intended to increase the productivity of the cover soils. Other uses could include incorporation into surface materials at mining reclamation sites or soil borrow areas where subsoil material with low growing potential is exposed at the surface. Large-scale reclamation uses (i.e., for use in areas of more than 20 acres) are likely to occur in rural areas rather than urban settings because landfills and mining operations are typically not compatible with urban environments.

Future Biosolids Production and Use in California

Future biosolids production can be estimated based on population projections and estimated per capita generation rates. Statistics were compiled from the California Department of Finance and CASA for use in this EIR. The California Department of Finance tracks and prepares reports on various population trends and regional distribution statistics. The use of census information to estimate biosolids generation must discriminate between rural and urban areas because urban areas are more likely to be served by municipal sewer and wastewater treatment systems. Based on census information, the population in urban areas in 1990 (when the last CASA survey was completed) was 29.8 million (California Department of Finance 1998a), and this figure is expected to increase by approximately 42.3% to 42.4 million by 2015 (California Department of Finance 1998b). Based on the 1991 CASA estimate of biosolids generation (1,610 dry TPD) and assuming that the rate of per capita biosolids generation remains similar until 2015, the total estimated production of biosolids is expected to increase to 2,329 dry TPD. If the percentage of biosolids that are land applied remains constant in the next 15 years, the amount of material being land applied would be 1,579 dry TPD in 2015, with an annual total of 576,690 dry tons.

Reuse and disposal practices in California have changed over the years, as can be seen in the differences between the 1988 and 1998 CASA surveys. Consequently, it is difficult to predict how the additional biosolids generated in California will be used and disposed of in the future. The costs of all treatment and disposal options are likely to increase as land values and regulatory controls increase. The future disposal destinations of biosolids will also be affected by available space in landfills, public perception and government policies toward acceptable uses of biosolids, and new information developed by the scientific community. Given that biosolids generation will increase substantially along with the state's population, it is clear that the demand for land application sites will increase as well.

Table 2-1.
Quantities of Land-Applied Biosolids in California by County in 1998

County	Biosolids Land Application (dry tons per year)
Alameda	13,887
Calaveras	8
Contra Costa	2,200
Fresno	895
Humboldt	332
Kern	148,000
Kings	60,000
Lassen	180
Los Angeles	400
Madera	800
Mendocino	200
Merced	60,000
Napa	700
Placer	240
Riverside	34,800
Sacramento	23,601
San Diego	45,297
San Joaquin	7,418
San Luis Obispo	2,890
Santa Barbara	300
Solano	30,000
Sonoma	11,540
Shasta	2,000
Tehama	1,569
Tulare	10,438
Tulomne	200
Total	457,895

Sources: California Association of Sanitation Agencies 1999; Fondahl, Brisco, and Thurber pers. comms.

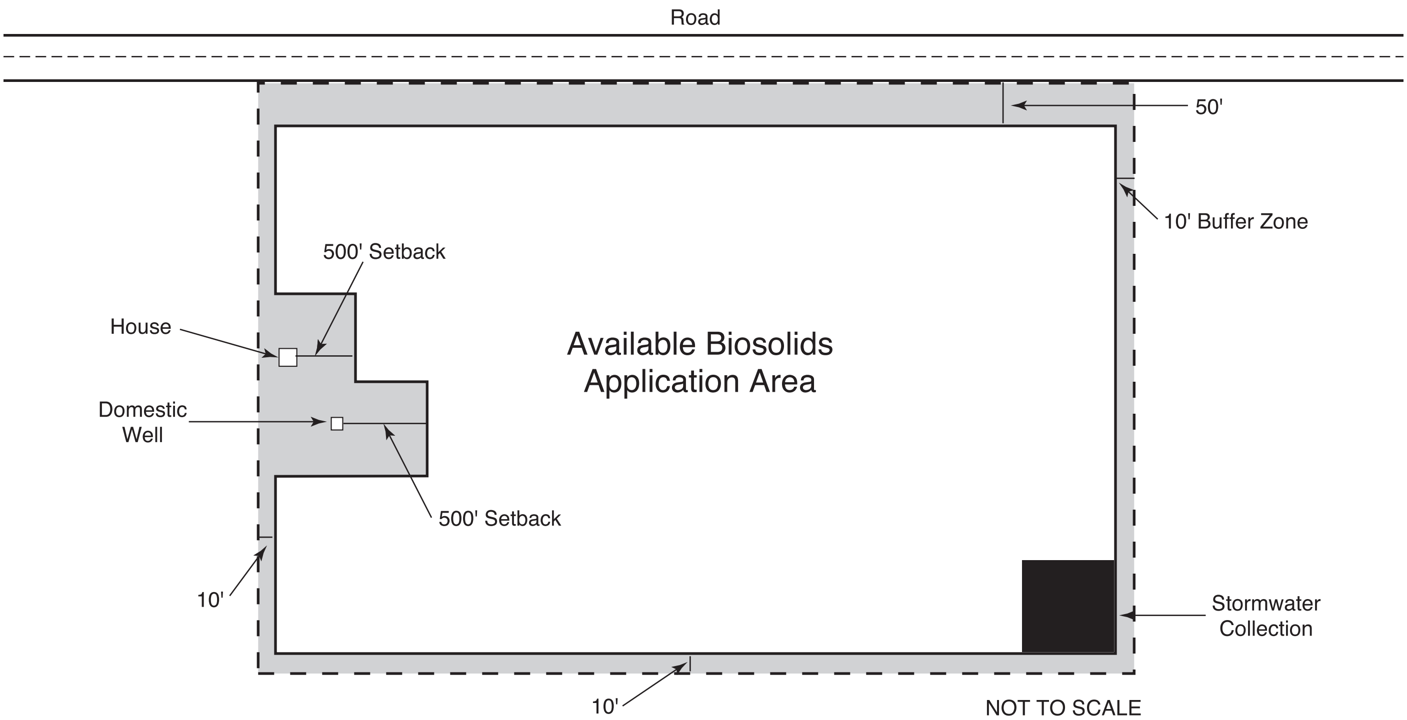
Table 2-2.
Quantities of Land-Applied Biosolids in California by RWQCB in 1998

Regional Board	Biosolids Quantity (dry tons per year)
North Coast	9,764
San Francisco	8,067
Central Coast	3,190
Los Angeles	400
Central Valley	334,786
Lahontan	29,600
Colorado River	28,890
Santa Ana	5,220
San Diego	37,978
Total	457,895

Biosolids staging at farm

Loading spreader

Land application by spreader



Land application by injection

Incorporation of biosolids into soil

SOURCE:
Carollo Engineers 1997.

Jones & Stokes Associates, Inc.

Figure 2-3
Typical Biosolids Land Application Site

Existing Regulatory Programs

The principal regulatory programs that currently have an influence over biosolids disposal and use include the RWQCB implementation of water quality protection programs under the Clean Water Act and California Porter-Cologne Water Quality Control Act, implementation of the federal Part 503 regulations for biosolids management by EPA, and local control of waste disposal at the county level through ordinances and land use regulations. A more detailed description of these and other, less influential state programs is contained in Appendix C.

State Programs—Role of RWQCBs

In California, the land application of biosolids by individuals or parties not involved in biosolids generation is currently regulated primarily through the issuance of waste discharge requirements (WDRs) by the individual RWQCBs in accordance with Section 13260 of the Porter-Cologne Water Quality Control Act. Existing biosolids land application projects have been permitted with individual WDRs issued in several of the nine RWQCB regions. The WDR process requires a potential discharger of biosolids to prepare a Report of Waste Discharge that describes the biosolids application project in detail. The RWQCB then evaluates the project and prepares WDRs that specify discharge conditions, prohibitions, and monitoring and reporting requirements for the project. The RWQCBs often make the WDR process contingent on the project's adherence to the federal Part 503 regulations. Several RWQCBs have adopted waivers for WDR preparation if the biosolids application project would involve biosolids with low pollutant and pathogen concentrations, as specified in the Part 503 regulations (see details below under "Discharge Specifications").

Federal Programs—Part 503 Regulations

The federal regulatory program for biosolids land application is based on the Part 503 regulations. These regulations are overseen by EPA and are considered self-implementing. No site permit is issued for the land application of biosolids. Instead, permits are issued to the biosolids generator. Part 503 restrictions and conditions are typically included in the National Pollutant Discharge Elimination System (NPDES) permit issued by the RWQCB for the operation of a POTW. The Part 503 regulations establish limits for pollutant levels; operational standards and management practices; and monitoring, record keeping, and reporting requirements. The Part 503 regulations are applicable to projects that generate sewage sludge to produce biosolids or material derived from biosolids. The following section describes the details of the Part 503 regulations as they apply to land application of biosolids.

Discharge Specifications

EPA developed the Part 503 regulations to primarily protect the public and agricultural productivity. An emphasis was placed on persons who are extensively exposed to biosolids material (primarily POTW operators and persons applying biosolids to the land), from pathogens and pollutants. The Part 503 regulations establish two pathogen reduction standards for land-applied biosolids: Class A biosolids are treated sufficiently for all pathogens to be essentially eliminated, and Class B biosolids have been treated sufficiently for the level of pathogens to be substantially reduced but not completely removed. Class A biosolids must be monitored for bacteria growth at the time of use. Land application of biosolids that meet Class B criteria are restricted by the following conditions:

- food crops with harvested parts that touch the soil and are totally above the soil cannot be harvested for 14 months,
- food crops with harvested parts below the soil cannot be harvested for 20 months if biosolids remain on the land surface for at least 4 months before being incorporated into the soil,
- food crops with harvested parts below the soil cannot be harvested for 38 months if biosolids remain on the land surface for less than 4 months before being incorporated into the soil,
- feed and fiber crops cannot be harvested for 30 days after biosolids application,
- animals cannot be grazed on the site within 30 days of biosolids application,
- turf cannot be harvested for 12 months if the site would have a high potential for public exposure,
- public access is not allowed for 12 months to land with high potential for public exposure, and
- public access is not allowed for 30 days to land with low potential for public exposure.

Part 503 regulations for reducing vector attraction specify several alternative treatment processes and management practices that the biosolids must undergo. Vectors are pests such as flies, mosquitos, and rodents that can be attracted to incompletely treated biosolids and could transmit diseases to other organisms. Biosolids must be treated to at least Class B level for pathogen and vector reduction levels to be land applied.

The Part 503 regulations establish minimum standards for concentrations of nine pollutants in biosolids that are to be applied to land (Table 2-3). Biosolids are considered Class A Exceptional Quality (EQ) if they meet all of the pollutant concentration limits as well as Class A pathogen reduction standards. EQ biosolids can

Table 2-3. Regulatory Pollutant Concentrations and Loading Rates under Part 503 Regulations

Pollutant	Pollutant Concentration in EQ Biosolids (mg/kg)	Ceiling Concentration in Biosolids Applied to Land (mg/kg)	Cumulative Pollutant Loading Rate Limits (kg/ha)	Annual Pollutant Loading Rate (kg/ha/yr)
Arsenic	41	75	41	2
Cadmium	39	85	39	1.9
Copper	1,500	4,300	1,500	75
Lead	300	840	300	15
Mercury	17	57	17	0.85
Molybdenum	--	75	--	--
Nickel	420	420	420	21
Selenium	100	100	100	5
Zinc	2,800	7,500	2,800	140
Applied to:	Bulk biosolids and bagged biosolids	All biosolids that are land applied	Bulk non-EQ biosolids	Bulk biosolids

____

Notes: mg/kg = milligrams per kilogram.
kg/ha = kilograms per hectare.
kg/ha/yr = kilograms per hectare per year.

Sources: Pollutant concentration in EQ biosolids—Part 503, Table 3; ceiling concentration in biosolids applied to land—Part 503, Table 1.

be distributed in bulk or packaged and are not subject to general management practices other than monitoring and reporting to confirm that the criteria have been met. Class A biosolids that contain any one of the nine pollutants (Part 503, Table 1) in concentrations exceeding the pollutant concentration limits for EQ biosolids, but that are below the ceiling limits, can be applied to land but are subject to cumulative and annual pollutant loading restrictions depending on their intended use, as shown in Table 2-3. Class A biosolids with all pollutants below the pollutant concentration limits for EQ biosolids can be applied without loading rate restrictions. If the biosolids contain any of the listed pollutants at concentrations that exceed the ceiling concentration limits, they cannot be applied to land.

Other Policies and Procedures

The Part 503 regulations specify several standard conditions that must be followed for site management; distribution and marketing of biosolids products; and monitoring, record keeping, and reporting procedures. If biosolids do not meet EQ standards, those general management practices that are specified include the following:

- biosolids cannot be applied to a site if doing so is likely to affect a threatened or endangered species;
- biosolids must not be applied to frozen, snow-covered, or flooded ground; and
- biosolids cannot be applied to land within 10 meters (33 feet) of a surface water body.

In some cases, the Part 503 regulations contain specific requirements for labeling of biosolids materials and products to be marketed, sold, or given away. The label must contain the name of the person or agency that prepared the biosolids, statements of land application prohibitions with respect to pollutant limits, and loading rates. The required monitoring frequency is determined based on the quantity of biosolids generated at the POTW. Monitoring can vary from once per year for small operations to monthly for large POTWs. A report must be submitted to EPA once per year and monitoring records must be kept for 5 years.

Local Programs—County Ordinances

Several California counties have adopted local ordinances that directly regulate biosolids reuse and disposal practices or indirectly affect biosolids management by requiring conditional use permits for certain activities. The local ordinance adoption process could affect the implementation of permitting procedures under the GO. RWQCB staff engineers and reviewing agencies would need to be aware of local permit requirements and conditions of local ordinances to assess the applicability of the GO to specific projects.

Of the 58 counties in California, 16 currently have ordinances that relate directly to land application of biosolids. Three counties have outright bans on land application, seven have effective bans (their ordinances are so restrictive that they effectively discourage land application), and five allow regulated use. The remaining 42 counties without ordinances rely on the RWQCBs to regulate land application through the WDR process. These local ordinances are important because they restrict the areas within the state that can currently accommodate land application of biosolids, and they supercede the controls of the proposed GO where they are more restrictive.

General Order Program Objectives

The goal of the GO is to provide a clear and consistent regulatory process that is adequately protective of environmental resources, streamlines the permitting process for land application of biosolids, and includes policies and procedures that ensure continued refinement of biosolids disposal practices and protection of the environment. Therefore, the GO is intended to:

- comply with Section 13274 of the California Water Code and the judicial order by the Superior Court of California for the County of Sacramento by adopting statewide general WDRs for the discharge of dewatered, treated, or chemically fixed sewage sludge (biosolids) for beneficial use as a fertilizer and/or soil amendment;

- provide a regulatory framework for biosolids application to land that can be used by individual RWQCBs to act on NOIs filed by potential dischargers in a manner that avoids or mitigates potentially adverse environmental effects; and

- provide a flexible regulatory framework that allows implementation of a biosolids disposal program for land application operations at the regional level and contains requirements that are based on sound science and best professional judgment.

Each of these program objectives is described below.

Comply with California Water Code and Judicial Order

The first objective of the GO, to provide a statewide regulatory program, is based on the need to comply with Section 13274 of the California Water Code, which requires the issuance of WDRs for projects that may affect waters of the state, and to respond to the legal challenges brought against the individual GOs proposed by the Central Valley RWQCB. In particular, any proposed program must be applicable on a statewide basis because biosolids generated within one region may be applied in a different area. In addition, resource protection factors specific to California that are not addressed through the Part 503 regulations must be incorporated into a statewide regulation.

The existing process of individually issuing WDRs for land application of biosolids could lead to inconsistencies between regions that may affect the feasibility, operation and maintenance procedures, and costs of land application. Consequently, a statewide regulation must promote an effective statewide permitting process to minimize inconsistent regional permitting requirements.

Provide Regulatory Framework for RWQCB Permit Process

The objective of creating a cost-effective regulatory framework is a critical aspect of streamlining the RWQCBs' processes for biosolids management, CEQA review, and permitting. The current process (individual review and issuance of WDRs and the corresponding CEQA environmental review requirements implemented by each RWQCB) requires a substantial expenditure of resources by regulatory agencies and other involved parties. The federal Part 503 regulations are developed using environmental risk exposure models to ensure that the regulatory criteria cover a wide range of environmental conditions under which biosolids may be applied. Consequently, for most land application projects, the regulatory framework should allow for streamlined permit and CEQA review and approval procedures if the threat of adverse environmental effects is determined to be negligible. The approach of establishing a general order provides each RWQCB with objective screening criteria against which to evaluate each NOI and through which routine land application projects can be expedited. The regulatory program must also provide objective criteria and guidelines under which each RWQCB can implement additional review or develop supplemental permit conditions if these are found to be necessary to ensure environmental compliance.

Provide Flexible Regulatory Framework

The third objective of the GO is to provide a regulatory setting that uses the environmental risk-based analyses developed for the Part 503 regulations or an equivalent analysis so that the program is adequately protective of the environment. A program that has statewide application and involves complex pollutant management issues must be based on thorough scientific justification. In addition, the regulatory program must be responsive to new scientific evidence relating to biosolids and allow for incorporation of new practices and procedures if the scientific community determines that changes are necessary. Areas of controversy are the safety of land application of biosolids, the applicability and level of protection afforded under the federal Part 503 regulations, and the efficacy of the GO regulatory framework in the evaluation and protection of site-specific resources. Therefore, any proposed regulation related to biosolids land application should include mechanisms that allow for incorporation of future management practices that are determined to better protect environmental resources or improve the regulatory and permitting process.

Description of General Order

Overview

The proposed GO was developed to provide a single regulatory framework for the land application of biosolids in California and to streamline the permitting process that each RWQCB uses for biosolids application projects. Provisions of the GO were based largely on the federal Part 503 regulations to ensure that the state regulation incorporates the extensive health risk assessments and scientific review that went along with developing the federal regulation. Baseline criteria that were established under the Part 503 regulations must be met under the GO and associated general WDRs. This section generally describes the principal permit conditions and procedures of the GO.

Applicability

For the purposes of the GO, *biosolids* are defined as only those sewage sludges produced at municipal wastewater treatment plants that meet the requirements of the Part 503 regulations. Unstabilized sewage sludge, septage, and wastes that do not meet the Part 503 regulations or are determined to be hazardous under Title 22, Division 4.5, Chapter 11, Article 3 of the CCR would not be regulated under the GO.

Under the GO, the *discharger* is defined as primarily the landowner but could also include any individual, business, or organization involved in the generation, transportation, and application of biosolids. The discharger would be legally responsible for implementing and complying with the provisions of the general WDRs issued by the RWQCB in accordance with the GO.

A biosolids application project that is permitted under a single NOI must involve less than 2,000 acres of land that receive biosolids, and all application sites must be within 20 miles of each other. In addition, each landowner involved with a biosolids application project must file a separate NOI and pay a separate filing fee. A permitted project applicable to the GO may involve a single application of biosolids or repeated applications. The identification of permitted activities under the GO does not preempt or supersede the authority of local agencies to prohibit, restrict, or control biosolids reuse.

The discharger is responsible for making inquiries about permitted uses and obtaining applicable local permits and authorizations.

An important component of the GO is the requirement that each biosolids application project operator, before applying any biosolids, must prepare and submit an NOI for the area in which the biosolids are to be applied. The appropriate RWQCB would then review information contained in the NOI and, if it finds the information to be adequate, issues a Notice of Applicability under the general WDRs of the GO along with discharge monitoring requirements. A complete NOI includes a preapplication report that provides the RWQCB with specific information relating to each field or distinct application area, including:

- contact personnel;
- project location;
- map that shows site topography and elevation; staging/storage and application areas; and nearby residences, roads, surface waters, and groundwater wells;
- source and chemical test results for biosolids;
- description of proposed application area, application practices, and type of crops to be grown;
- spill response plan; and
- any applicable erosion control, biosolids storage, and groundwater monitoring plans that would be required under the GO.

An annual filing fee is required for each year that the project is operating and is based on the threat to water quality and complexity of the project as identified in 23 CCR 2200. Biosolids projects encompassing an area of 40-2,000 acres would be designated a Category II threat to water quality and given a Category "b" complexity rating. Biosolids projects of less than 40 acres would be classified a Category III threat to water quality and given a Category "b" complexity rating.

Relationship of the GO to Part 503 Regulations

Some of the minimum standards established under the Part 503 regulations are applicable to the proposed GO program:

- Biosolids must be treated to reduce potential disease-causing pathogens.

- Class A biosolids have been treated sufficiently that pathogens are essentially eliminated; Class A biosolids must be monitored for bacteria growth at the time of use.

- Class B biosolids have been treated sufficiently that pathogens are substantially reduced, but not completely eliminated. Land application of biosolids that meets Class B criteria is restricted by the following conditions:

  – food crops with harvested parts that touch the soil cannot be harvested for 14 months after biosolids application;

  – food crops with harvested parts below the soil cannot be harvested for 20 months after application if biosolids remain on the land surface for 4 months or longer before being incorporated into the soil;

  – food crops with harvested parts below the soil cannot be harvested for 38 months after application if biosolids remain on the land surface for less than 4 months before being incorporated into the soil;

  – food and fiber crops cannot be harvested for 30 days after biosolids application;

  – animals cannot be grazed on the site within 30 days of biosolids application;

  – turf cannot be harvested for 12 months after biosolids application if the site is likely to have extensive public exposure (e.g., golf courses, parks);

  – public access to land that is likely to have extensive public exposure is not allowed for 12 months after biosolids application; and

  – public access to land that is unlikely to have extensive public exposure is not allowed for 30 days after biosolids application.

The Part 503 regulations also outline several alternative chemical and physical treatment processes and management practices that the biosolids must undergo to reduce vector attraction. Biosolids must be treated to meet at least Class B criteria for pathogen reduction and vector reduction levels before they can be applied to land.

The material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations of 10 metals, nine of which are regulated under the Part 503 regulations (see the discussion below in “Discharge Prohibitions” and “Discharge Specifications”). Restrictions on pollutant addition levels are described above in “Discharge Specifications”.

Discharge Prohibitions of the GO

The GO contains prohibitions that apply to all land application projects that request authorization. In general, biosolids must not be applied under the following conditions:

- the biosolids to be discharged cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste;
- the biosolids cannot be discharged except as allowed at authorized storage, processing, and land application sites;
- no application is permitted until the RWQCB has issued a Notice of Applicability, a set of individual WDRs, or a waiver of WDRs;
- no application is permitted if the discharge would cause or threaten to cause pollution or create a nuisance as defined by Section 13050 of the California Water Code;
- no application is permitted that would cause a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5);
- no application is permitted to areas not specified in the applicant's NOI;
- no application is permitted to surface waters or drainage courses;
- no application is permitted when the application rate would exceed the nitrogen requirements of the vegetation or the rates that would degrade groundwater unless specifically authorized (application in excess of nitrogen requirements may be allowed for land reclamation sites if a certified agronomist, registered agricultural engineer, or registered civil engineer demonstrates that application would not degrade the quality of underlying groundwater);
- no surface water runoff resulting from irrigation of the site is permitted within 30 days of application unless a sufficient buffer of grass (more than 33 feet) is present to prevent biosolids from being carried in runoff from the application site;
- no application is permitted to frozen or water-saturated ground or during periods of rain heavy enough to cause runoff from the site;
- no application or incorporation into the soil is permitted when wind may reasonably be expected to cause airborne particulates to drift from the site;
- no application is permitted in areas subject to erosion or washout offsite; and

- discharge of biosolids with pollutant concentrations greater than those shown in Table 2-4 is prohibited.

Discharge Specifications of the GO

The GO contains specifications for the quantity and quality of biosolids that are allowed to be land applied. Most of these specifications are similar to the requirements of the Part 503 regulations and include the following:

- Biosolids must be treated to meet Part 503 standards for vector reduction and be treated to either the Class A or Class B level of pathogen reduction standards.
- Cumulative lifetime metals loading limits for a given application site shall not exceed those presented in Table 2-5 (including background soil levels and levels in applied biosolids).
- Biosolids application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed for reclamation sites or biosolids research projects.
- Following incorporation of biosolids into the soil, tilling practices must minimize erosion of the site resulting from wind, stormwater, and irrigation water.
- If the slope of the application site is greater than 10%, an erosion control plan must be prepared by a qualified erosion control specialist.
- For Class B biosolids, the harvesting period for crops is restricted as described in the Part 503 regulations. In addition, the location of application is specified with respect to property lines, municipal and agricultural supply wells, public roads, surface waters, agricultural buildings, and residential buildings.

Storage and Transportation

The GO specifies conditions for the storage and transportation of biosolids. Major conditions of the GO include the requirement for biosolids to be transported in covered, leakproof vehicles; drivers must carry a copy of an approved spill response plan and be trained with regard to the proper response to accidents or spill events. The GO defines *storage* as placement of biosolids on the ground or in nonmobile containers for more than 7 consecutive days at an intermediate site other than the place of generation and/or processing. If biosolids are to be stored at the application site, the operator must prepare and implement an RWQCB-approved storage program. Biosolids must not be stored for

Table 2-4.
Pollutant Concentration Limits for Biosolids Being Land-Applied

Constituent	Ceiling Concentration (mg/kg dry weight)
Arsenic	75
Cadmium	85
Chromium	3,000
Copper	2,500
Lead	350
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7,500

Table 2-5. Cumulative Loading Limits for Biosolid Land Application Sites

Constituent	Kilograms per Hectare	Pounds per Acre
Arsenic	41	36
Cadmium	39	34
Copper	1,500	1,336
Lead	300	267
Mercury	17	15
Molybdenum	18	16
Nickel	420	374
Selenium	100	89
Zinc	2,800	2,494

longer than 7 consecutive days; storage areas must be covered between October 1 and April 30 during periods of runoff-producing precipitation; public access to storage areas must be restricted; and control measures should be implemented to prevent leachate into the soil, surface runoff, and washout from floods.

Provisions

The GO contains 20 general conditions and procedures that must be followed by the discharger. The general provisions are summarized under the following categories of responsibilities:

- **Obtaining, maintaining, and terminating coverage under the GO:** An NOI must be submitted for each biosolids source and discharge site. Specific agencies, adjacent residents, and adjacent landowners identified in the GO and any local agency with jurisdiction over the application site must be notified. The RWQCB must be notified in advance of any transfer of the project to another party. The RWQCB must be notified of project completion through submittal of a Notice of Termination and a Final Discharge and Monitoring Program report. Provisions of the general WDRs issued by the RWQCB are severable.

- **Chain of responsibility:** Individual property owners and companies responsible for biosolids discharges and site operations are primarily accountable for compliance and enforcement actions under the GO. The discharger is responsible for informing all biosolids haulers using the land application site of the conditions contained in the GO. Individual property owners are responsible for applicable crop selection, property access, and harvesting restrictions under the GO.

- **Monitoring, reporting, and record keeping:** The preapplication form that is attached to the GO describes the general reporting requirements and specific groundwater monitoring requirements (if deemed necessary). Groundwater monitoring would generally be required if the depth to groundwater at the disposal site is less than 25 feet and biosolids would be applied to the site more than twice in a 5-year period. If required, one upgradient and two downgradient wells must be monitored annually at each application site to evaluate water level, pH, total dissolved solids, sodium, chloride, nitrate, and total nitrogen levels.

  The discharger is responsible for implementing the requirements of the GO and for site operations and conducting the required monitoring programs. Sampling must be conducted using approved methods, accurate and properly calibrated equipment, and certified laboratories. Information that must be recorded includes the quantity of biosolids applied at each site along with its nitrogen content, crops grown, and total pollutant loading. The discharger must notify the RWQCB of any noncompliance with the GO within 24 hours. The discharger must keep monitoring records for at least 3 years. Annual monitoring reports submitted to the RWQCB must be signed and certified by the discharger or a duly authorized representative.

GO Exclusion Areas

The proposed GO specifies several areas of the state within which biosolids application projects under the GO cannot be permitted. Generally, the exclusion areas are unique or valuable public resources, jurisdictional waters or preserves, or state-designated management areas. The general areas excluded from this GO are the following:

- the Lake Tahoe Basin;
- the Santa Monica Mountains Zone;
- the California Coastal Zone;
- the area within 0.25 mile of a wild and scenic river;
- the jurisdictional Sacramento-San Joaquin River Delta;
- Suisun Marsh;
- the area under the jurisdiction of the San Francisco Bay Conservation and Development Commission; and
- several specific areas within the jurisdiction of the Lahontan RWQCB, including the Antelope Hydrologic Unit above 3,500 feet, areas in the Mojave River Planning Area, the Hilton Creek/Crowley Lake areas, and areas of the Mono-Owens Planning Area.

These areas are not included in the analysis of this EIR.

Chapter 3. Soils, Hydrology, and Water Quality

This section briefly describes the soil properties, hydrologic characteristics, and existing water quality conditions of California watersheds in each of the nine RWQCB regions. Appendix D provides a more comprehensive discussion of the factors that can affect fate and transport mechanisms of biosolids in the soil and aquatic environment. The fate and transport characteristics of pathogens and radioactive substances related to biosolids application are described in Chapter 5, "Public Health".

Environmental Setting

Soils

Soil Properties Relevant to Biosolids Application

The soil properties described below affect the suitability of a site to be used for biosolids application. Some of these properties may change as a result of biosolids application. Additionally, most of the properties are closely related to a site's productivity with regard to food and fiber crops and livestock forage.

Texture. Probably the most influential soil property relative to land application of biosolids is texture (i.e., the proportions of sand-, silt-, and clay-sized particles in the soil). With other factors held constant, most fine-textured soils (e.g., silty clays and clays) have relatively high capacity to retain nutrients and metals, have moderate available water-holding capacity (i.e., the amount of water that can be taken up by plant roots, measured as inches of water per inch of soil or as the water available throughout the root zone), have slow infiltration capacity and permeability (to gas and water movement), and are relatively difficult to till. The pH (discussed below) of fine-textured soils ranges from near neutral to alkaline. Most clayey soils are fairly resistant to erosion when the vegetation cover is removed, except on steep slopes.

Coarse-textured soils (e.g., loamy sands) generally have relatively low nutrient- and water-holding capacities, have low native fertility, have rapid infiltration capacity and permeability, and are easily tillable. Many coarse-textured soils have low organic matter content. The pH of coarse-textured soils ranges from near neutral to acidic. Fine-sandy soils are among the soils most subject to water erosion.

Medium-textured soils (e.g., loams and silt loams) usually have fertility and hydrologic characteristics intermediate between those of fine- and coarse-textured soils, although they usually have the highest available water-holding capacity. Medium-textured soils, particularly those with high organic matter content, are generally resistant to erosion on gentle to moderate slopes.

Cation Exchange Capacity. Cation exchange capacity (CEC) is a measure of a soil's net negative charge and thus of the soil's capacity to retain and release cations (i.e., positively charged ions) for uptake by plant roots. Cations (e.g., calcium and ammonium) are often essential for plant growth in small concentrations, but they may be toxic at higher concentrations (e.g., molybdenum, zinc, and copper). Some trace elements such as lead are not required for plant growth but may be toxic to plants and the animals that feed on them. The CEC of a particular soil is controlled primarily by the amount and type of clay mineral in the soil and the humus (highly decomposed organic matter) and iron oxide contents. In coarse-textured soils, humus may provide most of the soil's CEC. For a given quantity (i.e., weight) of soil, the CEC of humus is typically several times that of most pure clays. Clayey soils commonly have a CEC more than five times that of sandy soils. A high CEC is desirable because it reduces or prevents essential nutrient loss from the soil by leaching (Donahue et al. 1983). Soils with high CEC can also immobilize heavy metals such as copper and lead by binding the negatively charged metal anions to cation exchange sites associated with the clay minerals and organic matter.

Organic Matter. Organic matter, another important property of soil, enhances the physical condition of surface soil layers by binding individual soil particles together into larger aggregates (the natural arrangement of soil aggregates provide soil structure). Organic matter particularly benefits the structure of sandy soils. Improved soil structure creates large pores through which gases and water move and which promote root growth. Accordingly, soils with good structure have a lower bulk density and are more permeable than soils with poor structure. A well-aerated, permeable soil is usually more productive than a poorly aerated soil. High permeability improves a soil's infiltration capacity and makes the soil easier to till (Donahue et al. 1983). Furthermore, soils with large, stable aggregates (i.e., well-structured soils) are more resistant to erosion than soils with poor structure (National Academy of Sciences 1996).

Organic matter content also affects the capacity of the soil to retain water and many soluble nutrients and metals, particularly in coarse-textured soils. Organic matter is also the source of most of the nitrogen in an unfertilized soil and can be an appreciable source of available phosphorus and sulfur. Soil microbes use organic matter as a food source (Donahue et al. 1983).

pH. Soil pH is the measure of the acidity or alkalinity (the amount of hydrogen ion) of a soil. Nearly all California soils have a pH in the range of 5.0-8.5; a pH of 7.0 is considered neutral. Soils with a low pH (i.e., less than 5.5) are acidic and may have lower nutrient concentrations and less microbial activity (Tucker et al. 1987). In strongly acidic soils, bacteria that decompose organic matter and therefore release nitrogen and other nutrients for plant growth are less active. In addition, most heavy metals and some nutrients are soluble, and aluminum and manganese may be present at toxic concentrations. Soil pH also greatly affects the solubility of minerals and many heavy metals, and therefore affects their availability for plant growth and uptake in biomass and their potential to be leached from the soil profile. A slightly acidic soil (e.g., pH 6.5) is typically best for many agricultural crops because macronutrients and micronutrients are overall most available for plant uptake under slightly acidic conditions (Donahue et al. 1983). Maintaining neutral to slightly alkaline soils is often recommended in places where high levels of heavy metals are present because the metals tend to be less mobile at these pH conditions.

Salinity. Salinity refers to the salt content of a soil. Salts are dissolved mineral substances, including sulfates, chlorides, carbonates, and bicarbonates, which may form from the elements sodium, calcium, magnesium, and potassium. Although a low level of salts in the soil is desirable, high salinity levels (commonly above an electrical conductivity of 4 deciSiemens per meter for many crops) make it more difficult for plant roots to extract water from the soil, which may reduce growth rates. (Donahue et al. 1983.)

Bulk Density. Bulk density is a measure of the mass of dry soil per unit volume. It is usually expressed in terms of grams per cubic centimeter. Bulk density affects permeability and root penetration and is affected by texture, structure, organic matter content, and soil management practices. (Donahue et al. 1983.)

Depth. Soil depth affects the capacity of a soil to retain nutrients and metals. References to soil depth pertain to the depth of a soil over rock or a restrictive layer that prevents significant root penetration, such as a hardpan or dense claypan. (U.S. Department of Agriculture 1993.)

Microorganisms. Soil microorganisms, including bacteria, actinomycetes, fungi, algae, and protozoa, play an important role in the decomposition of organic matter, including that contained in biosolids (Phung et al. 1978), and in the cycling of plant nutrients such as nitrogen, phosphorus, and sulfur (National Academy of Sciences 1996). Some evidence indicates that the rate of decomposition of organic matter by microorganisms may be reduced in the presence of high concentrations of heavy metals (Sommers et al. 1976).

Drainage. A soil's drainage class is determined primarily by its permeability, depth of the seasonal high water table, and slope. At the dry end of the drainage spectrum, soils that are excessively drained tend to be coarse textured, not influenced by high groundwater, and located on steep slopes. Soils that are poorly drained typically have groundwater at or near the surface for much of the crop-growing season and are in level areas and topographic depressions (U.S. Department of Agriculture 1993).

Water and Wind Erodibility. Soils that are highly susceptible to detachment and entrainment (i.e., erosion) by water and wind are those made up mostly of coarse silt and fine sand-sized particles (Donahue et al. 1983), particularly in areas where organic matter content is low and the soil structure is poor or nonexistent. Erodibility is usually a characteristic of concern when the vegetative cover is removed or reduced or the soil is otherwise disturbed. Water erosion typically is not a major concern on gentle slopes (e.g., 10% or less, as generally used for biosolids application) because little rainfall runoff results at such slopes. Erosion is usually controlled by maintaining vegetative cover.

The erosion rate of a particular soil in the absence of human activities is referred to as the natural or geologic erosion rate. Erosion in excess of the natural erosion rate is called accelerated erosion and is usually a result of human-caused activities such as cultivation, grazing, and grading.

Generalized Descriptions of Soil Properties

Soils in California are extremely variable and reflect the diverse geologic, topographic, climatic, and vegetative conditions that influence soil formation and composition. Broad generalizations can be made of soil properties in each RWQCB region which may influence or be influenced by biosolids application, and these are tabulated in Appendix D (Table D-1). Major Land Resource Areas (MLRAs), as classified by the U.S. Natural Resources Conservation Service (NRCS), are large areas that are broadly similar with respect to soils, geology, climate, water resources, and land use. Sixteen MLRAs have been designated in California. MLRA information is appropriate for statewide resource description and planning. Because biosolids are nearly always applied on moderate to shallow slopes (i.e., a maximum of approximately 15%), only soils occurring in valleys, basins, terraces, and alluvial fans are described in Appendix D. Soils occurring in large geographic areas that have been excluded from the GO (i.e., the Sacramento-San Joaquin River Delta, Suisun Marsh, and the jurisdiction of the San Francisco Bay Conservation and Development Commission) are also not described.

Typical Soil Properties in Forested Areas. Soil properties in forested areas of the state that are suitable for biosolids application (i.e., have slopes no greater than approximately 15%) differ from soils typically used for agricultural land application in that they are generally shallow and underlain by bedrock. Forest soils in California tend to have neutral to acidic pH. The organic matter content ranges from relatively low to high (for mineral soils) but is usually concentrated in the upper soil layers. A layer of plant litter often rests on the soil surface. Forest soils are often more thoroughly leached of nutrients than agricultural soils. The texture typically ranges from clay loam to sandy loam, and the soils often have rock fragments in the profile. Except in meadows (which typically would be excluded from biosolids application because they may qualify as jurisdictional wetlands) and seep areas, groundwater tends to be deep. (Colwell 1979, U.S. Soil Conservation Service 1981.)

Typical Soil Properties at Mined Sites. Conditions at mined sites differ from those at agricultural land application sites in that the native soil material has typically been partially or entirely removed or mixed with less productive subsoil material. Although soil and site conditions may vary widely according to the type of mine, the soil materials at such sites often have low nutrient- and water-holding capacities, a large amount of rock fragments, low organic matter content, low pH, and high concentrations of trace metals. These conditions result in unfavorable conditions for seed germination and plant growth, making revegetation efforts difficult (Reed and Crites 1984). Slopes may be steep at some mined sites.

Typical Soil Requirements of Horticultural Operations. In California, biosolids are not used extensively for horticultural plantings. It is expected that the most frequent uses would be in large parkland or golf course settings, or at large-scale nursery operations. These settings could occur throughout the state, but would likely be focused in valley or low foothill areas with relatively deep soils, moderate to shallow slopes (less than 15%), and a wide range of soil textures (loams to clays). Because horticultural areas are usually selected for their ability to support some type of planted vegetation, they would be expected to have low to medium organic matter content, be well drained, and have a pH from slightly alkaline to slightly acidic. Soil conditions that would be unfavorable for seed germination and plant growth would be avoided. Where new parks or golf courses are being developed, biosolids may be applied to soil material imported from offsite. These soils may have little or no remaining soil structure.

Hydrology

Surface Water

The surface waters of California can be divided into six regions of similar hydrologic character, established by the California Department of Water Resources (1994a), that exhibit distinct precipitation, runoff, and geologic conditions. Vast differences in climate, vegetation, and geography between these regions lead to extremes in seasonal patterns, precipitation, and runoff potential throughout the state. The North Coast region, for example, can receive up to 200 inches of rainfall per year, whereas the Colorado Desert region in the southern part of the state receives the least annual rainfall, with some areas averaging less than 2 inches per year (Mount 1995). These patterns, combined with other regional factors, determine the amount and type of runoff emanating from the area, the rate of deep percolation and aquifer recharge, and the potential for flooding. Table 3-1 shows the seasonal patterns, precipitation, and runoff characteristics of the six regions.

Groundwater

Approximately 40% of the total land area of the state is underlain by groundwater basins. The storage capacity of these basins is estimated to be approximately 1.3 billion acre-feet of water, and many of the basins are estimated to be full or nearly full. The fraction of water that is usable from these basins, about 143 million acre-feet, is more than three times the total capacity of the state's surface storage reservoirs.

Many of California's groundwater basins are located in arid valleys and are recharged by percolation of rainfall and surface water flows. Recharge occurs more readily in areas of coarse sediments, which are usually located near the alluvial fans associated with mountain ranges. Percolation in southern California occurs only during periods of intense precipitation, whereas northern California groundwater basins often receive direct recharge from precipitation on an annual basis (California Department of Water Resources 1975). The location and extent of impermeable, confining layers in the alluvial deposits that contain groundwater basins play a major role in the amount and rate of recharge of percolating water and the overall quality of the groundwater.

About 250 important groundwater basins are present throughout California, supplying about 40% of the state's applied water needs. Statewide, more than 15 million acre-feet of groundwater are extracted for agricultural, municipal, and industrial uses. Table 3-2 lists California's major groundwater basins by region.

Water Quality

Monitoring for water quality protection purposes is conducted through a variety of federal, state, and local programs. The state evaluates current water quality conditions and prioritizes funding efforts for protection, cleanup, and monitoring programs through the individual water quality assessments that are compiled into the SWRCB Section 305(b) reporting process, which is mandated under the federal Clean Water Act (California State Water Resources Control Board 1996a). The Section 305(b) report

Table 3-1.
Watershed Characteristics of California

Region	Seasonal Patterns	Runoff Characteristics	Precipitation
North Coast (Region 1)	Inland - distinct rainy, cool winters and hot, dry summers. Coastal - cool and wet year round with little temperature variation.	Highest peak discharges recorded in state, with highest total sediment yields.	Dominated by rainfall. Average annual precipitation in region is 53 inches.
Sacramento, San Joaquin and Tulare Lake (Region 5)	Valley: Hot, dry summers and cool, wet winters. Mountains: Mild summers with intermittent thundershowers, heavy winter snowfalls above 5000 feet.	Prolonged spring runoff fed by Sierra Nevada snowpack. Low sediment yields due to widespread vegetation and stable rock types/soils. Locally high sediment yields due to land uses (e.g., logging, grazing, and urbanization).	Valleys receive winter rainfall, and mountains receive moderate to heavy snowfall. Total average annual precipitation ranges from 36 inches in the Sacramento River region to 13-14 inches for the San Joaquin and Tulare Lake regions.
San Francisco Bay and Central Coast (Regions 2 and 3)	Coast: Cool and foggy year-round with rain in the winter. Small seasonal temperature variations. Inland areas: Warmer, dry summers with cooler, rainy winters.	High peak runoffs due small, steep watersheds. Local rivers susceptible to severe flooding during high rainfall events. Some watersheds produce high sediment yields due to unstable rock types/soils.	Precipitation from rainfall, with insignificant snowfall. Northern area average annual precipitation is 31 inches, with greater than 50 inches in some areas. Southern area average annual precipitation is 20 inches.
North and South Lahontan (Region 6)	Valleys: Semi-arid high desert terrain. Hot, dry summers with locally intense thunderstorms. Mild, dry winters. Mountains: Cool to mild summers, cold winters with regionally heavy snowfall.	Valleys: High peak runoffs in ephemeral drainages. Watersheds except Owens River are short and steep ephemeral drainages. Stable rock types/soils result in low, coarse-textured sediment yields. Mountains: Extended spring runoff with locally high sediment yields in Sierra.	Valleys: Low to moderate precipitation totals due to rainshadow effects of Sierra Nevada and Cascade Mountains. Mountains: Regionally heavy winter snowfall and intense summer thunderstorms. Average annual precipitation ranges from 8inches in the south to 32inches in the north.
South Coast (Regions 4, 8, and 9)	Mediterranean climate with several dry years interrupted by infrequent high precipitation years. Warm, dry summers and mild, wet winters. Inland summer temperatures can exceed 90 degrees. Intense subtropical storms.	Watersheds are largely ephemeral and fed by rainfall. Rivers susceptible to frequent flooding due to high peak discharge events. Sediment yields are locally high due to intense urbanization, low vegetation cover and unstable soils. Debris flows and mudflows frequent in some smaller drainages.	High rainfall with insignificant snowfall contribution. Locally heavy storms have the highest 24-hour rainfall totals in the state. Average annual precipitation is 18.5 inches.
Colorado Desert (Region 7)	Arid desert region with hot, dry summers with locally intense thunderstorms and mild winters. Rainfall is limited to a few storms per year.	Low runoff due to limited rainfall, but locally heavy during infrequent storm events. Overall sediment yields are low, but produce debris flows during storms.	All precipitation fall in the form of rain. Region has the lowest yearly precipitation totals in the state, with some areas receiving less than 2 inches. Average annual regional rainfall is 5.5 inches.

____

Sources: Mount (1995), California Department of Water Resources (1994a), Regional Water Quality Control Board Water Quality Control Plans (1991-1995).

Table 3-2.
Major Groundwater Basins of California

Region	Major Groundwater Basins	Extraction (ac-ft/yr)
1 - North Coast	Tule Lake, Siskiyou Butte Valley, Shasta Valley, Scott River Valley, Hoopa Valley, Smith River Plain, Mad River Valley, Eureka Plain, Eel River Basin, Covelo Round Valley, Mendocino County	242,338
2 - San Francisco Bay	Petaluma Valley, Napa-Sonoma Valley, Suisun-Fairfield Valley, Santa Clara Valley, Livermore Valley, Marin County, San Mateo County	190,128
3 - Central Coast	Soquel Aptos, Pajaro Basin, Salinas Basin, S. Santa Clara - Hollister, Carmel Valley-Seaside, Arroyo Grande/Nipomo Mesa, Cuyama Valley, San Antonio, Santa Ynez Valley, South Central Coast, Upper Salinas, San Luis Obispo	1,075,800
4 - Los Angeles	Central Basin, West Coast Basin, San Fernando Valley, Raymond Basin, San Gabriel, Upper Ojai Valley, Fox Canyon	808,000
5 - Central Valley	Butte County, Colusa County, Tehama County, Glenn County, Sacramento County, Western Placer County, Yuba County, Sutter County, Eastern Solano County, Yolo County, Sierra Valley, Goose Lake Basin, Big Valley, Fall River Valley, Redding Basin, Almanor Lake Basin, Upper Lake Basin, Lake County/Scotts Valley, Kelseyville, Valley Basin, Coyote Valley, Middletown-Colalyomi Valley, San Joaquin County, Modesto Basin, Turlock Basin, Merced Basin, Chowchilla Basin, Madera Basin, Delta Mendota, Kings Basin, Tulare Lake Basin, Kaweah Basin, Tule Basin, Westside Basin, Pleasant Valley Basin, Kern County Basin	8,302,100
6 - Lahontan	Surprise Valley, Honey Lake Valley, Long Valley Basin, Thermo-Madeline Plains, Willow Creek Valley, Secret Valley, Owens Valley, Death Valley, Mojave River Valley, Antelope Valley	397,200
7 - Colorado River	Warren Valley, Coachella Valley, Cuckwalla	114,740
8 - Santa Ana	Orange County (also in Region 9), San Bernardino Basin Area, Riverside Basin Areas 1 and 2, Colton Basin	498,180
9 - San Diego	Temecula Valley, San Juan Valley, El Cajon Valley, Sweetwater Valley, Otay Valley, Warner Valley, San Luis Ray	34,000 (total does not include Warner Valley or San Luis Rey - extraction rates unknown)

____

Sources: California Department of Water Resources (1994a), and California Department of Water Resources (1975).

includes the Section 303(d) lists, which identify water bodies that do not meet applicable water quality standards or designated beneficial uses that are subject to technology-based controls for waste discharges.

Water quality issues differ depending on the location and type of water resource; the size and extent of the watershed and water resources; the location with respect to potential pollutant sources; seasonal and climatic factors; and many other interacting physical, chemical, and biological processes. Medium to large surface water bodies typically have a large capacity to assimilate waste loads of pollutants because various physical and chemical processes are effective at diluting pollutants or transforming them to less harmful components. Biological processes are especially important because many chemical constituents can be absorbed by plants or animals and removed from the water or metabolized in biological tissues to less harmful substances. Consequently, water quality impairment at a large scale is generally associated with watersheds that have extensive development and receive pollutants from a variety of point and nonpoint sources. Point-source pollution is a discharge that originates in a single location, such as a wastewater treatment plant, landfill, or industrial site. Nonpoint-source discharges are generated over a larger area and result from nonlocalized activities such as urban stormwater runoff; mining, agricultural and forestry activities, residential septic systems, or accidental spills.

Surface Water Quality

Surface water quality depends on seasonal hydrologic pattern, mineral composition of the watershed soils, topography, sources of contaminants, and beneficial uses. During summer low-flow conditions, the surface water quality characteristics of most importance to aquatic life are temperature, dissolved oxygen, turbidity, biostimulatory nutrients (e.g., nitrogen and phosphorus) and nuisance algae growth, and toxic constituents (e.g., un-ionized ammonia and residual chlorine). During the higher streamflow conditions common during winter, water quality is influenced more by stormwater runoff and associated pollutants (e.g., sediment, oil and grease from automobiles and paved areas), nutrients from agricultural fields and livestock boarding areas, and organic litter (e.g., leaves and grass clippings). The quality of surface water and groundwater used for domestic, agricultural, and industrial supply are characterized by standards such as total dissolved solids content, turbidity, taste and odor, and levels of toxic contaminants.

The most recent Section 305(b) report indicates that most of the state's surface lakes and reservoirs, rivers and streams, freshwater wetlands, and estuaries only partially support all of their designated beneficial uses. Of the water bodies not supporting all of their uses, a small fraction fail to support one or more designated beneficial uses all the time. For example, 10,838 miles of California's rivers and streams only partially support all beneficial uses; however, only 2,142 miles fail to support one or more beneficial uses all the time. For lakes and reservoirs, approximately 569,000 acres partially support beneficial uses, but only 9,670 fail to support one or more uses all the time. For freshwater wetlands, approximately 107,000 acres partially support beneficial uses, but no wetlands fail to support a beneficial use all the time. The Section 305(b) report also identifies the physical or chemical constituents that cause beneficial uses to not be met. In general, lake and reservoir beneficial uses are impaired predominantly by the presence of noxious weeds, trace metals, pesticides, and taste and odor problems. Rivers and streams are affected by a much larger variety of constituents, including sediment, pathogens, pesticides, and trace metals. Freshwater wetlands are affected primarily by trace metals, salinity, and other trace elements.

Groundwater Quality

Groundwater quality has typically been less of a concern than surface water quality because many of the usable aquifers for domestic consumption have been protected by the overlying soils and geological structures. Impairment of groundwater quality has typically been associated with percolation from landfills, leaking underground storage tanks, and other readily identified sources of pollution. The public attention and regulatory focus of managing and protecting groundwater quality are increasing, however, because nonpoint sources are known to cause widespread impairment of groundwater quality through the introduction of contaminants such as nitrates from septic systems and agricultural fertilizers, large-scale use of pesticides and herbicides, and potential infiltration of hazardous wastes from past land uses. The long-term increase in salt content of groundwater is also a major source of impairment. Increases in salts are primarily a result of subsurface percolation of irrigation water or seawater infiltration. The San Joaquin Valley has large areas of shallow groundwater that have experienced long-term increases in salt concentration as a result of irrigated agriculture. The most recent Section 305(b) report indicates that approximately 20,000 acres of groundwater basins only partially support all beneficial uses; however, only 1,150 acres fail to support one or more beneficial uses all the time. Approximately 24,800 acres of groundwater basins have elevated levels of toxic constituents.

Nitrates in Groundwater and Nitrate-Sensitive Areas. Nitrate contamination of groundwater has been documented throughout California (California State Water Resources Control Board 1988, California Department of Food and Agriculture 1989). Nitrogen is present in groundwater primarily in the nitrate form, although minor amounts of ammonium or nitrite may be present. The California drinking water standard or maximum contaminant level (MCL) is 45 milligrams per liter (mg/l) of nitrate (NO_3). This is approximately the equivalent of the state and federal drinking water standard, 10 mg/l of nitrate expressed as nitrogen (NO_3-N).

Potential sources of nitrate contamination include human and animal waste and large-scale use of nitrogen-based fertilizers. Potential groundwater contamination from nitrates is related to soil characteristics, crop type, irrigation practices, timing and application of nitrogen, geology, climate, and hydrologic conditions. It is difficult to determine whether an observed level of nitrates in groundwater is a result of current or past operations. It is also difficult to quantify the level of nitrate contribution from each potential source (e.g., agricultural, animal waste, septic, or wastewater sources). The most recent statewide assessment of nitrate conditions in groundwater by geographic area in California was produced in 1988 (California State Water Resources Control Board 1988). In general, the data and research available suggest that the potential for subsurface transfer to groundwater of surface-applied nitrogen is highest in highly permeable, sandy soils with low organic matter content under heavy irrigation, and that shallow wells are extremely susceptible. Areas that do not receive a large amount of freshwater recharge also may act as "sinks" and be more susceptible to cumulative loading of nitrates.

The California Department of Food and Agriculture (DFA) has developed criteria for evaluating nitrate-sensitive areas to prioritize funding and research on nitrates (California Department of Food and Agriculture 1998). Soil scientists with the University of California and DFA's Fertilizer Research and Education Program (FREP) identified seven criteria with which to determine the nitrate sensitivity of an area:

- **Groundwater use**—Nitrate concentration is critically important if groundwater is used for domestic or animal drinking supplies.

- **Soil properties**—Sandy or otherwise coarse-textured soils transmit water containing dissolved nitrates downward more rapidly. Also, these soils are less likely to provide the conditions under which nitrate turns to a gas and escapes from the soil (denitrification).

- **Irrigation practices**—Inefficient irrigation systems that lead to large volumes of subsurface drainage increase the leaching of nitrates. Typically, these are surface-flow systems with long irrigation runs. Well-managed sprinkler or drip systems, or surface-flow systems with short runs, reduce the risk of nitrates leaching to groundwater.

- **Type of crop**—Crop types most likely to increase nitrate leaching are those that (1) need heavy nitrogen fertilization and frequent irrigation; (2) have high economic value, so that the cost of fertilizer is relatively small compared to revenue produced; (3) are not harmed by excess nitrogen; and (4) take up only a small fraction of the nitrogen applied. Many vegetable, fruit, nut, and nursery crops fit these criteria, and therefore have high potential for nitrate leaching.

Crops with lower potential include field crops such as alfalfa, wheat, and sugar beets.

- **Climate**—High total rainfall, concentrated heavy rains, and mild temperatures lead to extensive leaching of nitrates.
- **Distance from the root zone to groundwater**—Small distance from the root zone to groundwater indicates that leaching, if it occurs, will be a more immediate problem.
- **Potential impact**—Such factors as population density and availability of an alternate water supply indicate that nitrate leaching is a potential impact in an area.

The focus of FREP field activities has been established on the basis of these criteria. In general, two regions of the state, the Central Coast valleys and parts of the east side of the Central Valley, fit the above criteria.

Mobility, Bioavailability, and Potential Toxicity of Plant Nutrients and Trace Elements in Biosolids

Several closely related issues are associated with the occurrence of nutrients, trace metals, and synthetic organic compounds in biosolids. The evaluation of what happens to these compounds in the soil, how their presence may affect agricultural productivity and sustainability, how they change and move through soil (to be taken up by plants and grazing animals and ultimately enter the human food chain), and how they are removed from the immediate land application site as soil dust, as eroded particles, or with surface runoff and groundwater flow, is termed a fate and transport analysis.

Most elements present in soil and taken up by plants (including nutrients and toxic metals) must be dissolved in soil water (called the solution phase) to be recovered by plant roots and incorporated into the root mass or aboveground plant biomass. Once absorbed, elements may be preferentially concentrated in certain parts of the plant (e.g., leaf, petiole, flower, seed, fruit). Where preferential concentrations greatly exceed background soil levels, the compounds are said to bioaccumulate. Elements contained in biosolids are released into the solution phase by microbial decomposition of organic matter containing the elements and by various physical and chemical processes. For this discussion, elements (aside from pathogens, which are discussed in Chapter 5, "Public Health") that are contained in biosolids and released following application during the subsequent decomposition can be placed into three broad groups:

- **Major elements and plant nutrients** (including nitrogen, phosphorus, and potassium)—These and other elements, such as calcium and magnesium, are generally fairly soluble, occur naturally in soils in relatively large amounts, and are required for plant growth in moderate to large amounts.

- **Trace elements and heavy metals**—These occur in biosolids primarily in small quantities and, when released, often form sparingly soluble reaction products. Some trace elements are required for plant growth, whereas other heavy metals may be toxic to plants.

- **Potentially harmful synthetic organic compounds**—These typically are present in biosolids in small amounts and are generally not taken up by plants. The principal concerns with these compounds are ingestion of plants coated with dust from biosolids sources that are unusually high in synthetic organic compounds and direct biosolid ingestion by grazing animals.

Surface Water Runoff and Groundwater Leaching

Two of the fate and transport pathways evaluated in the Part 503 risk assessment process for land application of biosolids were surface water runoff (pathway 12) and leaching of pollutants to groundwater (pathway 14). Surface water runoff from application sites can occur when rainfall exceeds the infiltration capacity of the soil. Infiltration is influenced primarily by the texture of the soil and the amount of water already stored in the soil. Runoff from application sites may cause accelerated soil erosion and transport of either dissolved or suspended contaminants into surface water bodies.

Leachate is water from either natural precipitation or irrigation that is transported through the soil. Some potential contaminants are soluble in water and may be transported in dissolved forms through the soils. Dissolved contaminants may then move through the soil and percolate to groundwater. Complex biological, chemical, and physical processes govern how water moves through saturated and unsaturated, porous materials.

Major Elements and Plant Nutrients in Soil

Major plant nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium are typically present in moderate amounts in biosolids; however, their total content, mobility in the soil, and bioavailability can vary widely. In addition, biosolids can contain low to moderate levels of soluble salts.

Nitrogen may be present as organic nitrogen, ammonium, nitrate, and nitrite ions. The transformation processes within the nitrogen cycle are biologically and chemically controlled and include volatilization and biological fixation, mineralization, nitrification, and denitrification. With respect to nitrogen content, biosolids are approximately comparable to barnyard manure, and thus provide a source of low-grade, slow- to moderate-release nitrogen. Biosolids contain 1%-6% total nitrogen as measured by dry weight (National Academy of Sciences 1996). Commercial fertilizers contain 11%-82% total nitrogen. Phosphorus is present in both organic and inorganic forms in biosolids, typically at 0.8%-6.1%. Inorganic forms of phosphorus are relatively insoluble, and phosphorus tends to concentrate in the organic and inorganic solid phases.

Organic forms of nitrogen generally predominate in biosolids and must be converted to inorganic forms by the microbial process of mineralization before they can be used by plants. Nitrogen mineralization rates vary as a function of the organic nitrogen content of the biosolids, soil, and climatic conditions; complete mineralization can take 1-5 years, depending on application rates and site conditions. A smaller percentage of total nitrogen is in the form of gaseous ammonia or dissolved ammonium. Immobilization is the conversion of mineral forms of nitrogen to organic forms. Nitrogen can be stored in soil through binding to cation exchange sites, immobilization by soil microorganisms, or absorption and accumulation in biomass. The ability to store nitrogen as ammonium on cation exchange sites is dependent on the CEC level and soil pH. Dissolved ammonium is converted to nitrite and then to nitrate. Nitrate is highly soluble, biologically available, and chemically stable and is either absorbed into biomass, lost to leaching, or converted to nitrogen gas under anoxic conditions.

In addition to the amount of available nitrogen, another important factor in soil management is the relative quantities of nitrogen and various other nutrients (e.g., nitrogen and phosphorus, nitrogen and carbon). Phosphorus is typically present in biosolids in low to moderate amounts, and organic forms must be mineralized to biologically available forms. The relative proportions of nitrogen and phosphorus are as important in plant nutrition management as the total amounts. If nitrogen in the soil is a limiting factor in plant growth relative to phosphorus, then the relative excess of phosphorus may accumulate in the soil and be subject to erosion and leaching, which could affect surface water and groundwater. This usually is not a significant concern in most native California agricultural soils, which are generally deficient in both phosphorus and nitrogen. In most California soils, phosphorus is tied up in various chemical forms and is only lost from the soil when it is attached to soil particles entrained by runoff. Phosphorus deficiency in plants can reduce plant growth or affect quality and yield. Similarly, biosolids that are high in carbon but relatively low in nitrogen can induce nitrogen deficiency because soil microorganisms have insufficient soil nitrogen available to fuel their decomposition of the organic matter in the biosolids. Nitrogen deficiency is a rare phenomenon in California. If recognized early, these situations can be remedied by application of commercial fertilizers to bring the carbon:nitrogen or nitrogen:phosphorus ratio into balance with crop needs.

Transport Mechanisms of Plant Nutrients to Surface Water and Groundwater. Biosolids application rates are typically dictated by the nitrogen content of the biosolids relative to crop needs, which raises the concern that overapplication may result in the excess nitrogen leaching to groundwater and possibly degrading water quality. Nitrates are difficult to remove from potential sources of drinking water, and both water and fertility must be managed carefully to prevent leaching of nitrates. The total amount of nitrate leaching depends on the amount of nitrate dissolved in the soil-water profile, the volume of water percolating per unit time, and the rate of nitrogen uptake by plants. Once out of the root zone, further movement is governed by complex flow and transport mechanisms, and nitrates may take many years to reach saturated groundwater aquifers (University of California 1995). The nitrate concentration in groundwater is influenced by freshwater recharge and dispersion, both of which may help to reduce contaminant concentrations. Nitrates in groundwater do not impair agricultural beneficial uses of water but may impair the water's usefulness for municipal and domestic purposes.

Runoff of biostimulatory nutrients (nitrogen and phosphorus) may result in eutrophication in receiving waters. Eutrophication is the process by which nutrients increase biological productivity and cause nuisance conditions such as algae scum formation, attached filamentous algae growth on rocks, and excessive growth of vascular emergent and submerged aquatic plants. Increased algae and plant growth can alter the biological system by altering dissolved oxygen and pH conditions in the water or reducing fish habitat. Biosolids application techniques (surface application or incorporation into the soil, with or without tilling), total application rates, seasonal weather patterns, ambient soil moisture, and the duration and intensity of rainfall all influence the potential for runoff to mobilize nutrients in biosolids (Northwest Biosolids Management Association 1998). Liquid biosolids have much greater concentrations of the mobile mineral forms of nitrogen and phosphorus than do the dewatered biosolids. Studies of application of liquid biosolids to a watershed have found little or no impact on stream water quality with respect to nitrogen and phosphorus levels. The application of dewatered biosolids would probably have no significant impact on the quality of water emanating from watersheds in which dewatered biosolids are applied.

Trace Elements and Heavy Metals

Trace Elements and Heavy Metals in Soil. Trace metals and trace elements are chemical elements that are normally present in the environment in very low concentrations. In small quantities, many elements are essential to plant growth, including fluoride, silicon, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, silicon, selenium, molybdenum, tin, and boron. At higher concentrations, some of these elements may become toxic to plants or accumulate in plants at levels that are toxic to the animals that feed on them (McBride 1984, Dragun 1988, Davies 1980, Kabata-Pendias 1984). In some cases, the range in concentration between deficiency and toxicity is narrow, as is the case with boron. In several cases, there is no known biological necessity for the trace metal, and its occurrence in small quantities in the soil solution may be harmful to plants. Lead, cadmium, and arsenic are examples of this effect. In other instances, such as with molybdenum, there is little or no plant toxicity at elevated soil levels, but grazing animals can be adversely affected if the element is present at high levels in plant forage. Plants can vary widely in their sensitivity to trace element concentrations in the deficiency or toxicity range, their capability to absorb trace elements, and their ability to avoid uptake even at high soil-water concentrations.

Trace metals may behave differently compared to more common soluble salts and plant nutrients in soils. Soil clay content, CEC, organic matter content, oxidation/reduction state, and pH all influence the mobility and bioavailability of metals and nutrients in the soil to varying degrees. The concentrations of major elements and trace metals in the solution phase of the soil-water-plant system are governed by reactions such as acid-base equilibrium, chelation (i.e., a process that binds and stabilizes metallic ions), precipitation and dissolution of solids of oxides and carbonates, and ion exchange-adsorption on clay minerals. Unlike soluble salts, most metallic compounds are not readily soluble in water or very mobile in the soil, except at the low pH levels present in strongly acidic soils. Because of their affinity to soil particles, including clay, organic colloids, carbonates, and iron complexes, trace metals are often retained in the soil and normally do not move readily with the soil-water solution.

Arsenic, molybdenum, and cadmium can be mobile in nonacidic soils and, under certain conditions, can accumulate in bioavailable forms and be potentially toxic in low soil-solution concentrations. Boron is also somewhat soluble and mobile, and plants vary widely in their boron phytotoxicity. Boron is naturally present in extremely high concentrations in a small proportion of California soils. The solubility, and hence the mobility and bioavailability, of cadmium, copper, nickel, zinc, and chromium compounds are significantly pH-dependent. These metals are associated with iron and manganese hydrous oxide compounds, the solubility of which increases with decreasing soil pH and/or more chemically reducing conditions. As a result, the poorly drained, acidic conditions that occur in some California soils favor mobilization of metals whereas well-drained, nonsandy, basic (alkaline) to slightly acidic soils immobilize most cationic metals. Lead generally has limited mobility in the soil. In slightly acidic, non-calcareous (i.e., low calcium content) soils, lead generally is not bioavailable; instead, it precipitates out as lead hydroxides or lead polymorphites and, consequently, does not readily reach groundwater. Thus, the process of maintaining suitable soil pH levels, drainage, and organic matter content is extremely important in managing lands to which biosolids have been applied. Phytotoxic effects of trace elements to crops and other plants are also addressed in Chapter 4, "Land Productivity".

The valley bottomland, basin, and low terrace soils in many areas of California, which are rich in organic matter and clay, should rapidly and effectively immobilize metals contained in biosolids through chelation and cation exchange. Of greater concern are soils that are sandy and acidic and have low organic matter; in these soils, metals are easily transformed to be readily bioavailable and water moves freely with little soil interaction. These soil conditions are somewhat rare in California but occur on recently formed sandy, alluvial fan soils associated with the granitic foothills of the southern San Joaquin Valley, in some high mountain valleys, and in parts of San Diego and Monterey Counties. The soils of valley margin foothills, which often are acidic and have low organic matter content, may also be difficult to manage for effective biosolids application. Areas of shallow perched groundwater may also raise management concerns.

In measuring total metals concentrations in soils and biosolids and total loading rates, no distinction is made between plant-available and mobile forms of metals in the soil-water solution. Except in biosolids from cities with large amounts of heavy industry, most biosolids contain low concentrations of trace metals relative to levels that can accumulate and adversely affect soil productivity and agricultural sustainability under normal California soil conditions and loading rates. The low mobility of biosolids-derived metals in typical soil environments has been demonstrated in research conducted by Camobreco et al. (1996) and Dowdy et al. (1991). However, some scientists recommend caution in assessing the potential for adverse soil quality and health effects of poorly designed and poorly managed programs of biosolids land application and of such programs operating where unusual soil conditions and cropping patterns occur (Cornell Waste Management Institute 1999). Annual application rates and the total amount of biosolids that can be applied over the long term may be dictated by the trace element content of the biosolids to be used.

Trace Metals in the Aquatic Environment. The risk assessment procedures used to develop the Part 503 regulations are important factors for the environmental evaluation of the proposed GO regulation. The following trace metals are identified as priority pollutants by the EPA under federal statutes: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Molybdenum is another trace metal that is of general concern in the regulation of biosolids disposal practices because of its potential for uptake in grazing livestock. The priority pollutant trace metals and molybdenum are known to cause toxicity or otherwise have potential to degrade water resources if present under certain environmental conditions and in sufficient concentrations.

As the metals are transported to lower soil layers, small fractions of metals are partitioned between the soil and water. Several studies have shown that only small fractions of metals move to lower soil layers (Camobreco et al. 1996, Dowdy et al. 1991, Sidle and Kardos 1977, McGrath and Lane 1989). One significant factor that may increase the leachability of metals is the decrease in pH caused by mineralization of biosolids organic matter over time. No conclusive evidence has been found, however, to indicate that decreased pH will increase trace metal leachability. Other studies imply that low pH may be a precursor of high metal mobility leading to groundwater contamination (Wallace and Wallace 1994, Emmerlich et al. 1982, McGrath and Lane 1989).

Part 503 Risk Assessments of Trace Metals for Surface Water and Groundwater Pathways. The Part 503 regulations represent the most current understanding of the risks associated with land application of biosolids and are the basis for the proposed GO. Approximately 200 pollutants were originally evaluated for possible consideration in the Part 503 regulations; the risk assessments for surface water and groundwater pathways were ultimately conducted for seven trace metals (U.S. Environmental Protection Agency 1992). All other trace metals either were not detected in the sewage sludges tested during the 1990 National Sewage Sludge Survey (U.S. Environmental Protection Agency 1990) or were detected at sufficiently low concentrations to warrant no further consideration. Of the 14 pathways evaluated for the Part 503 regulations (surface water was designated pathway 12 and groundwater was designated pathway 14), neither the surface water nor the groundwater pathway was found to be limiting to trace metal concentrations or cumulative loading rates resulting from land application of biosolids. Some of the factors evaluated and assumptions used during the Part 503 development process to set limits on trace metals are controversial among researchers and respondents to the scoping notice for this EIR.

In the 1998 CASA survey of trace metal concentrations in sewage sludges from California (California Association of Sanitation Agencies 1999), average concentrations and variability were below the levels reported from the 1990 National Sewage Sludge Survey (NSSS) (U.S. Environmental Protection Agency 1990). Average concentrations of cadmium, copper, lead, nickel, and zinc in the 1998 CASA data range from 25% to 50% of the 1990 national averages; 1998 CASA averages for arsenic, mercury, and molybdenum are generally similar to the respective national estimates. Selenium is the only trace metal that has higher average concentrations in the 1998 CASA data than in the 1990 NSSS results. Maximum reported concentrations of copper, mercury, and selenium are the only trace metals in the 1998 CASA survey data that exceed the concentration limits identified under the discharge prohibitions of the proposed GO regulation.

Synthetic Organic Compounds

Synthetic Organic Compounds in Soil. Many SOCs used in industrial, commercial, and household applications can be transported to wastewater treatment plants through the municipal wastewater collection and treatment process and therefore can be present in biosolids. As is the case with nutrients and trace elements, the SOC content of the biosolids is determined by the type of business and industry within the wastewater treatment service area, any onsite pretreatment conditions, and the effectiveness of the wastewater treatment process. Many of these organic compounds either are volatile, and so are lost during the treatment process, or biodegrade readily during the treatment process, which is designed and managed to foster microbial decomposition. Other volatile compounds are quickly lost to the atmosphere following biosolids incorporation in the soil. For these reasons, the possible presence of volatile organic compounds in biosolids has generally not been of great concern to regulators and the general public.

Various other nonvolatile organic compounds or semivolatile organic compounds (SVOCs) generally are present in low amounts in municipal biosolids. These include plastic-like compounds (phthalates), pesticides, phenols, detergent additives, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and the group of chlorinated dibenzo-para-dioxin and chlorinated dibenzo-furan compounds that are often cumulatively referred to as dioxins. The Part 503 regulations do not require that biosolids be tested for SOCs; however, the proposed GO monitoring program would require testing of biosolids for PCBs and SVOCs. Upper limits are set by state and federal hazardous materials rules and regulations, with local municipalities enforcing source inspection and pretreatment provisions associated with their wastewater discharge permits. Toxic chemicals such as DDT, chlordane, aldrin, dieldrin, benzo(e)pyrene, and lindane are known to cause cancer, and other compounds (e.g., dioxin; 2,4,5-trichlorphenol; and pentachlorophenol) are known to cause birth defects. Consequently, many SOCs have been prohibited from being used or manufactured in the United States.

Compared to the large amount of detailed information available on trace elements, much less is known about soil accumulation, plant uptake, and concentration mechanisms of SOCs in soils. The knowledge base is much broader for the attenuation, degradation, and mobility of volatile compounds, pesticides, and PAHs in the soil. The primary exposure pathways for organic compounds are generally understood to be migration to drinking water sources or dispersal as residues and soil dust that accumulate on plant leaves, rather than direct plant uptake. Direct ingestion, either of soil that contains biosolids or of dust on plant parts by grazing animals, is another exposure pathway of concern. Bioaccumulation of these compounds may lead to increased risk factors for human health effects. Potential phytotoxic effects of SOCs to crops and other plants are addressed in Chapter 4, “Land Productivity”.

Synthetic Organic Compounds in the Aquatic Environment. More than 100 EPA-designated organic compounds are regulated as priority pollutants through federal and state drinking water standards, ambient surface water quality criteria, and hazardous waste laws. Most of these compounds are generally not detected in biosolids or are present at very low levels (U.S. Environmental Protection Agency 1990).

In general, transport of organic compounds from the solid to the liquid phase of the soil environment is limited for most constituents (U.S. Environmental Protection Agency 1992, Chaney 1990). Demirjian et al. (1987) showed that organic compounds originating from biosolids application were degraded in the soil or were adsorbed in the surface layer. At an application rate of 100 tons per acre, most compounds degraded considerably during one irrigation season. At an application rate of less than 25 tons per acre, most compounds degraded to less than 50% of their initial concentration. The authors concluded that the sandy soils in the study area and the heavy irrigation required for the experiment represented severe conditions for land application and that nutrients and trace metals would be the limiting factors in determining appropriate application rates under average soil conditions (Demirjian et al. 1987).

Alexander (1995) showed that the binding effect that causes toxins to persist in the soil becomes more pronounced the longer the pollutant remains in soil and that higher organic matter content leads to a greater binding effect. The report states that the disappearance of appreciable amounts of insecticides from a field was not a result of leaching because all chemicals were extensively adsorbed to soil particles or organic matter and little vertical movement has been detected, even after many years. As a chemical persists in the soil and remains in contact with particulate matter for an extended period, it becomes increasingly resistant to extraction by many solvents. For example, Rappe et al. (1997) reported that dioxins have extremely low solubility and are unlikely to leach from soil into groundwater.

Part 503 Risk Assessments of Synthetic Organic Compounds for Surface Water and Groundwater Pathways. SOCs were included in the original pollutant screening and risk assessments conducted during development of the Part 503 regulations for land application of biosolids. Of approximately 200 pollutants originally evaluated for possible consideration in the Part 503 regulations, the risk assessments for surface water (pathway 12) and groundwater (pathway 14) were ultimately conducted for 10 priority pollutant organic compounds (U.S. Environmental Protection Agency 1992). Other organic compounds either were not detected in the tested sewage sludges or were detected at sufficiently low concentrations to warrant no further consideration. The groundwater pathway was not found to be the limiting pathway for concentration limits or cumulative loading rates of any organic compounds resulting from land application of biosolids. The surface water pathway (i.e., humans eating fish that have accumulated pollutants from surface runoff) was the limiting pathway for setting limits on DDT/DDE compounds.

Upon completion of the risk assessments for organic compounds, the EPA concluded that regulations for organic compounds were not required for the final Part 503 regulations because each of the compounds met at least one of the following criteria:

- the pollutant is banned from being used, has restrictions on its use, or is not manufactured in the United States;
- it was detected in less than 5% of the sludges tested for the 1990 National Sewage Sludge Survey; or
- the 1-in-10,000 cancer risk limit was less than the 99% maximum probable concentration based on 1990 NSSS data.

Limits were not set for DDT/DDE compounds because they are excluded from all EPA screening criteria. Several organic compounds were deferred for future consideration and evaluation during the second round of regulation development. The organic compounds of interest for future consideration are PCBs, chlorinated dibenzo-para-dioxins, and chlorinated dibenzo-furans (dioxin). Research is also being conducted on other aromatic surfactants (e.g., linear alkylbenzene sulphonates and ethoxylates) that may have hormone-mimicking properties; however, little is known about their means of transport from biosolids application sites (Krogman et al. 1997, Clapp et al. 1994).

Some of the factors and assumptions used during the Part 503 development process to set limits on toxic organic compounds are controversial. The elimination and deferment of Part 503 limits for organic compounds is a source of some controversy among researchers, as indicated by respondents to the scoping notice for this EIR. The primary arguments presented in favor of setting limits on organic compounds in the Part 503 regulations include the following:

- the elimination process was arbitrary,
- the lack of monitoring requirements means that no information is available on which to base application decisions,
- the risk assessment does not address risks associated with specific compounds for which supporting research data are lacking, and
- groundwater dilution factors identified in the risk assessment may have been too large (Cornell Waste Management Institute 1999).

Comments received during the scoping process indicated a concern that the Part 503 risk assessments may not accurately reflect environmental conditions in California or account for risks from new organic compounds such as pharmaceuticals. General concern was also expressed regarding the assumptions used for the Part 503 regulations regarding synergistic or combined risks from exposure to multiple constituents that may be present in biosolids. EPA contends that the risk assessment process was based on conservative assumptions and that no scientific data have been presented that would invalidate the results of the risk assessments (U.S. Environmental Protection Agency 1995).

Regulatory Setting

Key Policies, Laws, and Programs

Water Quality Regulations and Permits

Numerous policies, laws, and programs are administered by local, state, and federal agencies to enforce limitations on the discharge of pollutants to the environment; maintain surface water and groundwater quality at existing levels; and protect beneficial uses such as municipal, industrial, and agricultural water supply, recreation, and fish and wildlife habitat. Federal, state, and local water quality regulations apply to any chemical constituent contained in biosolids or any activity that would occur as a result of land application of biosolids.

The SWRCB establishes water quality control policies in California in accordance with the State Porter-Cologne Water Quality Control Act and the federal Clean Water Act and implements those policies through nine RWQCB offices. The nine regions were initially established according to similar and unique hydrologic and water quality characteristics. Figure 1-1 shows the names and boundaries of the nine RWQCBs.

Each RWQCB has primary responsibility for designating the beneficial uses of water bodies within its region, establishing water quality objectives for protection of those uses, issuing permits, and conducting enforcement activities. Beneficial uses are defined as those uses of the water resource for which numerical and narrative water quality objectives have been established to prevent water quality impairment. Water quality objectives and associated narrative and numerical water quality objectives are established in a Basin Plan for each region that is updated through a triennial review process. The principal permitting processes administered by the RWQCBs for water quality protection are WDRs imposed on waste discharges to land and water, and permits issued under the NPDES as required by the federal Clean Water Act. WDRs and NPDES permits issued to waste dischargers impose discharge restrictions and pollutant limits that take into consideration applicable state and federal water quality criteria for surface water, groundwater, and drinking water. The permit processes must also consider the state's antidegradation policy, which is intended to protect high-quality waters by setting criteria that must be met before a discharge is allowed that would reduce water quality and yet maintain beneficial uses.

Numerical Water Quality Criteria. Numerical water quality criteria that apply to this program include Basin Plan water quality objectives for surface water and groundwater, state and federal ambient surface water quality criteria, and state and federal drinking water standards. The RWQCBs are required to include effluent limitations on toxic priority pollutants in any WDRs and NPDES permits issued for wastewater discharge to surface waters when the discharge may cause the surface water to exceed established standards for priority pollutants. Regulated priority pollutants include approximately 130 trace metals and organic compounds that are known to be toxic to living organisms when present in water at sufficient concentrations.

Regulations pertaining to priority pollutants have been developed in four main regulations: narrative requirements in the Clean Water Act, the National Toxics Rule (NTR), the rescinded Inland Surface Waters Plan/Enclosed Bays and Estuaries Plan (ISWP/EBEP), and the recently proposed California Toxics Rule (CTR). The proposed CTR was developed in accordance with Section 303(c)(2)(B) of the Clean Water Act (Federal Register Vol. 62, No. 150 - August 5, 1997) to fill the gap in regulation created when the ISWP/EBEP was legally challenged and overturned. The SWRCB subsequently issued a Draft Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California and Accompanying Functional Equivalent Document (California State Water Resources Control Board 1996b) that identifies the proposed rules for using the CTR criteria as a new ISWP/EBEP. Following adoption of the CTR or another form of ISWP/EBEP, wastewater discharges and NPDES-permitted facilities will be required to comply with the new standards for priority pollutants.

Drinking water standards, established by DHS under Title 22 CCR Division 4, Chapter 15 - Domestic Water Quality and Monitoring, apply to groundwater and surface water. EPA has developed similar standards under the federal Safe Drinking Water Act. Both sets of laws contain MCLs that are based on a one-in-a-million (10^{-6}) incremental risk of cancer from ingestion of carcinogenic compounds and threshold toxicity levels for other compounds. The MCLs are also based on technological and economic factors relating to the feasibility of achieving and monitoring the pollutants in a drinking water supply. Secondary MCLs are established for welfare considerations such as taste, odor control, and laundry staining. The MCLs apply primarily to the quality of water after it has entered a distribution system they apply to source water only when specifically established in a region's Basin Plan by the RWQCB.

NPDES Permits. Discharges of waste to surface water bodies, including discharges from wastewater treatment plants (WWTPs), are regulated through the NPDES permitting process, which is mandated under the Clean Water Act. The NPDES permit program regulates point-source discharges, such as industrial stormwater facilities and WWTPs. The NPDES permit process for WWTPs typically involves the imposition of various chemical, physical, and biological standards on the effluent and receiving water body. Biosolids treatment and disposal regulations can be included in the NPDES permit for the treatment plant or can be covered under separate WDRs.

National Pretreatment Program for Industrial Discharges. Pretreatment of industrial discharges is mandated by the Clean Water Act of 1977 (33 U.S. Code [USC] Sections 1251-1376; Public Law [P.L.] No. 95-217, 91 Stat. 1566). EPA has established pretreatment standards (40 CFR Part 403) for various industrial categories. EPA created the National Pretreatment Program and first issued pretreatment regulations in November 1973. Following amendment of the Clean Water Act, the regulations were revised in June 1978 and again in January 1981. The purpose of the National Pretreatment Program is to regulate the discharge of pollutants to municipal sanitary sewers. The goal is to protect receiving water quality and the environment from pollutants that can pass through a WWTP relatively unaffected by the treatment processes. An individual pretreatment program will typically involve several steps:

- identification of pollutants that could cause upset or bypass (pollutants of concern);
- development of discharge limitations for nondomestic discharges (local limits);
- identification of nondomestic discharge sources; and
- implementation of nondomestic monitoring programs to enforce the local limits.

Source control programs have significantly reduced the biosolids pollutant concentrations. This is shown by the decrease in biosolids pollutant concentrations at facilities with aggressive source control programs. As source control programs are continually being improved because of more stringent pollutant limitations, pollutant concentrations in biosolids will continue to decrease or, at a minimum, remain the same.

Nitrate Management: Research, Technical Support, and Technology Transfer on Agronomic Rates

In 1988, the SWRCB prepared the Nonpoint Source Assessment Report (California State Water Resources Control Board 1988), documenting water quality threats and evaluating programs designed to reduce nonpoint-source pollution. Unlike point sources of contamination that are discreet and subject to regulatory control, nonpoint sources of contamination are typically associated with longstanding and generally acceptable societal practices and land use activities where liability for contamination is hard to determine, and where regulatory programs cannot easily remedy the problem. Agriculture, silviculture, urban stormwater runoff, and grazing are land use activities that have the potential to degrade water quality. The SWRCB has begun to define strategies to deal with nonpoint-source contamination and is developing a watershed management initiative (California State Water Resources Control Board 1995a). The Technical Advisory Committee for Plant and Nutrient Management was convened to assist in developing the Initiatives in Nonpoint Source Management (California State Water Resources Control Board 1995b); these management initiatives respond to nonpoint-source contamination in California. The committee recommended that specific assessments of farming activities be conducted by agricultural experts familiar with unique agronomic conditions and local practices. It was anticipated that these assessments would be used to define appropriate best management practices (BMPs) to control nutrient leaching and make available the best available information and current research.

DFA's FREP program was created to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. The program facilitates and coordinates the development of applied research and demonstration projects that provide technical assistance and funding to carry out research, demonstration, and education projects related to use of nitrogen fertilizers in agriculture. FREP also seeks to improve access to information on agronomic uses of nitrogen and serves as a clearinghouse for data and research. Funding is provided by a tax on agricultural fertilizers. FREP is part of the Nitrate Management Program established by DFA in 1990 to identify nitrate-sensitive areas and reduce the agricultural industry's share of nonpoint-source nitrate contamination. The information and research generated and distributed by FREP will assist in defining nitrogen agronomic rates for a range of crops and conditions found in California.

The Certified Crop Adviser (CCA) program has been developed by the American Society of Agronomy (ASA) in cooperation with agribusiness retail dealers, cooperatives and manufacturers, state and national trade associations, the U.S. Department of Agriculture (USDA), and independent consultants. The aim of this group is to develop a voluntary program for crop advisers that would establish standards for knowledge, experience, ethical conduct, and continuing education; enhance professionalism; and promote dialogue among those involved in agriculture and natural resource management.

The University of California, California State University, local County Agricultural Extension Service offices, NRCS, and USDA are all actively pursuing projects and research related to nutrient management and agronomic rates of nitrogen for various crop conditions in California. This information is being made widely available through local resource conservation districts, water districts, agricultural organizations, and county agricultural commissioners. These same groups have been conducting research and demonstration projects to evaluate the effectiveness of on-farm BMPs for reducing nitrate contamination.

Drinking Water Source Water Assessment and Protection Program

The DHS Division of Drinking Water and Environmental Management is developing a program to assess the vulnerability of drinking water sources to contamination (California Department of Health Services 1999). This program, which is required by federal and state law, is called the Drinking Water Source Water Assessment and Protection (DWSWAP) Program. The wellhead protection portion of the program has been approved by EPA, and DHS anticipates receiving approval of the surface water component in mid-1999. Completion of drinking water source assessments is required by April 2003. The federal Safe Drinking Water Act requires states to develop a program to assess sources of drinking water and establish protection programs.

California's DWSWAP Program is the first step in the development of a complete drinking water source protection program. The DWSWAP Program will include evaluation of both groundwater and surface water sources. The groundwater DWSWAP program includes components intended to fulfill the requirements for state development of a Wellhead Protection Program strategy, as required by Section 1428 of the Safe Drinking Water Act amendments of 1986. A Wellhead Protection Area (WHPA), as defined by the 1986 amendments, is "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield".

DHS must inventory possible contaminating activities (PCAs) that might lead to the release of microbiological or chemical contaminants within the delineated area. An essential element of the DWSWAP program is an inventory of PCAs that are considered to be potential sources of contamination in the designated drinking water source areas and protection zones. Irrigated agriculture and land application of biosolids are recognized as PCAs. As such, specific setback requirements from municipal and domestic wells and from surface water sources that provide drinking water will be required upon completion of the assessments and vulnerability analyses by DHS or locally responsible agencies. Biosolids application and agricultural applications of fertilizer are classified as having a moderate potential risk of contaminating drinking water (California Department of Health Services 1999).

Groundwater Management Plan (AB 3030)

Sections 10750-10756 of the California Water Code (AB 3030) were signed into law in 1992 and describe components that may be included in a groundwater management plan developed by a local agency to protect groundwater. In all, 149 agencies have adopted groundwater management plans in accordance with AB 3030 (California Department of Water Resources 1994c). Each component would play a role in evaluating or operating a groundwater basin so that groundwater can be managed to maximize the total water supply while protecting groundwater quality. California Department of Water Resources Bulletin 118-80 defines groundwater basin management as including planned use of the basin's yield, storage space, transmission capability, and water in storage (California Department of Water Resources 1975). Ground water basin management includes:

- protection of natural recharge and use of intentional recharge,
- planned variation in amount and location of pumping over time,
- use of groundwater storage conjunctively with surface water from local and imported sources, and
- protection and planned maintenance of groundwater quality.

The 12 components listed in Section 10753.7 of the Groundwater Management Act (AB 3030) form a basic list that includes data collection and operation of facilities that may be undertaken by an agency operating under this act. With respect to protecting groundwater from potential contamination from biosolids, the critical components to be included in local plans include the following:

- identification and management of wellhead protection areas and recharge areas,
- regulation of the migration of contaminated groundwater,
- administration of a well abandonment and destruction program,
- monitoring of groundwater levels and storage, and
- review of land use plans and coordination with land use planning agencies to assess the risk of groundwater contamination from various activities.

Impacts and Mitigation Measures

Approach and Methods

The evaluation of impacts is supported by the information provided in "Environmental Setting", which is referred to when necessary to support the impact determinations. The evaluation included a review of the available research and scientific literature used to support the development of the Part 503 requirements and similar documentation from other biosolids application projects. Potential impacts were evaluated based on available data regarding the extent, duration, frequency, and intensity of possible biosolids-related effects on soils, hydrology, and water quality. Impacts that affect land productivity and land classification are described in Chapter 4, "Land Productivity".

Thresholds of Significance

Adoption of the GO may have a significant impact on soils, surface water, or groundwater if it would:

- substantially alter existing drainage patterns of the site or area in a manner that would result in substantial erosion or sedimentation, either onsite or offsite;
- substantially alter existing drainage patterns on the site or in the area, resulting in substantial increases in the rate or amount of surface runoff and cause flooding onsite or offsite, or which would contribute runoff water that would exceed the capacity of the existing or planned stormwater drainage system;
- increase the demand for surface water or groundwater supplies in areas with existing shortages;
- violate RWQCB water quality standards or objectives or cause impairment of beneficial uses of water;
- substantially deplete groundwater supplies or interfere with groundwater recharge to such a degree that there would be a net deficit in aquifer volumes or lowering of the local water table.

Impacts of Agricultural Use

Impact: Changes to Existing Drainage Patterns or Increase in Surface Runoff

In many areas of the state, land application of biosolids may have beneficial impacts on soils associated with reduction in runoff as a result of increased infiltration capacity and improvement in soil conditions that reduce the potential for erosion. Biosolids application activities that would occur under the GO would cause negligible alteration of existing drainage patterns or increase in erosion or sedimentation, either onsite or offsite.
None of the activities that may occur under adoption of the GO would increase the rate or amount of surface runoff, result in flooding onsite or offsite, or contribute to additional runoff of water exceeding the capacity of existing or planned stormwater drainage systems. The improvements in soil water-holding capacity may reduce water demand in silvicultural, horticultural, or agricultural operations. This impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Changes in Groundwater Supply and Hydrology

None of the actions anticipated to occur through application of the GO are anticipated to cause increases in demand for groundwater or to alter the rate or direction of groundwater flow. Improvement of the soil's water-holding capacity may be a beneficial impact and reduce water demand over pre-application conditions at horticultural, silvicultural, reclamation, and agricultural sites. This impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential Degradation of Surface Water from Nutrients in Biosolids

Land application of biosolids has the potential to degrade the quality of surface water, including adjacent streams, lakes, and wetlands, through surface runoff of pollutants from the application sites. Potential mechanisms of contamination from pollutants include the following:

- During low-probability rainfall events or accidental overirrigation, surface flow rates could exceed soil infiltration capacities and the capacity of runoff control facilities, resulting in runoff entering surface water less than 30 days after application, in violation of provisions of the GO.

- Biosolids being applied to previously uncultivated land could be placed directly into undetected seasonal wetlands (e.g., vernal pools) during the dry season.
- Accidents could occur during transport of biosolids, with resulting discharge to surface water.

In California, environmental conditions that could lead to surface water runoff are primarily present in areas with many surface streams and other water bodies. Areas of high winter rainfall, such as the north and central coastal regions and interior northern California, have the greatest potential for rainfall intensities that could exceed the capacity of runoff control facilities. Seasonal wetlands are present throughout the Central Valley and coastal plains, and in these areas careful consideration would be required in selecting locations for biosolids application projects. Accidents related to transport of biosolids might also result in discharge of biosolids to surface waters, but this event would not be expected with sufficient frequency or probability to warrant specific mitigation measures at the programmatic level of analysis.

The proposed GO contains several prohibitions and specifications that would minimize or prevent the occurrence of pollutant runoff for most site-specific conditions in California. The GO prohibits discharges that could cause pollution and further requires that there shall be no discharge of biosolids from the storage or application areas to adjacent land areas not regulated by the GO, to surface waters, or to surface water drainage courses. The discharger would not be able to apply biosolids directly to surface waters, and GO specifications are consistent with Basin Plan policies for water quality protection. The NOI requires dischargers to provide site-specific information that each RWQCB would use to evaluate whether surface runoff would be prevented. This information includes the site location and map, location of surface waters, types of crops grown, rate of biosolids application, and identification of periods to be avoided to prevent runoff from the biosolids application site. The SWRCB and individual RWQCBs are responsible for reviewing discharger-provided information, evaluating site-specific conditions, and determining whether the biosolids application project under an individual NOI would comply with the minimum standards of the GO.

For the discharger to be able to comply with the GO, appropriate BMPs that meet industry standards and guidelines would have to be implemented that are effective at preventing accelerated erosion and runoff. The discharge of contaminants to surface waters from biosolids application sites can be prevented by controlling offsite runoff, avoiding wet-weather application of biosolids, and incorporating biosolids into the soil after application. The information needed to design and implement a biosolids application project that is in compliance with provisions of the GO is readily available from existing databases; agricultural extension programs; and through the services of knowledgeable agricultural, horticultural, or forestry professionals. As described above, several state and federal agencies maintain databases that provide hydrologic and climatic information.

Minimum standards under the GO that would ensure protection of surface waters from water quality impairment include setback distances from water bodies, requirements to control runoff through limited seasonal periods for application, use of vegetated buffer strips, and preparation of erosion and sediment control plans for steep slopes. Refer to Chapter 8, "Fish", for the discussion regarding potential impacts on fisheries productivity resulting from temporary discharges of suspended solids and sediment. Surface and subsurface runoff of toxic substances could also affect fisheries by causing toxicity to protected species in enclosed water bodies. These specific impacts are not considered significant to water quality, however, and this impact is therefore considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential Degradation of Groundwater from Nutrients

The evaluation of potential impacts on groundwater is focused on nitrate because the GO prohibits biosolids application rates that exceed the agronomic rate of nitrogen uptake by plants. Nitrate is highly soluble in water and chemically stable in the aquatic environment, and the requirements for applying biosolids at the agronomic rate were established to reduce the available pool of nitrate, which may then be leached and transported to groundwater. The GO defines the agronomic rate as "the nitrogen requirements of the plant needed for optimal growth and production, as cited in professional publications for California, the County Agricultural Commissioner, or recommended by a Certified Agronomist". This is a conservative standard and is acknowledged to be the limiting factor for determining the total allowable dry-weight application rate of biosolids under typical environmental conditions. The GO prohibitions also state that "the discharge shall not cause or threaten to cause pollution", which implies that nitrate levels in groundwater must not cause violations of the Safe Drinking Water Act such as exceedance of the 45-mg/l-as-NO_3^- standard at a well providing municipal or domestic drinking water. The potential rate of leaching of other pollutants to groundwater, such as trace metals and SOCs, would be less than the leaching rate for nitrate because those compounds are less soluble and are typically present in lower concentrations relative to their solubility characteristics.

Biosolids applications could provide a net benefit if the nitrogen contribution is factored into the overall on-farm soil, water, and fertility management program. Biosolids have the potential to reduce the reliance on chemical fertilizers. A large fraction of the nitrogen contained in biosolids is bound in an organic form, such that the required mineralization process reduces the rate and quantity of soluble nitrate formation that is then available to leach beyond the root zone. Increased water-holding capacity of the soil resulting from biosolids application could reduce nitrate leaching. Increases in soil organic matter as a result of biosolids application could improve nutrient cycling and overall soil productivity, and the improved management techniques that may result from consultation with certified crop consultants could reduce cumulative nitrate loading from historic levels.

Even at agronomic rates, however, some leaching of nitrates may occur at biosolids application sites. The potential for leaching of nitrates is closely related to the amount of water that is available to transport dissolved contaminants from the root zone. When water moves out of the root zone, whether as a result of irrigation or as runoff from rainfall during winter fallowing of agricultural land, some nitrate will move out of the biologically active soil zone as a dissolved constituent in the leachate. This could affect groundwater if land application resulted in any of the following conditions:

- nitrogen concentrations in biosolids leachate that exceed drinking water standards as a result of:
  - unknown agronomic rate or inaccurate rate calculation (i.e., failure to account for cropping pattern and rotation, timing of biosolids application, total volume of nitrogen applied, rate of mineralization);
  - irrigation not being closely managed and water being applied in excess of the soil's water-holding capacity at times when nitrates are available for leaching from the soil;
  - rainfall exceeding the soil's water-holding capacity over the winter or during fallow periods, resulting in nitrates leaching from the soils;
- nitrogen concentrations in biosolids leachate that exceed drinking water standards and site-specific evaluations that do not consider local hydrogeology, groundwater assimilative capacity, or vulnerability of municipal and domestic wells; or
- nitrogen concentrations in biosolids leachate that exceed drinking water standards and existing groundwater quality that is close to exceeding the drinking water standard, groundwater quality that is unknown and close to exceeding the standard, or a groundwater basin that is internally drained such that there is limited assimilative capacity.

There are several areas in California where the susceptibility to nitrate contamination is particularly severe. Nitrate-impaired basins have been identified by the SWRCB (California State Water Resources Control Board 1988). In areas with high evapotranspiration rates and high dissolved salt concentration of irrigation water, irrigation water is intentionally overapplied to maintain soil productivity. In California, the major areas where irrigation is used for leaching of salts are the Imperial and Coachella Valleys, the southern San Joaquin Valley, Tulare Basin, and other regions of the Central Valley. Winter precipitation on fallow land may also mobilize nitrates in many areas of the state, primarily the coastal communities that receive heavy rainfall, interior areas of northern California that receive heavy rainfall, and forested areas that have large amounts of snow.

Even if nitrate levels in biosolids leachate may exceed the established drinking water standards, the impact of leachate on groundwater would not necessarily be significant if water quality standards in the groundwater are not exceeded and beneficial uses are not impaired. Some nitrate leaching is acceptable if the groundwater assimilative capacity is sufficient to prevent degradation of groundwater quality or if the nitrate concentration in the leachate is less than that in the groundwater. In some areas of the state, the groundwater may not support the beneficial use as domestic supply, in which case the RWQCB is allowed to make site-specific decisions regarding the level of pollution control that is required for a project.

For typical soil and hydrologic conditions present in California, land application of biosolids at agronomic rates of nitrogen uptake has a low probability of impairing groundwater because the GO prohibits biosolids application projects that would cause such degradation and requires management practices to ensure compliance. The GO also specifies minimum setback requirements from wells and a minimum depth of groundwater at which monitoring would be required. Each RWQCB would have to consider all of the available information and data resources to ensure that general WDRs issued under the GO conform with the prohibitions and do not lead to water quality impairment. The SWRCB and individual RWQCB staff members are required to review discharger-provided information, evaluate site-specific conditions, and determine whether the proposed biosolids application project identified in an individual NOI would comply with the minimum standards of the GO. The databases and regulatory programs described above provide adequate resources for RWQCB engineers to make informed decisions on issuing a notice of applicability (NOA) for the project under the GO or rejecting the application (an NOA indicates that the proposed project can be permitted under the conditions of the GO). Given the full consideration of all available site-specific information for a proposed land application project, as specified in the NOI, and of other supplemental information and resources available to the RWQCB engineer, the RWQCB would not issue an NOA for the project if it could not ensure that the application project would comply with the GO.

As described above, various resources and programs are available with which to determine whether a project would result in violations of minimum standards specified in the GO. The SWRCB recognizes that individually prescribed fertilizer management practices should be specific to the unique crops, soils, and the potential risks to groundwater (California State Water Resources Control Board 1994).

The calculation of agronomic nitrogen uptake rates is becoming more fully integrated with complete farm fertility programs, and more environmental data are available to be used by certified crop advisors, agricultural engineers, agronomists, and other professionals in developing agronomic rates specific to local conditions and crop types. Agricultural water management plans required by state and federal programs have also been developed throughout the state and are intended to improve water conservation and reduce water demands. Farmland water management occurring as a result of these plans will also serve to reduce deep percolation of irrigation applied water and the potential for leaching of nitrates and other potential contaminants. Farm-level plans are currently not required in many areas of California. Several state and federal agencies maintain databases that provide real-time hydrologic and climatic information for optimal management of farm irrigation systems. This information is being made widely available through the agricultural industry by County Agricultural Commissioners, Agricultural Cooperative Extension, local water districts, resource conservation districts, and other state and federal agencies and as a result of the other programs described in the settings sections. The voluntary implementation of BMPs is being promoted as a means of reducing agrochemical contamination (California State Water Resources Control Board 1995b).

The activities to be undertaken as part of DHS's implementation of the DWSWAP Program, described above, will result in development of wellhead protection zones to protect groundwater and assess the vulnerability of municipal and domestic drinking water supplies that serve more than two service connections. (Single-connection residential wells are not part of the program.) The wellhead protection portion of the DWSWAP Program will include specific groundwater vulnerability analysis of all possible contaminating activities, including biosolids. In addition, local AB 3030 plans that characterize the local hydrogeology or have established wellhead protection programs and local requirements will also provide some assurance that groundwater assimilative capacities will not be exceeded. This impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential Degradation of Surface Water and Groundwater from Trace Elements in Biosolids

Biosolids application to land has the potential to contribute to surface runoff or to leachate beyond the plant root zone trace metals and other elements that could eventually reach groundwater. For water quality impacts to occur, the concentrations in surface runoff or subsurface leachate would have to exceed applicable regulatory water quality criteria (the lower of either ambient water quality criteria for aquatic life, human health from consumption of organisms, or drinking water standards) and result in toxic effects on the aquatic environment or impair beneficial uses of the water.

The GO contains numerous minimum standards that the discharger must implement to control surface water runoff from the application site. As described above, the potential for surface water runoff of biosolids is low because provisions of the GO would require dischargers to implement appropriate BMPs, such as maintaining minimum setback distances from surface waters and wells, prohibiting application directly to surface waters, prohibiting application to saturated or frozen ground or areas subject to washout, preventing runoff for the period within 30 days of application, and requiring that an erosion control plan be professionally prepared for areas with slopes greater than 10%. Consequently, the probability of washout is substantially reduced because biosolids application projects would have to be designed to meet the runoff prohibitions.

Potential impacts on groundwater quality were evaluated based on information developed for the Part 503 risk assessment process and other available data. The risk factors for increased leaching of trace metals from biosolids into groundwater increase under extreme soil pH conditions, high concentrations of trace metals in the biosolids or soil, and hydrologic conditions such as high rainfall or presence of shallow groundwater. In some areas in California, as described above, one or more risk factors are higher than under typical conditions statewide. Low soil pH can exist in such areas as reclamation sites where acid drainage is present, some forest soils, and isolated regions of the Monterey and San Diego coastal regions. Some areas of the state have naturally high background concentrations of trace elements in the soil, such as selenium and boron in some southern San Joaquin Valley areas. Historical mine sites also may have high background levels of trace elements such as copper, zinc, mercury, lead, and cadmium, such as in northern California.

The potential impact of trace metals on groundwater quality is considered less than significant based on the regulatory performance standards established under the GO, operational requirements for a discharger applying biosolids under the GO, or naturally occurring conditions that would result in low probabilities for water quality impairment. The following list describes types of impact mechanisms and mitigating factors and/or protections provided under the GO to reduce the potential impacts:

- Cultivated California soils generally have a neutral to alkaline pH (Holmgren et al. 1993), which thereby reduces the potential for trace metal mobility to the soluble phase. Over time, soil pH may become lower as a result of biosolids application, but there is no evidence that this condition increases metal mobility in soil. Low soil pH is a factor that needs to be considered by each RWQCB when evaluating proposed biosolids application projects. Each potential discharger would be required to submit soil pH data, and the RWQCB would evaluate the data for mine reclamation sites where pH conditions may be low as a result of acidic drainage water from mines. Some forest soils may also have lower pH than agricultural soils. RWQCB engineers would evaluate the information provided in each discharger's NOI to determine whether the application project is consistent with the GO prohibitions.

- The Part 503 risk assessment process for 14 contaminant pathways determined that the surface water and groundwater pathways were not limiting to any of the allowable trace metal concentrations or cumulative loading limits. The limiting pathway is the transport route for the contaminant in the environment that poses the lowest acceptable risk for application of biosolids to land. The risk assessments were conducted to evaluate risks from long-term application every year for 100 years as well as the risks associated with the total amount of metals that would build up in the soil after continuous application. Because biosolids applied under the GO would be tested for heavy metals, land application of biosolids for the entire 15-year period of the GO has a very low probability of exceeding risk thresholds for surface water and groundwater pathways that were developed using models that assumed application would continue for 100 years.

- The maximum concentrations of trace metals in sewage sludge produced in California, as reported in the recent 1998 CASA survey, indicate that most metals would comply with the proposed limits under the GO. Copper, mercury, and selenium are the only trace metals in the 1998 CASA data for which maximum reported concentrations would exceed the ceiling concentration limits under the discharge prohibitions of the proposed GO regulation. Consequently, some biosolids produced in the state would require additional treatment to be available for land application under the proposed GO.

- The proposed GO includes concentration limits and cumulative loading rates for chromium and molybdenum. The proposed GO is therefore more restrictive than the existing Part 503 regulations that do not include limits for these trace metals.

- A large percentage of metals are bound in the surface soil layers and are not mobile in the aquatic environment.

- Biosolids application is prohibited under wet or frozen conditions, thereby limiting potential infiltration and transport of dissolved trace metals to groundwater.

- Depth to groundwater during normal biosolids application periods in summer is typically sufficient in most regions of the state to preclude substantial transport of trace metals to the water table. Areas that could have shallow groundwater are distributed throughout California, but these conditions can generally be present in areas such as the southern San Joaquin Valley where confining layers restrict downward movement of groundwater, near natural groundwater recharge areas such as large regional low areas, and near streams. In areas with shallow groundwater, monitoring is required that would result in early detection if leaching of substantial quantities of pollutants were occurring.

- There is a low probability that all the conditions suitable for metals transport would occur in California (i.e., high metals concentrations in biosolids, high biosolids application rates, low soil pH, and high rainfall conditions).

For the reasons described in this discussion, the impact of trace metals on surface water and groundwater is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential Degradation of Surface Water and Groundwater from Synthetic Organic Compounds in Biosolids

Biosolids application to land has the potential to contribute SOCs to surface runoff or soil leachate beyond the plant root zone, which could eventually reach groundwater. For water quality impacts to occur, the concentration of runoff or leachate would have to exceed applicable regulatory water quality criteria (ambient water quality criteria for aquatic life, human health from consumption of organisms, or drinking water standards, whichever is lowest) or otherwise induce toxic effects in the aquatic environment. The potential for surface water runoff of biosolids is very low and the GO contains numerous minimum standards that the discharger must implement to control surface water runoff from the application site. As described above, provisions of the GO would require dischargers to implement appropriate BMPs, such as maintaining minimum setback distances from surface waters and wells, prohibiting application directly to surface waters, prohibiting application to saturated or frozen ground or areas subject to washout, preventing runoff for 30 days after application, and requiring that an erosion control plan be professionally prepared for areas with slopes greater than 10%. Consequently, the probability of washout is substantially reduced because biosolids application projects would have to be designed to meet the runoff prohibitions.

Potential impacts on groundwater quality were evaluated based on information developed for the Part 503 risk assessment process and other available data. The risk factors for increased leaching of organic compounds from biosolids into groundwater are based primarily on low soil organic matter content and microbial activity, high concentrations of organic compounds in the biosolids, and hydrologic conditions such as high rainfall or presence of shallow groundwater. In some areas in California, as described in the "Environmental Setting" section, one or more risk factors are higher than is the case under most conditions statewide. The major risk factors are related to hydrologic conditions that can contribute to increased groundwater concentrations such as the high rainfall areas of northern California and central coast, soils with low organic matter content (such as in some sandy soils), and shallow groundwater areas.

The potential impact of SOCs was evaluated based on the regulatory performance standards established under the GO, operational requirements for a discharger applying biosolids under the GO, or naturally occurring conditions that would result in low probabilities for water quality impairment. The following information describes types of impact mechanisms and mitigating factors or protections provided under the GO to reduce the potential impacts:

- The Part 503 risk assessment process for 14 contaminant pathways determined that the groundwater pathway was limiting only for DDT/DDE compounds. EPA subsequently eliminated all SOCs from consideration in the final Part 503 regulations because they failed to meet one of three screening criteria described above. DDT/DDE compounds were eliminated based on all three screening criteria. Consequently, land application of biosolids under the GO for 15 years has a very low probability of exceeding risk thresholds that were developed on models that assumed application would occur annually for 100 years.

- Organic compounds are generally strongly bound in the surface soil layers and are not mobile in the aquatic environment.

- Biosolids application is prohibited during wet or frozen conditions, thereby limiting potential infiltration and transport of organic compounds to groundwater.

- Depth to groundwater at the time of normal biosolids application during summer is typically sufficient in most regions of the state to preclude substantial transport of organic compounds to the water table. Areas that could have shallow groundwater are distributed throughout California but are generally areas such as the southern San Joaquin Valley, where confining layers restrict downward movement of groundwater, near natural groundwater recharge areas such as large regional low areas, and near streams. In areas with shallow groundwater, monitoring is required that would result in early detection if leaching of substantial quantities of pollutants were occurring.

- Although not regulated with pollutant concentration or annual cumulative loading rate limits, the GO contains narrative limits that the land application of materials classified as hazardous waste are not allowed. The lack of discharge limits for organic compounds in the GO does not imply lack of discharger responsibility to meet applicable federal and state hazardous waste disposal laws. In addition, testing and reporting are required as part of the NOI process in the GO rules for PCBs, the pesticides aldrin and dieldrin, and SVOCs. Existing federal and state hazardous waste laws would be applicable to biosolids application projects, and testing may be required; the existing Part 503 regulations do not require testing for any organic compound. The testing would provide a means of evaluating the potential for soil accumulation and transport of organic compounds at land application sites. If it is found in the future that the land application of biosolids is responsible for unlawful disposal of hazardous waste, cleanup actions (if required) would be taken by the responsible parties.

For the reasons described above, the impact of SOCs on surface water and groundwater quality is considered less than significant.

Mitigation Measures: No mitigation is required.

Impacts of Other Activities

Horticultural Use

The use of biosolids for horticultural purposes (for turfgrass production, cut-flower production, road medians, parks, and golf courses) would result in similar or fewer impacts on soil and water resources compared to those described above for agricultural use because applicable minimum standards under the GO would be the same, and it is expected that horticultural operations would account for substantially fewer acres of the available biosolids application areas. There would be no appreciable difference between the fate and transport of trace metals and SOCs discharged with biosolids for agricultural or horticultural uses because the same concentration and cumulative loading rate limits under the GO are applicable.

Silvicultural Use

The application of biosolids for silvicultural use would generally result in impacts on soil and water resources similar to those described for agricultural use because applicable minimum standards under the GO would be the same. Biosolids application projects in forested areas, which tend to have greater slopes than urban and agricultural areas, may have slightly greater potential for runoff of biosolids during extremely wet weather conditions. However, each RWQCB is required to review each NOI for compliance with the minimum standards under the GO, and each discharger would be required to maintain the same setback distances from water bodies and wells, implement controls for surface runoff and storage of biosolids, and have erosion control plans for steep slopes. There would be no appreciable difference between the fate and transport of trace metals and SOCs discharged with biosolids for agricultural or silvicultural uses because the same concentration and cumulative loading rate limits under the GO are applicable.

Land Reclamation

The use of biosolids for land reclamation would generally result in impacts on soil and water resources similar to those described for agricultural use because most applicable minimum standards under the GO would be the same, and it is expected that land reclamation would account for substantially fewer acres of the available biosolids application areas. Biosolids application projects at land reclamation sites may have slightly greater potential for water quality impacts on nitrate-sensitive groundwater basins because the dry-weight application rates would not be limited by agronomic rate of nitrogen uptake. However, each RWQCB is required to review each NOI for compliance with the minimum standards under the GO, and each discharger would be required to maintain the same setback distances from water bodies and wells, implement controls for surface runoff and storage of biosolids, and have erosion control plans for steep slopes. There would be no appreciable difference between the fate and transport of trace metals and SOCs discharged with biosolids for agricultural or land reclamation sites because the same concentration and cumulative loading rate limits under the GO are applicable.

Chapter 4. Land Productivity

Introduction

This chapter describes the potential impacts of biosolids applications on land productivity, including agricultural lands, forest lands, reclamation sites, and horticultural areas. Land productivity is the amount of biomass a soil and the associated climate can produce on a sustainable, long-term basis. For agricultural crops, land productivity is typically measured as the annual yield per acre (e.g., in bushels, pounds, or tons per acre). For grazing lands, productivity is normally measured in pounds or tons of forage per acre, but sometimes as the number of grazing animals per acre per month (animal-unit months) the land can support without deteriorating.

Inherent or native land productivity usually assumes normal agricultural management operations, not unusual operations such as installation of a tile drainage system, land leveling, or deep ripping of hardpans. These measures can greatly improve the productivity of certain marginal farmlands. Application of fertilizers or soil amendments can increase crop yields in the short term by compensating for deficiencies in soil nutrient status and taking advantage of the soil's ability to store added nutrients and transform them to bioavailable forms. Normal fertilization and soil amendment practices generally are not considered to have an effect on long-term land productivity when fertilizer and organic amendments contain low levels of heavy metal contaminants.

Land productivity can also be decreased or even eliminated by certain agricultural and grazing activities, excessive erosion of fertile topsoil layers, gullying, salt accumulation, and water table problems. Accumulation of phytotoxic compounds through incorporation of fertilizer or organic amendments containing heavy metal contaminants into the soil is another possible means by which land productivity becomes degraded (Witter 1996). Normally, application of fertilizers and soil amendments, including biosolids, that are not acutely toxic to plants would take long periods of time to accumulate in the soil in damaging quantities.

Environmental Setting

As discussed in the setting section of Chapter 3, “Soils, Hydrology, and Water Quality”, both the physical and chemical conditions of the soil determine the inherent productivity of a specific parcel of land. The chemical conditions of a soil include the level of native or inherent plant-available nutrients; the nutrient storage and supplying capacity of the soil; and the presence of phytotoxic substances such as heavy metals, boron, or soluble salts. Although adding fertilizers to land can improve plant yields, inherent productivity usually does not change because most fertilization effects are short lived. Vegetation management systems, plant types, other land management practices, and seasonal weather factors dictate the actual yield of land over the long term.

Soils also contain macro- and micro-organisms (e.g., small mammals, earthworms, bacteria) that have important functions in carrying out the biochemical processes and transformations that convert chemical compounds to bioavailable and mobile forms that can be taken up by plant roots. Important soil micro-organisms and beneficial soil insects may have different sensitivities to the presence of toxic compounds in soils than do plants, which can also vary greatly in their sensitivities to differing heavy metal concentrations in soils (McGrath et al. 1994, 1995; Cornell Waste Management Institute 1997).

Impacts and Mitigation Measures

Thresholds of Significance

The adoption of the proposed GO would have a significant impact on the environment if it would:

- cause substantial accelerated erosion and sedimentation;
- adversely and substantially affect soil productivity, yield, or quality; or
- cause a change in the land classification of a given area.

Impacts of Agricultural Use

Impact: Changes in Physical Soil Properties and Resulting Effects on Productivity

Application of biosolids to soil would increase the organic matter and organic carbon content of the soil; however, most of the organic matter contributed by biosolids is rapidly mineralized. Artiola and Pepper (1992) reported that 65% of the organic matter contributed by biosolids was mineralized within the first year. Resistant residual organic matter increased by 0.013% per year in that study. Aitken (1995) noted a 0.9% increase in organic carbon content over an 8-year biosolids application period. Over time, however, even resistant organic carbon content would decrease once biosolids applications have ceased. For example, Hyun et al. (1998) noted a 40% decrease in organic carbon content of the soil over a 10-year period after biosolids land applications ended.

Increased organic carbon content in soil from biosolids applications would result in the following beneficial effects on physical properties of the soil:

- increased water-holding capacity, particularly in soils already low in organic matter and in medium- to coarse-textured soils (a study conducted by Epstein [1975] found that applications of biosolids increased soil water retention) and
- reduced bulk density, particularly in fine-textured soils, because biosolids have a lower bulk density than most soils (Darmody et al. 1983).

Application of biosolids may temporarily impede soil infiltration and permeability by plugging soil pores. However, this temporary effect may be offset by the beneficial effect of decreased bulk density (National Academy of Sciences 1996). Soils with lower bulk density tend to be more permeable and have a higher infiltration capacity than soils with high bulk density.

A long-term, well-managed program of biosolids application would normally be expected to improve soil productivity, both over the short term and over the long term. In unusual circumstances (e.g., a clayey soil worked when too wet during biosolids incorporation), physical conditions of the soil could be adversely affected and yields could suffer. This is likely to be a short-term or transitory effect that subsequent proper soil tillage and management could correct. Because the potential for these adverse impacts on soil physical conditions is low, reversible, and manageable given the experience and capabilities of California farmers and ranchers, this impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Changes in Soil Fertility and Salinity and Resulting Effects on Productivity

Application of biosolids would increase the levels of nutrients and salts in the soil. Elements that would be added to the soil include nitrogen, phosphorus, potassium, calcium, magnesium, sodium, and chloride. All of these elements except phosphorus are water soluble and can be leached from upper soil layers. Phosphorus commonly is retained in the upper soil layers.

Soil pH would decrease as a result of the application of biosolids (Harrison et al. 1994). The pH decrease would result from the mineralization and nitrification of biosolids organic matter (Harrison et al. 1994, Emmerlich et al. 1982).

The soils' cation exchange capacity (CEC) would increase. This would be especially beneficial to coarse-textured soils with low organic-matter content. Agronomically appropriate applications of biosolids to farmlands generally have positive effects on plant growth and yield through the addition of plant nutrients (National Research Council 1996). Most biosolids contain both fast-release and slow-release forms of plant nutrients, as well as complex and stable organic fractions that improve the soil's ability to store nutrients. Therefore, the soil-fertility and plant-nutrient effects of a long-term, well-managed biosolids application program would generally be beneficial to agricultural soils and land productivity.

Several potential problems could arise, however, from implementation of the GO as currently proposed. For example, the proposed GO requires that land applications be based on agronomic rates for nitrogen (primarily to protect water quality) but does not provide direction or guidelines for management of other essential plant nutrients, such as phosphorus. The proposed GO has no requirement to balance biosolids applications with fertilizer additions of other plant nutrients. The GO also does not require that appliers or land managers develop a long-term view of biosolids as part of an overall soil-fertility and nutrient-management program. (Under similar circumstances, RWQCBs often require land-intensive livestock and dairy operators to develop overall nutrient management plans to control potential water quality impacts from their animal waste land-spreading operations.)

Under unusual circumstances, plant nutrition and soil fertility could be adversely affected by biosolids applications. For example, productivity could be adversely affected if biosolids applications create nutrient imbalances.

Similar to poor fertilization practices, such atypical problems could cause short-term to intermediate-term reductions in yields. In severe cases (e.g., long-term additions of biosolids with high carbon-nitrogen ratios or biosolids with lime-stabilized, low-bioavailable phosphorus), land productivity could be reduced, but this effect would be reversible once recognized. Recognition of complex fertility problems may not be within the experience or management capability of many California farmers, but assistance with potential problems would be available from the University of California (UC) Cooperative Extension or private agricultural and soil testing/agronomic consulting firms.

Although adverse crop productivity impacts from changes in soil nutrient and salt levels are unlikely to occur under the proposed GO, this impact is considered potentially significant. The following mitigation measure should be implemented to reduce this potential impact to a less-than-significant level.

Mitigation Measure 4-1: Provide Soil- and Site-Screening Information with the Pre-Application Report. The GO Pre-Application Report should be revised to require that WDR applicants provide sufficient soil and site information such that RWQCB staff can determine whether soils would be degraded and/or land productivity would be reduced as a result of biosolids application. In particular, providing the information is intended to ensure that 1) essential soil nutrients other than nitrogen are applied so that significant nutrient imbalances do not occur, 2) metals-related phytotoxicity does not occur, 3) increases in salinity do not occur to the point that the yields of the crop(s) typically grown at the site is appreciably reduced, and 4) appreciable accelerated soil erosion does not occur.

The Pre-Application Report already requires sufficient information with which effects of potential nutrient imbalances, metals phytotoxicity, and excessive salinity can be analyzed. This information should be used by the applicant, a qualified soil scientist, or a qualified agronomist to evaluate the above potential effects on producivity. The GO Pre-Application Report also should be amended to include the erosion hazard (derived from USDA soil survey reports[1]) of the proposed application site.

Additionally, the following table should be added to the GO Pre-Application Report. Applicants or qualified soil scientists or agronomists should use the table to further determine whether soils could be degraded or land productivity reduced.

[1] Where a soils survey report is not available for a proposed application site, the applicant should have a qualified soil scientist determine the erosion hazard (using NRCS guidelines), unless the slope of the site is 3% or less. Sites with slopes of 3% or less will be considered to have a slight erosion hazard.

Limitations to Land Application

Parameter	Slight	Moderate	Severe
Cation exchange capacity[a] (average milliequivalents per 100 g, 0-20 inches depth	>15	10-15	<10
pH[b] (average 0-20 inches depth)	>6.5	5.0 to 6.5	<5.0
Erosion hazard rating[c]	None to slight	Moderate	High to severe

[a] Cation exchange capacity limits based on professional judgment.
[b] pH limits based on U.S. Department of Agriculture (1993).
[c] Erosion hazard limits based on professional judgment.

Sampling of biosolids and soils should follow the procedures and protocols currently approved by the EPA/DHS.

Provided that the applicant, a soil scientist, or agronomist has provided written confirmation to the RWQCB that soils would not be degraded and/or land productivity would not be reduced as a result of nutrient imbalances, metals-related phytotoxicity, or adverse salinity effects, biosolids may be applied on any site having a “slight” limitation as defined in the table. At sites having a “moderate” limitation, biosolids may be applied only where the crop is not particularly sensitive to metals and nutrient imbalances. Sites having a “severe” limitation are excluded from eligibility under the GO and a site-specific waste discharge investigation and planning study should be conducted by a qualified soil scientist or agronomist to provide, in writing to the RWQCB, written confirmation that biosolids application would not cause soil degradation and would not reduce crop yield.

The GO and the Pre-Application Report also should be amended to specify an absolute upper slope limit of 20% at sites in which the biosolids would not be immediately covered by sod or a sufficient mulch cover to control erosion.

Impact: Changes in Trace Elements and Heavy Metal Plant Toxicity in Soils and Resulting Effects on Productivity

Trace elements and heavy metals present in biosolids in elevated amounts and incorporated in agricultural soils can, under certain unique circumstances, have direct adverse effects on soil productivity by reducing crop yields and affecting crop quality and appearance (Schmidt 1997). Most California soils have a high capacity to bind up additional heavy metals, making them biologically unavailable. However, because California soils vary widely in their ability to attenuate or bind up heavy metals, and crops also vary widely in their sensitivity to bioavailable heavy metals in the soil-water solution, applications of biosolids at high rates onto certain combinations of soils and crops over the long term could result in potentially significant phytotoxicity problems. Leafy vegetables (e.g., lettuce, spinach) are often extremely sensitive to heavy metal phytotoxicity (Channey and Hundemann in U.S. Environmental Protection Agency 1992). These crops can be grown on sandy soils with low heavy metal-attenuating capabilities, such as some soils in the Salinas Valley, Central Valley, and Imperial Valley.

Phytotoxicity problems are normally expected to emerge slowly over time and, once recognized, to be managed accordingly. Because for most heavy metals bioavailability is pH-dependent, the most common management action would be to add lime to the acidic soils to bind or tie up the heavy metals in unavailable forms. Under this assumption, biosolids management relies almost entirely on the abilities of the farmer or rancher to recognize emerging phytotoxicity problems, correlate the problem with bioavailable heavy metals in the added sludge, and know that the management solution is to add lime to the soil and eliminate further biosolids applications. Some heavy metals, however, are not more bioavailable under acidic soil conditions, and self-management of problem soils would require that farmers also have a good general knowledge of soil chemistry and a working knowledge of how to diagnose and manage a range of phytotoxic heavy metals problems.

The degree of impact on crop productivity could range from negligible, with only a slight decrease in yield, to significant phytotoxic effects, with yield reductions of 10%-40% or more for certain highly sensitive crops (such as green leafy vegetables) and in certain soils with low native heavy metals-attenuation capabilities (such as the valley sandy soils mentioned above); this level of reduction could result from biosolids application levels that might be permitted under the federal Part 503 regulations and the proposed GO (Cornell Waste Management Institute 1997). The degree of impact is expected to correlate well with the heavy metal in question, the amount of bioavailable heavy metal in the biosolids, total cumulative loading amounts, the chemistry of the soil, soil management actions, and the crop. Potential impacts would likely occur only after years of biosolids heavy metals loading under the existing annual and total allowable loading limits. However, in some cases, farmlands could reach their maximum allowable heavy metals loading limits (at which yield reductions would begin to be experienced) after 10 years of annual applications at the high end of the annual loading limits (California Farm Bureau 1998). Only certain soils (e.g., acidic and poorly managed) would be subject to yield reductions. Synergistic toxicity effects between heavy metals may also occur, making impacts additive in some cases.

The GO relies on the federal Part 503 regulations to minimize or control potential heavy metal-related impacts on agricultural soils and land productivity; it adds several new restrictions to reflect California's soil and crop conditions.

Some experts question the conclusions of the analysis conducted for the Part 503 regulations concerning the potential long-term effects on soil productivity from the presence of heavy metals in biosolids and their accumulation in soils after years of application at allowable rates. The allowable cumulative loading limits established in the Part 503 regulations are based on nationwide average soil conditions and do not conservatively reflect potential problems that could be encountered with some soil/crop combinations. Because it is difficult to effectively remove heavy metals from soil, permanent land degradation could result.

Considerable disagreement exists within the scientific and farming communities on this issue. Some of the controversy surrounds the fact that thorough research and long-term field trial information is not available on crop effects over the full range of soils and crop conditions where biosolids could be applied, making it difficult to accurately characterize the consequences of long-term biosolids heavy metals additions, particularly for atypical or unusual soil chemistry conditions, for sites that are managed poorly (in terms of tracking application rates, spreading sludge, and managing pH), or for specialty crops for which toxicity data do not exist.

The EPA analysis has been criticized for using average soil conditions and nonconservative assumptions when data were missing to complete the risk assessments for potential crop effects under the Part 503 regulations. This is a concern to some parties because California supports a wide variety of soils and crops that could be outside the range of conditions assumed by the EPA's risk assessment models.

The Part 503 regulations regarding heavy metals have been criticized for the following reasons:

- A relatively narrow range of soils and crops were considered by the EPA in evaluating potential impacts on crop yields and productivity. This range did not adequately reflect the range of soil and crop conditions found in California. Crops can vary widely in their sensitivity to heavy metals, and soils vary widely in their heavy metals attenuation ability.

- The Part 503 regulatory approach relies on projections of possible future quantities and types of heavy metals in the soil and amounts that may be phytotoxic under normal soil conditions and to typical crops, based on mathematical calculations of heavy metals in biosolids and estimates of loading. Estimation of average biosolids concentrations of total heavy metal levels, available heavy metals in soils after years of application, and biosolids application rates cannot in themselves be precise.

- There is no requirement to characterize soil conditions at a proposed biosolids application site for fertility, erosion hazard, or heavy metal-attenuating capability; track actual bioavailable heavy metals concentrations in the soils; or manage the soils to reduce phytotoxicity problems.

Properties and characteristics of soils that make them potentially subject to heavy metals toxicity problems include low pH, high sand content, low CEC, and low organic-matter content. The NRCS has recognized more than 1,700 soil series in California. An analysis of the NRCS soil database indicates that only a small proportion (perhaps 10%-15%) of California soil series have conditions that would lend themselves to potential problems under poor management and would therefore make them potentially susceptible to heavy metal bioavailability problems. However, biosolids have been land applied to California soils for more than 20 years in some areas and no problems related to heavy metals have been documented. Additionally, the proposed GO requires that cumulative loading limits for heavy metals at land application sites include the natural levels of heavy metals in the soil before application of biosolids.

Based on the above analysis, significant impacts relating to land productivity and heavy metals accumulation on agricultural soils could occur under the proposed GO for some combinations of California soils and crops and at poorly managed sites, but this circumstance would most likely be rare. The probability that the impact would not be widespread, however, does not reduce the potential for adverse effects in specific areas of California caused by the buildup over time of the bioavailable forms of heavy metals at phytotoxic levels in a small number of agricultural soil-crop combinations. Therefore, this impact is considered potentially significant.

Mitigation Measure 4-1 should be implemented to reduce this impact to a less-than-significant level.

Impact: Changes in Amount of Synthetic Organic Compounds in Soils and Resulting Effects on Agricultural Productivity

No synthetic organic compounds (SOCs) are currently regulated under the Part 503 regulations or the proposed GO, although the proposed GO and existing state regulations require routine testing of biosolids for semi-volatile organic compounds, aldrin, dieldren, and polychlorinated biphenyls (PCBs). Testing for other organic compounds is conducted at the discretion of the producer and the RWQCB. Testing decisions are based, in part, on the characteristic industries within the treatment plant service area. No annual or cumulative loading limits have been established for SOCs; concentrations in biosolids are limited by general hazardous waste requirements contained in Title 22 of the California Code of Regulations. Sludge standards for PCBs, dioxins, furans, and perhaps polycyclic aromatic hydrocarbons (PAHs) and persistent pesticides are proposed for future development by the EPA (Cornell Waste Management Institute 1997). When adopted, these standards would automatically become a mandatory part of the state's biosolids management program.

Except in highly unusual situations, the presence of elevated levels of SOCs in soils as a result of biosolids application would not have a direct effect on soil productivity or crop yield because SOCs are typically not taken up by plants in measurable or phytotoxic quantities at concentrations normally found in biosolids. Human health or food quality effects, however, could result from plant uptake of low levels of SOCs that are not phytotoxic. This issue is addressed in Chapter 5, "Public Health". Direct impacts on agricultural soil productivity resulting from the presence of SOCs in biosolids are not expected, although impacts on the health of grazing animals could result from the use of biosolids high in SOCs if animals ingest soil directly during grazing.

Within Title 22 limits, high levels of SOCs originating from POTWs with industrial sources are still permitted in biosolids, adversely affecting populations of beneficial soil microorganisms and insects that may be more sensitive to these toxins than vascular plants (McGrath et al. 1994, 1995). Microorganisms assist plants in breaking down organic matter and using nutrients in various elemental transformations, such as the nitrogen cycle, and in direct uptake of plant nutrients through mycorrhizal bacteria. Although in some situations populations of soil microorganisms may be harmed by SOCs in soils, not enough information is available to conclude that biosolids with high SOCs would substantially damage soil productivity, particularly over the long term. The field of bioremediation of hazardous materials present in soils relies on the resiliency of soil microbial populations to eventually biodegrade SOCs and recover. The Title 22 regulations on hazardous waste establish upper limits for allowable levels of SOCs in materials that can be incorporated in soils. Many of these compounds would be expected to biodegrade over time when put in a soil environment with a good food source, such as the organic matter in the biosolids.

This potential impact is considered less than significant. (Note: An Oak Ridge National Laboratory [ORNL] study of biosolids SOC effects on soil microfauna is in progress. The findings of that study could alter the conclusions of this analysis. Any proposed or final changes in the Part 503 regulations that result from the findings of the ORNL study would be reflected in required updates to the state's GO.)

Mitigation Measures: No mitigation is required.

Impact: Changes in Grazing-Land Productivity

Grazing animals typically ingest some soil along with forage plants. Depending on variables such as the kind of animal, time of year, condition of pasture, method of biosolids application, and amount of time between application and use of fields by livestock, grazing animals could ingest 1%-30% of their total intake in soil matter (Fries

1996 as cited in Cornell Waste Management Institute 1997); therefore, compounds present in biosolids could be directly ingested by grazing animals in a variety of ways: from forage plants that have taken up compounds through their roots, from dust on the plants, and from the soil-biosolids mixture. (Concerns over potential human health risks associated with consuming meat from animals raised on biosolids-treated fields are addressed in Chapter 5, "Public Health".)

Agriculture-related impacts could result from two activities associated with long-term, excessive land applications of biosolids containing elevated levels of heavy metals or SOCs and from the subsequent ingestion by grazing animals of soils contaminated with heavy metals or SOCs:

- Nutritional deficiency or toxicity problems could become severe, acute, and lethal, causing mortality of animals and the corresponding devaluation of pastureland as unsuitable for grazing.

- Nutrition problems could occur that result in sublethal effects, including low animal weight, low reproductive success, or low milk yields (for dairy animals). Some of these problems could remain undetected.

Based on the present knowledge of typical California agricultural and rangeland soils and the common range of regulated heavy metals in biosolids, it appears unlikely that regulated heavy metals would accumulate in pastures to levels or at bioavailable concentrations that could substantially affect forage productivity or animal health. Such problems, should they occur from long-term heavy metal buildup, are likely to be relatively rare. Conversely, biosolids applied at appropriate rates should usually result in an improvement of pastureland productivity.

In spite of the proposed GO's provisions regarding regulation of heavy metals, there are specific conditions where extra care should be taken. Some California soils are naturally high in selenium (e.g., the soils of portions of western San Joaquin Valley), increasing the risk of selenium toxicity from combined native and biosolids sources. Both molybdenum and selenium can be present in soil at concentrations that are not detrimental to plant growth, yet be taken up by forage plants and result in concentrations in plants that are toxic to grazing animals (Cornell Waste Management Institute 1997). Unlike many other heavy metals, these elements can also be bioavailable at neutral to slightly alkaline soil pH levels.

The Cornell Waste Management Institute (1997) has concluded that the possibility of grazing animal toxicity problems occurring under the current Part 503 regulations (and therefore under the proposed GO) is real. The institute's research leads to the conclusion that the present database on soils, plant uptake, and biosolids composition is inadequate to assess the full magnitude of this potential problem.

Although the combination of circumstances that could lead to toxicity in grazing animals in California is probably only remotely possible, this impact is considered potentially significant. In addition to Mitigation Measure 4-1, the following mitigation measure should be implemented to reduce this impact to a less-than-significant level.

Mitigation Measure 4-2: Extend Grazing Restriction Period to Allow for SOC Biodegradation. For grazing sites where biosolids applications are proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after land application. The GO should also be revised to prohibit grazing animals from using a site for at least 60 days after application of biosolids. Average daytime daily temperatures must exceed 50EF for 60 cumulative days. These measures will promote maximum biodegradation of SOCs and pathogens before grazing animals are exposed to the soil.

Impact: Increases in Soil Erosion Rates and Resulting Effects on Production

Soil erosion rates can accelerate when cultivated lands are disturbed by tilling operations, such as for biosolids incorporation, and the soil surface is left barren and unprotected from winter rains. This could occur at some erodible sites if biosolids are incorporated in the early fall and early, unseasonable rains occur before a protective cover crop becomes well established.

Severe, long-term soil erosion can affect agricultural productivity through loss of fertile and productive topsoil layers. In extreme cases, gullying can leave an area untillable. Most soil erosion on farmland is easily controlled through development and implementation of conservation tillage methods, proper water management, and use of cover crops.

The greatest hazard of erosion occurs on sloping lands. The proposed GO addresses this hazard by requiring that an erosion control plan be prepared by a qualified professional on slopes greater than 10%. No upper slope gradient limits are imposed. Some sandy California soils, however, are relatively susceptible to erosion on slopes as shallow as 5%-7% when tilled and left unprotected. Although incorporation of biosolids on erodible soils with slopes gentler than 10% would probably be rare in most areas of California, the sandy Dinuba and Delhi series soils (for example), which occur along the eastern San Joaquin Valley, are susceptible to erosion on slopes gentler than 10%. Incorporating biosolids on these or similar soils could result in locally significant impacts on soil resources.

Additionally, early season erosion may be difficult to control on steep land-application sites, even when an erosion control plan has been developed and implemented. Therefore, potentially significant accelerated erosion could occur on slopes of 20%-30% (i.e., the upper slope limit for using the wheeled farm machinery typically used to spread biosolids). The impact of erosion on farmland productivity is considered potentially significant. Mitigation Measure 4-1 should be implemented to reduce these impacts to a less-than-significant level.

Impact: Changes in Farmland Classification

Agricultural lands are often classified by government agencies (such as the NRCS) according to their ability to produce crops, most often using a system based on a specific set of soil and site characteristics that influence or limit the ability of farmland to be cultivated or managed. Although farmland productivity issues have been addressed previously in this chapter for other impacts of the proposed GO, productivity effects that result in changes in the classification of certain farmlands could adversely affect farmers and agencies administering certain agricultural programs. For example, some U.S. Department of Agriculture programs (e.g., the Conservation Reserve Program) and state programs (e.g., the Williamson Act) use farmland classifications, such as prime farmland designations, to determine participation criteria and local funding levels for their programs.

Agricultural lands are classified using a variety of systems. Farmland classification systems, such as the U.S. Department of Agriculture's Land Capability Classification system, the University of California's Storie Index, and the California Department of Conservation's Important Farmland Mapping and Monitoring Program, consider such factors as salinity, fertility, and toxicity.

Farmland classification systems recognize human impacts on land by considering land-improvement practices such as land leveling, drainage, and irrigation in determining farmland status. In severe cases, accelerated erosion can downgrade a land classification level.

Application of biosolids could affect the classification of specific farmlands in various ways, although changes in classification would probably be unusual. For example, over the long term, the incorporation of biosolids could improve productivity and bring marginal farmland into a higher land classification status. Conversely, heavy metals buildup in soils as a result of biosolids application could reduce a site's productivity and classification if it approaches phytotoxic levels. Similarly, severe cases of erosion caused by biosolids application on erodible soils or steep slopes could decrease the productivity of farmland and its farmland classification.

Although changes in farmland classification could occur under the proposed GO, this impact is considered less than significant because changes would most likely be rare and would not result in environmental impacts over and above those already evaluated in this chapter. Additionally, implementation of the mitigation measures recommended in this chapter would reduce effects that are likely to lead to changes in farmland classification by ensuring that toxicity and adverse soil fertility problems would not occur.

Mitigation Measures: No mitigation is required.

Impact: Effect on Agricultural Lands Caused by Public Concerns about Crop Contamination from Biosolids Applications

Although accumulation of heavy metals and SOCs in soils as a result of biosolids application may affect crop yields only marginally, the productive value of farmlands may be reduced if consumers perceive that public health risks are associated with consuming crops produced on lands treated with biosolids. For farmlands on which biosolids have been applied and that have subsequently been poorly managed, farm operators could lose access to certain markets (e.g., the organic produce market, the food processing market) if crop contamination is perceived as a possibility by consumers or wholesale produce buyers.

Depending on public understanding and confidence in a biosolids regulatory program, the market exclusion could extend to most fresh produce originating from areas where biosolids have been extensively, but not comprehensively, applied. The problem could be compounded if no regulatory requirement exists to track and publicly identify lands on which biosolids have been applied (including EQ biosolids) because produce buyers could suspect that biosolids were applied to all lands near biosolids application sites.

This crop contamination concern, whether real or perceived, could nevertheless have adverse effects on the ability of farm operators to effectively market their produce, thereby limiting the productive value of their land. Regulations that are seen by consumers, wholesale produce buyers, or food processors as ineffective in preventing problems, distinguishing lands with good biosolids management from poorly managed lands, or tracking lands to which biosolids have been applied could affect the overall market for agricultural produce within a given market area.

Regulations established by the GO need to be sufficiently conservative to not only deal with real problems of land productivity damage and concerns relating to public health and the environment, but also to address public perceptions and thereby protect the farmers' ability to sell agricultural commodities. A regulatory program that is based on typical or average conditions, and that does not address problems resulting from nontypical conditions, may cause all lands treated with biosolids or located near biosolids application sites, to come under suspicion of posing a health and safety hazard.

Several large wholesale produce and agricultural commodities buyers have already adopted policies precluding the purchase of crops from lands on which biosolids have been applied, apparently because of concerns over potential consumer reactions. This reaction to a perceived problem indicates that the impact on farmers of lost commodity markets is potentially significant. In addition to Mitigation Measures 4-1 and 4-2, the following mitigation measure should be implemented to reduce this impact to a less-than-significant level.

Mitigation Measure 4-3: Track and Identify Biosolids Application Sites. A program to identify and track applications of biosolids on agricultural lands should be established to mitigate the potential perception by produce buyers and consumers that crops have been contaminated or damaged by biosolids applications. The program should allow for public access to information. The program should also identify previous biosolids incorporation sites and add them to the tracking system.

Impacts of Other Activities

Silvicultural Use

Impact: Changes in Soil Nutrient Properties and Resulting Effects on Productivity

Less is known about specific biosolids impacts on forest soils, timber production, and silvicultural activities because biosolids research has focused on agricultural soils, common crops, and home garden uses. However, the same basic principles of soil science and agronomy used to evaluate potential biosolids impacts on agricultural soils also apply to forest soils.

Application of biosolids at mature forestlands is much more difficult than application on agricultural lands and therefore beneficial effects on physical soil properties may not be as common as those on agricultural and rangeland soils. The physical property benefits would be expected to be more significant on new forest plantation-type operations, where soil incorporation is easier. Similar to agricultural and rangeland soils, chemical effects associated with the fertilizer value of biosolids are expected to be common and primarily beneficial. Overall timber production and forest yield would be expected to increase in most situations following biosolids incorporation. Adverse nutrient interactions and induced deficiencies or improper forest tree nutrition (such as from very high soil nitrogen and low phosphorous levels) can potentially cause wood quality problems (e.g., poor wood strength) in some tree species, but this effect is also likely to be very rare and, once recognized, easily managed with an overall soil fertilization program.

California forest soils are more commonly acidic than agricultural soils, and therefore the bioavailability of phytotoxic heavy metals added with biosolids after many years of soil incorporation may be greater. Plants, however, vary widely in their sensitivity to heavy metals in the soil solution, with leafy vegetables presumed to be the most sensitive and most nonornamental woody plants the least sensitive. As with agricultural soils, potentially significant impacts on silvicultural sites, including reductions in forest productivity from soils with elevated heavy metals levels from long-term applications of heavy metals, particularly those not regulated under the 503 Rules, could occur under the proposed GO. Such impacts on forest soil are possible, but are most likely rare and would occur only in specific unusual conditions or combinations of unfavorable soil conditions and unusual biosolids chemistry. The chances of such an unusual combination of conditions occurring is increased under the proposed GO because it does not require complete testing of biosolids for all potentially phytotoxic heavy metals that could be added to forest sites. However, such adverse phytotoxicity effects on silvicultural operations are expected to be even more rare than for agricultural operations because of the presumed nonsensitivity of forest trees to heavy metals phytotoxicity in the soil concentration range expected to develop within the limits placed on biosolids loading. The impact is considered potentially significant. Mitigation Measure 4-1 should be implemented to reduce this impact to a less-than-significant level.

Horticultural Uses

Impact: Potential Soil Degradation at Recreation-Area Application Sites

Horticultural operations that may use biosolids include parks and golf-course landscaping, turfgrass production, cut flowers grown on small plots and container-grown landscape plants, and vegetable seedling plants for home-garden transplanting. Potential public health effects of horticultural uses are discussed in Chapter 5, "Public Health". Although flowers and leafy vegetables are often very sensitive to nutrient imbalances and heavy metals toxicity problems, which could affect yield, quality, and appearance, such problems are also more likely to be noticed by horticulturalists and more easily addressed through soil management (e.g., liming to adjust soil pH, switching to a nonbiosolids source of organic soil amendment). Additionally, only one application of biosolids as an organic amendment in container-grown stock would be permitted; therefore, the potential problems from long-term metals buildup in the soil from multiple applications would occur only in recreation-area applications. The scale of operation in container-grown crops and the economics of most field horticultural crops will allow for intensive observation and management. Accordingly, the general agricultural soil mitigation measures are applicable to only the recreation-area horticultural uses and no other mitigation measures are required. As with silvicultural operations, soil and soil-amendment testing would be prudent and in the best interests, but at the discretion, of the operator.

Mitigation Measures: No mitigation is required.

Land Reclamation

Impact: Potential Soil Degradation

Reclamation activities typically would include incorporation of biosolids into infertile soil materials, such as those from gravel-quarry waste or mine spoils. In reclamation site applications, the intent of the application is to improve soil conditions so that a vegetative cover can be established for soil stabilization. Occasionally, more intensive land uses might be considered as part of a reclamation project, such as a park or athletic field. A program for topsoil salvage and topdressing is often included in the reclamation plan. Where the goal is to establish high-quality turf over the reclamation site, a program combining topsoil importation and soil improvement through incorporation of amendments such as biosolids is often implemented. Incorporation of biosolids into such materials would improve both the physical and chemical condition of the materials and would be beneficial. Land productivity would almost always be increased. The reclamation or soil improvement program, as developed by most professionals, would normally include a soil- and amendment-testing program, but one is not required under either the state Surface Mining and Reclamation Act, or the GO.

The proposed GO requirement differs for reclamation activities in that the biosolids do not necessarily need to be applied at agronomic rates for nitrogen, provided that impacts on water quality are managed. Maximum rates and annual and cumulative loading limits for heavy metals would still apply under the proposed GO. Heavy-metal phytotoxicity problems could occur in reclamation projects, affecting the growth of the cover crop. As with agricultural soils, the degree of heavy metal-plant impact is often related to pH. Because some mine spoils are extremely acidic from oxidation of pyritic compounds present in the rock waste materials, heavy-metal phytotoxicity may be more common at these sites. Often there may be a preexisting heavy metals phytotoxicity problem simply because of the inherent high level of heavy metals in the mine wastes or because of their acidity. In this case, biosolids applications can aggravate the problem, but also can be a part of spoils management and site stabilization, along with additions of other soil amendments, such as lime.

Mitigation Measures: Implement Mitigation Measures 4-1 and 4-2 described above for agricultural operations. This mitigation measure will reduce the impact to a less-than-significant level.

Chapter 5. Public Health

Chapter 5 analyzes the potential exposure of people to pathogenic microorganisms and other contaminants that may be present in both Class A EQ and Class B biosolids at levels that may cause disease. Pathogens (or pathogenic organisms) are disease-causing organisms, including certain bacteria, protozoa, viruses, and viable helminth ova (worm eggs). Other contaminants—or "pollutants"—discussed in this analysis are (1) substances that are regulated under the GO in provisions that limit ceiling concentrations and cumulative loadings in biosolids and (2) other substances regulated under the California Health and Safety Code that may be found in biosolids in concentrations at which they could adversely affect human health; these include trace metals and synthetic organic compounds (SOCs). For purposes of the analysis, exposure to pathogens or pollutants is assumed to occur through:

- direct contact (direct ingestion or adsorption),
- inhalation, or
- ingestion of food
  - produced directly from soils amended with biosolids or
  - produced indirectly from such soils (i.e., consumption of animals or wildlife that consumed vegetation or crops growing in the soils).

The information in this chapter is based on:

- the quantitative risk assessments completed by the EPA to support the development of the Part 503 regulations limiting the beneficial reuse of sewage sludge (biosolids) (ABT Associates 1993),
- extensive review of the literature published since the completion of the Part 503 risk assessments to determine whether assumptions used in the risk assessments are still valid and whether new information is available that might change the evaluation of potential risks from use of biosolids, and
- review of state regulations pertaining to biosolids and consultations with qualified experts.

Controversy exists over the risk assessments performed by the EPA and whether the EPA's assumptions regarding appropriate level of risk are protective of public health (Harrison et al. 1999); questions regarding this issue are being addressed by the EPA and others. The National Research Council in 1996 assembled a panel of experts to assess the issue. The panel concluded that continued research on pathogen-monitoring techniques was needed, that restrictions on animals grazing on biosolids-amended fields should be reevaluated, and that the testing of sludges for the presence of toxics should continue so that the risk assessment assumptions can be refined as needed as better data become available (National Academy of Sciences 1996). It is not the purpose of this EIR analysis to resolve such controversies. This analysis addresses the effects of implementing a project: adoption of a GO that would allow for beneficial use of biosolids in California that is protective of public health, the environment, and water quality.

The potential for biosolids to adversely affect groundwater underlying application sites or surface water adjacent to such sites is discussed in Chapter 3, "Soils, Hydrology, and Water Quality". Potential impacts associated with inhalation of biosolids during application or tilling of soils where biosolids have been applied are analyzed in this chapter; however, the effects on air quality are discussed in Chapter 10, "Air Quality". Effects on soils and crops are discussed in Chapter 4, "Land Productivity".

This assessment focuses on the public health protection provided by the Part 503 regulations and the public health provisions of the proposed GO in light of the conditions that exist in California. It also considers whether there is new scientific evidence that warrants a reconsideration of the protections provided by these existing and proposed regulations. Finally, the assessment evaluates the need to modify any provisions or add other mitigation to protect public health.

Environmental Setting

Introduction

This "Environmental Setting" section describes the pathogenic microorganisms that may be present in biosolids that could affect exposed hosts, inducing illness. The setting describes key disease-causing organisms and provides general information on their concentrations in biosolids; describes infectious doses (the numbers or concentrations of organisms that could induce illness in humans); and summarizes available information inscientific literature about their survival in soils, surface waters, and groundwater.

Summary data for the past few years are provided on the incidence of disease caused by known pathogens as reported by county and city health departments throughout California.

In addition, published reports on new disease outbreaks and newly discovered pathogens were reviewed. Emerging pathogens are briefly described in this section, although there is no information indicating that they are present in California (there have been no reported disease outbreaks). Because of a lack of cost-effective monitoring methods, pathogens in the environment are difficult to measure, but research laboratories are developing new techniques for detection (De Leon et al. 1990, De Leon and Gerba 1990, De Leon et al. 1992, Straub et al. 1995, Droffner and Brinton 1995, Patel et al. 1998) Also, information on survivability and infectious dose is not yet available for these pathogens. Despite the paucity of information on emerging pathogens, however, some discussion of the diseases they cause and their potential presence is warranted, in part because it is important to note that new pathogens not normally present in California can be transferred (for example, by travelers) at any time and can be introduced into the sewage system, and from there into biosolids. Where there are potential pathogens that pose risks that may be greater than those presently being reported, this information is noted.

Appendix E provides supporting information divided into three parts. Part 1 has detailed information on the individual pathogens and disease incidence in California. Part 2 contains a description of the EPA Part 503 risk assessment process, including the types of analyses undertaken to evaluate the risks of exposure to nonpathogenic contaminants and to establish the levels to protect public health that form the basis for the limitations established in the GO. Part 3 contains information on endocrine disruptors.

Pathogens

Pathogens of Concern

Sewage and sewage sludges may contain a wide variety of pathogens shed by humans (who may or may not exhibit outward signs of any disease). This analysis addresses those pathogen groups that have been identified in scientific literature as being of regulatory concern or to which waterborne or foodborne disease outbreaks in our society (not necessarily related to biosolids) have been attributed. Tables 5-1 through 5-4 show the pathogens that have the greatest potential to be found in biosolids and that are currently pathogens of known health concern, and the diseases caused by the pathogens (U.S. Environmental Protection Agency 1985a, 1989a, 1989b, 1992a, 1992b, 1992c; Kowal 1985; Sorber and Moore 1987; Yanko 1988; Straub et al. 1993; ABT Associates 1993; National Academy of Sciences 1996; and Feachem et al. 1978). The tables do not list diseases that are unrelated to biosolids, which include toxoplasmosis (affects unborn fetuses, from cat feces, not many cases); polio virus, which no longer is a cause of disease in the Western Hemisphere; and cholera, which is rare. Also excluded was gastroenteritis (because of its general nature); AIDs because it is not associated with wastewater; and the fungal diseases, which are rare and not reported. Many more potential pathogens exist than are listed and, as noted above, new microbial pathogens are always being discovered.

Biosolids derived from the treatment of sewage sludge consist of a complex mixture of organic and inorganic compounds of biological and mineral origin removed from wastewater during primary, secondary, and tertiary sewage treatment (Straub et al. 1994). Properly treated biosolids meeting the pathogen-reduction and vector-control requirements of the EPA Part 503 regulations can still contain microorganisms that include bacterial, viral, protozoan, fungal, and helminth pathogens of potential concern to human and animal health (see Tables 5-1 through 5-4). The concern over any particular pathogen that may be present in biosolids is related to its ability to infect a host and cause disease. This ability depends on a wide variety of environmental factors (e.g., ability to survive wastewater treatment, longevity in the environment) and host-specific factors (sanitary habits, overall health, and any immune system impairments). Tables 5-1 through 5-4 list the specific disease organisms, diseases they cause, host organisms, and the infection dose (minimum number of organisms it takes to cause infection or induce illness) and provides other data on their measured concentrations in biosolids and viability in the environment (in soils, on vegetation, and in water). The listed pathogens can survive days (bacteria), months (viruses), or years (helminth eggs), depending on environmental conditions (Straub et al. 1994). The infective dose for salmonellae and other pathogenic bacteria is much higher than that of viruses and helminths and these organisms can increase in numbers when conditions are favorable (e.g., when a nutrient source such as a moist foodstuff is encountered). Viruses cannot multiply outside their hosts.

Because individual pathogens cannot normally be detected or cannot be detected cost-effectively, indicator bacteria (such as the coliform group of bacteria) normally present in the human intestinal track are used as indicators of the presence of pathogens. For biosolids, the most favored group of indicators is *Salmonell*a, the most widely recognized enteric bacterial pathogen, with some 2,000 identified types. This species is responsible for some 1–2 million human disease cases a year in the United States (Straub et al. 1994). Fecal and total coliforms are normally used as indicators in wastewater and water samples and in contaminated soils.

It has been determined that the very young, the elderly, pregnant women, and the immunocompromised are at the greatest risk of serious illness and mortality from water and foodborne enteric microorganisms (Gerba et al. 1996). This segment of the population represents almost 20% of the population in the United States and is expected

Table 5-1.
Pathogenic Bacteria of Concern

				Survival Time			
Name	**Disease**	**Nonhuman Reservoir**	**Density in Biosolids**	**Soil**	**Crops**	**Surface Water**	**Infectious Dose**
Escherichia coli [pathogenic strains]	Gastroenteritis	Cattle		4-77	< 3 weeks	5-12	
Campylobacter jejuni	Gastroenteritis	Cattle, dogs, cats, poultry					—
Leptospira spp.	Leptospirosis (Weil's disease)	Domestic and wild mammals, rats		<15			
Salmonella (1700 types)	Typhoid, paratyphoid, salmonellosis	Domestic and wild mammals, birds, turtles	3-103	11->259	2-53	<16	10^3-10^8
Shigella spp.	Bacillary dysentery		20	26-77	<2-8	1-<12	
Yersinia enterocolitica	Yersiniosis (gastroenteritis)	Wild and domestic birds and mammals	10^5				
Yersinia pseudotuberculosis	Yersiniosis (gastroenteritis)						
Mycobacterium	Tuberculosis			90-450	10-49		
					10->35	<6	
Background Indicators							
Total coliforms			100-10^6		6-35		
Fecal coliforms			100-10^6		< 56		10^6-10^8

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

Table 5-2.
Pathogenic Viruses of Concern

Name	Disease	Density in Biosolids (No/gm dry wt)	Survival Time in Days: Soil	Survival Time in Days: Crops	Survival Time in Days: Survival in Surface Water	Survival Time in Days: Groundwater	Infectious Dose
Enteroviruses (General)		0.2-210 (<2-0.8 MPN/mL liquid)	15-180	4-23	>188		
Coxsackievirus viruses (A & B)	"Flu-like symptoms"		Up to 180		5-33		1-10
Echovirus	"Flu-like symptoms"						1-10 (10-100PFU)
Rotavirus	Acute gastroenteritis	14-485					
Norwalk virus	"Flu-like symptoms"						
Adenovirus	"Flu-like symptoms"						
Reovirus	"Flu-like symptoms"						
Papovavirus	"Flu-like symptoms"						
Astrovirus	"Flu-like symptoms"						
Calicivirus	"Flu-like symptoms"						
Coronavrius-Like Particles	"Flu-like symptoms"						
Small round viruses (SRV)	"Flu-like symptoms"						
Other							
Hepatitis A	Hepatits					>490	1-10
Hepatitis B	Infectious hepatitis						
Hepatitus E	Hepatitis						

———————

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

Table 5-3.
Pathogenic Protozoans of Concern

Name	Disease	Nonhuman Reservoir	Density in Biosolids (no/gm dry wt)	Survival Time in Days: Soil	Survival Time in Days: Crops	Survival Time in Days: Surface Water	Infectious Dose
Human Pathogens							
Entamoeba histolytica	Amebic dysentery, liver abcess, colonic ulceration	Domestic and wild mammals		8	4	2-6	10 cysts
Giardia lamblia	Giardiasis (Diarrhea, malabsorption)	Pigs and other mammals	100-1000			>16	10-25 cysts
Cryptosporidium	Cryptosporidiosis (Diarrhea)	Cattle					
Balantidium coli	Mild diarrhea, colonic ulceration						10 cysts
Cyclospora Cayetamensis	Cyclosporiasis (Severe diarrhea)	None known					
Human Commensals							
Endolimax nana							
Entamoeba coli	Amoebic dysentery						
Iodamoeba butschlii							
Isospora hominis							
Animal Pathogens							
Eimeria spp.		Fish, birds, mammals					
Entamoeba spp.		Rodents, etc.					
Giarida spp.		Dogs, cats, wild mammals					
Isospora spp.		Dogs, cats					

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

Table 5-4.
Pathogenic Helminths of Concern

Name	Common Name	Disease	Nonhuman Reservoir	Density in Biosolids	Survival Time			Infectious Dose
					Soil	Crops	Surface Water	
Nematodes (roundworms)								
Ascaris lumbircoides (ova)	Roundworm	Ascariasis		2-10	2-6 years	27-35	540	1 egg
Ascaris suum	Swine roundworm	Ascariasis	Pig*					1 egg
Enterobius vermicularis	Pinworm	Enterobiasis						
Trichuris trichiura (ova)	Whipworm	Trichuriasis		<1-3	>35	>18 months		1 egg
Necator americanus	Hookworm	Necatoriasis (anemia)			<4-6 months			1 egg
Ancylostoma duodenale	Hookworm	Ancylostomiasis (anemia)						
Ancylostoma braziliense	Curtaneous larva migrans		Cat, dog*					
Ancylostoma caninum	Dog hookworm	Cutaneous larva migrans	Dog*					
Stongyloides stercoralis	Threadworm	Strongyloidiasis	Dog		<35			
Toxocara canis	Dog roundwaorm	Visceral larva migrans	Dog*	<1				1 egg
Toxocara cati	Cat roundworm	Visceral larva migrans	Cat*					1 egg
Cestodes (Tapeworms)								
*Taenia saginata***	Beef tapeworm	Taeniasis					16-33	1 egg
Taenia solium	Pork tapeworm	Taeniasis, Cysticerosis						1 egg
Hymenolepis nana	Dwarf tapeworm	Taeniasis	Rat, mouse					1 egg
Echinococcus granulosus	Dog tapeworm	Unilocular hydatid disease	Dog*					
Echinococcus multilocularis		Alveolar hydatid disease	Dog, fox, cat*					

____

* Eggs not infective for man.
** Definitive host; man only incidentally infested.

Sources: Feachem et al. 1980, Kowal 1985, Yanko 1988, U.S. Environmental Protection Agency 1985a, Sorber and Moore 1987, EOA 1995, U.S. Environmental Protection Agency 1992c.

to continue to grow as the life span and number of immunocompromised individuals increases. It has been reported that half the documented deaths from gastroenteritis and hepatitis A illness in developed countries occur in the elderly and that the case fatality ratio for foodborne bacterial gastroenteritis outbreaks in nursing homes is 10 times greater than that for the general population (Gerba et al. 1996). Pregnant women also have a tenfold greater case fatality ratio than the general public from hepatitis E infection during waterborne disease outbreaks. Enteric diseases have their greatest impact on the immunocompromised, with *Crytosporidium* posing a particularly serious problem for AIDS (acquired immune deficiency syndrome) carriers. Cancer patients and transplant patients are also at greater risk than the population in general. Children are particularly affected by rotovirus.

Emerging Pathogens of Concern

Many disease outbreaks are of unknown origin, and research is ongoing to determine the responsible pathogenic microorganisms. New techniques using genetic techniques and electron microscopy have improved researchers' ability to detect and identify pathogens, particularly new viruses. Because some 50% of the cases of gastroenteritis have an unknown origin, such research is vital to our understanding of better ways to prevent disease through application of improved technology or management practices (disinfection of water, food handling and preservation, or biosolids treatment and management practices). A literature review of recent outbreaks of disease (worldwide) was undertaken to determine what some of the emerging pathogens are and their possible modes of transmission. The results of this search are summarized in Appendix E. None of these potential pathogens of emerging concern have yet been identified with the use or handling of biosolids. Most outbreaks are associated with poor sanitation, poor food preparation and handling practices, or drinking of contaminated water. Information on the following emerging pathogens of concern are presented in Appendix E: bacteria, parasitic microsporidian, viruses, and bovine spongiform encephalopathy.

Incidence of Biosolids-Related Illnesses

Years of study and review by health scientists from a wide variety of disciplines went into the development of the EPA's Part 503 regulations. Subsequent to the adoption of these regulations, studies have continued to evaluate the potential impacts on public health from biosolids management practices. To date, there have been no reported incidences of human disease that is directly related to biosolids land application operations (National Academy of Sciences 1996). A single recorded case of beef tapeworm transmission through the fertilization of land with untreated sludge has been reported in the United States (Hammerberg et al. 1978).

If any association between biosolids use and illness exists, it may be evidenced in an increase in reported incidences of illness in the existing areas of heaviest biosolids application. Most of the pathogens of concern, particularly viruses, induce flu-like symptoms or cause episodes of gastroenteritis that are of short duration and are not life threatening. Generally, fewer than 5% of gastroenteritis cases are reported (Gerba pers. comm.); therefore, existing data will not provide conclusive evidence of the degree of such a relationship but may nevertheless provide useful information.

Information on the acreages of land-applied biosolids in California counties was compared with data on reported disease outbreaks to determine whether any relationship between biosolids application and reported illness in California can be inferred. Table 5-5 shows quantities of applied biosolids in 1998 by California county in rank order along with the estimated number of permitted acres on which biosolids could be applied. Those counties not shown had no reported application of biosolids (there may have been negligible quantities applied, but they were not included in the totals).

Data on the diseases of interest (those listed in Tables 5-1 through 5-4) were obtained from the DHS (descriptions of the diseases of interest are provided in Appendix E). These data consisted of records on reportable diseases that are voluntarily provided by local county and city health departments (Starr pers. comm.). The diseases for which data were obtained are those with causative agents that could be derived from biosolids; therefore, certain diseases that were rare, not reported, or not related to biosolids were not included (AIDS, fungal diseases, and nonspecific gastroenteritis). The DHS information consisted of 46,159 records representing 300,818 cases of disease and covering the period from 1991 though 1998 for some diseases and 1993 to 1998 for others of more recent origin/or reporting requirements. The information was sorted by county, year, and disease (and broken down by pathogenic organisms) and is presented in Tables E-1 through E-16 in Appendix E and summarized on a statewide basis by year in Table 5-6. The summary data show that the number of cases of a particular disease varies from year to year as conditions favor its occurrence in a particular population.

The incidence of diseases presented on a statewide basis in Table 5-6 are shown by county for the past 6 to 8 years (depending upon when the reporting was started for a particular disease) in Tables 5-7 and 5-8. Also shown next to each county name (in parentheses) is the county's ranking in the state from the highest (1) to the lowest in terms of the amount of biosolids applied on land in that county in 1998. Table 5-7 contains a summary of the bacterial and viral diseases. Table 5-8 summarizes the data on parasitic protozoan and worm diseases that are reported.

As noted in Tables 5-7 and 5-8, the Central Valley counties of Kern, Merced, and Kings ranked first, second, and third in terms of the amount of biosolids that were land applied. The amounts applied (see Table 5-5) were 32%,13%, and 13%, respectively, of the statewide total, or about 58% of the statewide total that was land applied. These three

Table 5-5.
Summary of Biosolids Land Application in California 1998
(Ranked by Order of Land Applied Biosolids)

County	Biosolids Land Application (dry tons/ year)	Permitted Acres[a]
Kern	148,000	50,528
Merced	60,000	26,807
Kings	60,000	17,529
San Diego	45,297	4,000
Riverside	34,800	18,954
Solano	30,000	23,055
Sacramento	23,601	1,264
Alameda	13,887	1,920
Sonoma	11,540	4,520
Tulare	10,438	656
San Joaquin	7,418	2,210
San Luis Obispo	2,890	25
Contra Costa	2,200	1,480
Shasta	2,000	–
Tehama	1,569	–
Fresno	895	3,693
Madera	800	–
Napa	700	–
Los Angeles	400	–
Humbolt	332	–
Santa Barbara	300	–
Placer	240	–
Tuolomne	200	–
Mendocino	200	–
Lassen	180	–
Calaveras	8	–
Totals	**457,895**	**156,641**

---

[a] Permitted acres estimated from March 1997 report by Ray Kearney (City of Los Angeles staff) and does not necessarily correspond to land application quantities.

Sources: California Association of Sanitation Agencies 1999; Fondahl, Brisco, and Thurber pers. comms.

Table 5-6.
Summary of Reported Infectious Diseases in California 1993-1998
(Years in which Data Were Available for All Diseases)

	Year						
Disease	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**Totals**
Amoebiasis	237	175	163	223	125	127	1,050
Campylobacteriosis	931	864	914	2,477	1,136	903	7,225
Cryptosporidiosis	90	155	199	166	62	75	747
Cryptosporidiosis (Type S)	50	18	13	3	42	16	142
Crytpossporidiosis Subtotal	140	173	212	169	104	91	889
Enterotoxic E-coli	0	3	2	33	8	9	55
Giardiasis	1,089	821	693	1,335	858	510	5,306
Hepatitis A	874	953	1,079	1,300	1,415	725	6,346
Salmonellosis	1,153	1,498	1,311	1,894	1,292	1,010	8,158
Shigellosis (Type A)	14	8	5	17	0	5	49
Shigellosis (Type B)	439	796	435	348	251	196	2465
Shigellosis (Type C)	29	2	45	32	30	23	161
Shigellosis (Type D)	682	469	873	625	388	397	3434
Shigellosis (Unidentified Type)	116	105	172	178	62	80	713
Shigellosis Subtotal	1,280	1,380	1,530	1,200	731	701	6,822
Tapeworm (Taenia)	2	6	5	0	1	14	28
Toxoplasmosis	42	9	28	23	18	9	129
Viral meningitis	425	181	119	188	186	403	1,502

Source: Starr pers. comm.

Table 5-7.
Summary of Reported Infectious Disease Cases (Bacterial and Viral) by County 1991-1998

Health Department Reporting[a]	Salmonellosis Six Year Totals	Campylobacteriosis Six Year Totals	Enterotoxic-E-coli Six Year Totals	Shigellosis Total for All Six Year Totals	Hepatitis A Eight Year Totals	Viral Meningitis Eight Year Totals
Long Beach (City)	508	442	6	620	874	300
Los Angeles (19)	6735	5306	33	5281	5934	1502
Pasadena (City)	143	131	1	144	150	28
San Francisco	8	21	1	389	151	
Alameda (8)	280	537	9	150	56	3
Amador	3	12			3	
Butte		1			1	
Calaveras (26)	5	11				
Colusa	3	2		2	4	
Contra Costa (13)	1				8	4
El Dorado	5			2	12	
Fresno (16)	7	15		18	18	13
Glenn	6	4			3	1
Humboldt(20)					6	
Imperial	40	19		43	27	3
Inyo	6	6		1		
Kern (1)					19	2
Kings (3)					4	
Lake	8	5			3	
Lassen (25)	4	4		2	1	2
Marin	35	167	1	15	1	7
Mariposa	2	3			20	
Mendocino (24)	1	3			8	1
Merced (2)					14	

Table 5-7. Continued

Health Department Reporting[a]	Salmonellosis Six Year Totals	Campylobacteriosis Six Year Totals	Enterotoxic-E-coli Six Year Totals	Shigellosis Total for All Six Year Totals	Hepatitis A Eight Year Totals	Viral Meningitis Eight Year Totals
Modoc	1	3		2	1	
Monterey		2			1	3
Mono	16			1	15	
Napa (18)					2	3
Orange	159	160		43	180	187
Placer (22)	4	1			5	1
Plumas	6	2				
Riverside (5)					31	22
Sacramento (7)	2	86			38	11
San Benito	7	18	1	20	46	
San Bernardino	4	5		3	0	11
San Diego (4)	5	6	1	6	79	46
San Joaquin (11)					1	1
San Luis Obispo (12)	1				1	1
San Mateo					8	3
Santa Barbara (21)	1				2	
Santa Clara	2	3			19	3
Santa Cruz	60	100	1	28	13	11
Shasta (14)	6	9		3	13	
Sierra		1				
Siskiyou		13			4	
Solano (6)					1	1
Sonoma (9)					7	1
Stanislaus					9	
Sutter					1	

Table 5-7. Continued

Health Department Reporting[a]	Salmonellosis Six Year Totals	Campylobacteriosis Six Year Totals	Enterotoxic-E-coli Six Year Totals	Shigellosis Total for All Six Year Totals	Hepatitis A Eight Year Totals	Viral Meningitis Eight Year Totals
Tehama (15)	5	2		1	3	
Trinity		3			1	
Tulare (10)	68	115	1	45	65	9
Tuolumne	11	7			1	1
Ventura				1	6	3
Yolo					1	
Yuba					3	1
Total Number of Reported Cases	8158	7225	55	6693	7874	2185

[a] All are county health departments except City of Long Beach and City of Pasadena.

Source: Starr pers. comm.

Table 5-8.
Summary of Reported Infectious Disease Cases (Parasitic, Protozoan, and Worm) by County 1991-1998

Health Department Reporting[a]	Cryptosporidiosis Total Eight Year Totals	Amoebiasis Six Year Totals	Giardiasis Six Year Totals	Toxoplasmosis Six Year Totals	Tapeworm (Taenia) Six Year Totals
Long Beach (City)	77	91	671	6	
Los Angeles (19)	875	898	3832	121	26
Pasadena (City)	13	4	133	1	2
San Francisco	22	13	9		
Alameda (8)	1		152		
Amador			8		
Butte					
Calaveras (26)			12		
Colusa			2		
Contra Costa (13)			1		
El Dorado			1		
Fresno (16)	1		21		
Glenn			5		
Humboldt (20)					
Imperial			10		
Inyo					
Kern (1)	1				
Kings (3)					
Lake			14		
Lassen (25)			5		
Marin	3	30	75		
Mariposa		1	2		
Mendocino (24)			2		
Merced (2)					
Modoc			1		
Monterey	4				
Mono			1		
Napa (18)					
Orange	19	3	177		
Placer (22)			2		
Plumas			4		
Riverside (5)	1				
Sacramento (7)	1	6	63		
San Benito			6		
San Bernardino	3		5		
San Diego (4)	3		6	1	
San Joaquin (11)					

Table 5-8. Continued

Health Department Reporting[a]	Cryptosporidiosis Total Eight Year Totals	Amoebiasis Six Year Totals	Giardiasis Six Year Totals	Toxoplasmosis Six Year Totals	Tapeworm (Taenia) Six Year Totals
San Luis Obispo (12)	1				
San Mateo	1				
Santa Barbara (21)			1		
Santa Clara	1	2	1		
Santa Cruz					
Shasta (14)			4		
Sierra			1		
Siskiyou			3		
Solano (6)					
Sonoma (9)	1				
Stanislaus					
Sutter					
Tehama (15)		1	9		
Trinity			3		
Tulare (10)		1	59		
Tuolumne			5		
Ventura					
Yolo					
Yuba					
Total Number of Reported Cases	1028	1050	5306	129	28

[a] All are county health departments except City of Long Beach and City of Pasadena.

Source: Starr pers. comm.

counties had no reported cases of salmonellosis or shigellosis, the two most prevalent bacterial diseases, in 6 years.

The comparison of the number of reported outbreaks of acute infectious disease and the listing of counties where biosolids reuse occurs showed no association between the highest biosolids use and any unusual illness outbreaks or patterns. Furthermore, no incidents of acute or chronic disease associated with the use or handling of biosolids were found through examination of these data, discussions with public health officials, or review of available literature

Non-Pathogenic Contaminants

There are non-pathogenic contaminants in biosolids that could contribute to degradation of water quality if not properly managed in accordance with existing regulations governing the disposal of biosolids and the use of best management practices. A wide range of contaminants were evaluated during the development of the Part 503 regulations governing biosolids disposal and beneficial reuse (U.S. Environmental Protection Agency 1992b, 1994, 1995). Among those constituents of particular concern are those that might contaminate sources of drinking water and result in impairment of beneficial uses, including uses for potable supplies, which would result in direct impacts on public health. Any such impairments in quality could indirectly affect irrigation and livestock watering and, hence, crop and animal health. Included among these contaminants are nitrates, certain trace metals, selenium, salts, trace SOCs, and a large number of other compounds (200 were initially addressed in the EPA 503 rule development). A brief summary of health concerns related to these contaminants follows.

Nitrates. Of the public health issues related to contaminants that may be present in biosolids and affect water quality, perhaps the most important is the potential contribution of nitrates to groundwater. The mechanisms of transport and general subject of nitrates has been addressed in Chapter 3, “Soils, Hydrology, and Water Quality”. Nitrates are relatively nontoxic to humans when ingested with water or food unless they are converted to nitrite, which can enter the bloodstream and bind with hemoglobin to form methemoglobin, a condition known as methemoglobinemia, which reduces the blood’s oxygen-carrying capacity. The disease affects infants (generally those less than 6 months of age) because their gastric juices are more nearly neutral than those of adults (which have an acidic balance), resulting in nitrate reduction to nitrite being more prevalent. Methemoglobinemia is an extremely rare affliction with few reported fatalities. Only about 2,000 cases have been reported in the United States over the 30-year period since the disease was first reported (National Academy of Sciences 1988).

The EPA (in 1975) and the State of California (1989) have adopted drinking water standards of 45 mg/l (or parts per million [ppm]) nitrate (or 10 mg/l nitrate nitrogen) based on the first (1962) U.S. Public Health Service standard, which established 45 mg/l of nitrate in water as a warning level at which to avoid using water for feeding infants. Surveys of the scientific literature have found no cases of methemoglobinemia reported in the United States when water contained less than 45 mg/l of nitrate (10 mg/l nitrate nitrogen) (Winneberger 1982).

Another concern is the chemical reaction in which, under certain conditions, nitrate reacts with other compounds to form N-nitroso compounds, many of which are potent carcinogens. No health-related problems related to nitrates in biosolids were found during the literature review or discussions with health officials in California.

Metals. Health effects on humans associated with the presence of metals in water are addressed by the adopted water quality standards for surface waters and groundwater that protect the various designated beneficial uses. Health effects are avoided by the maintenance of water quality such that drinking water standards are not exceeded.

Selenium. Health effects resulting from selenium ingestion by humans are not well documented. The EPA risk assessment for land application of biosolids established the pollutant limits for selenium based on a child eating biosolids. The health effect resulting from exceeding the reference concentration for selenium is unknown. Studies of animals show that selenium can be lethal at high dosages and is a carcinogen in animals.

Salts. Increases in dietary salt in humans via water or foods are associated with an increase in heart disease, but the levels of concern and effects are still under debate.

Organics. Neither the EPA nor the SWRCB has placed limitations on the levels of SOCs in biosolids because SOCs were not found to pose a risk to health at the concentrations at which they are found in biosolids (U.S. Environmental Protection Agency 1995).

Endocrine Disruptors. The list of known and suspected hormone disruptors (pollutants with widespread distribution reported to have reproductive and endocrine-disrupting effects) include the following (after Colborn and Clement 1992, Colborn et al. 1993):

- Persistent organohalogens - dioxins, PCBs, furans, hexachlorobenzene,and pentachlorophenol

- Pesticides - 2,4,5-T,2,4-D, atrazine, benomyl, beta-HCH, chlordane, DDT and metabolites, endosulfan, lindane, heptachlor, h-epoxide, malathion, toxaphene, and many others
- Phenolic compounds - phthalates, such as di-ethylhexyl phthalate (DEHP), and many others
- Other organics - styrene dimers and trimers, benzo(a)pyrene
- Heavy metals - cadmium, lead, and mercury

All of the substances presently identified as hormone disruptors are now widely distributed throughout the environment, some are common constituents of consumer products, and many are now found in human tissues and have been shown to affect the health, reproduction, and behavior of animals.

Although trends in hormone-related diseases have not been clearly linked to environmental chemicals, it is probable that endocrine disruptors are contributing to human diseases and disfunction (Ankley et al. 1997). The EPA, through the 1996 reauthorization of the Safe Drinking Water Act, was directed to address possible endocrine disruptors in drinking water. The White House convened an interagency task force of national experts to improve the national response to the issue and evaluate consumer exposures, workplace exposures, and facility releases of chemicals, including the use of biosolids in land application (Ankley et al. 1997).

These “endocrine disruptors” include both natural compounds and synthetic chemicals. Some, called phytoestrogens, occur naturally in a variety of plants. Living things have evolved with these natural substances and have mechanisms to metabolize or degrade them so they do not bioaccumulate. Of current concern are the synthetic estrogens produced either through industrial manufacture or as byproducts of such processes or burning. Some of these have been found to speed the growth of cultures of breast cancer cells, raising questions about human health effects (Felsot 1994, MacMahon 1994, and Safe 1995). The effects have been detected at chemical concentrations of parts per trillion, levels at which most chemicals have never been tested.

Incidence of Chronic Disease in California Related to Non-pathogenic Contaminants

Diseases that are associated with general environmental exposure to toxic pollutants or other environmental contaminants are not well reported and the causes are difficult to pinpoint, even at some of the more infamous sites of exposure, such as the Love Canal in New York or other hazardous waste sites where high levels of contaminants can be found. At very low levels, such as those found in biosolids or in foods, the risks are measured in terms of a lifetime of chronic exposure. Such risk assessments have been performed by the EPA in support of the Part 503 regulations (Appendix E). No data are available that can be used to relate any type of biosolids-related exposure to any occupational or consumer-related exposure to chemicals that could be meaningfully interpreted. Further investigation would require an expenditure and work effort that are not warranted by the low risk reported by the EPA.

Routes and Pathways of Contact

Introduction

There are numerous pathways by which humans can come into contact with biosolids or biosolids-derived contaminants. These include direct contact or accidental ingestion, inhalation of biosolids-derived aerosols or dust, ingestion of water (surface waters and groundwater), and consumption of crops grown in biosolids-amended soils or of animals that have fed on crops grown in such soils. In addition, a variety of vectors can transmit pathogens (flies, mosquitos, fleas, rodents, or other animals than can transport the disease either mechanically or by biological processes) from biosolids to humans or intermediate hosts (Eastern Research Group 1992).

These various routes or pathways of contact can result in either acute or chronic disease if the exposure (dose) is high enough. For pathogens, the primary concern is acute diseases of a short-term duration (i.e., gastroenteritis or flu-like symptoms), while for the various potential chemical contaminants, risks are derived from chronic exposure via ingestion.

Pathogens that may be present in biosolids applied to land pose a disease risk only if there are routes of exposure that deliver an infective dose. The principal means of exposure is through ingestion or inhalation. Absorption through the skin is considered to be a minor route of exposure unless a field worker suffers a cut or other puncture to the skin and is exposed.

The EPA Part 503 regulations, which form a minimum set of standards for the regulation of biosolids in the GO, were developed after years of evaluation using various risk assessment methodologies (U.S. Environmental Protection Agency 1993). These methodologies focus on the various potential pollutants and the pathways that they might use to enter the human and animal diet. Risk assessments were not performed for the various pathogens, but risk management policies developed as part of the regulations assumed the use of technology and management practices to control pathogens (U.S. Environmental Protection Agency 1989a, 1989b, 1992c).

The scientific literature reviewed for this evaluation includes many general reviews and assessments of the environmental risks associated with various pathogens that may be present in biosolids (Feachem et al. 1978; Fitzgerald 1979; Little 1980; Clark et al. 1981; Kowal 1982, 1985; Sorber and Moore 1987; Scarpino et al. 1988; Dawson et al. 1982; and U.S. Environmental Protection Agency 1985b). Other risk assessments looked at bacterial and viral pathogens and how they might affect drinking water (Russin et al. 1997, Haas et al. 1993); in addition, Teunis and Havelaar (1996) assessed the risks for parasitic protozoans in drinking water. Adenovirus in wastewater was the subject of a risk assessment in 1997 (Crabtree et al. 1997) and rotaviruses and their risks were addressed in 1996 (Gerba et al. 1996).

Many other studies have been conducted to characterize the levels of chemical compounds found in biosolids (Kowal 1985; U.S. Environmental Protection Agency 1985b, 1990, 1992b) and the risks they might pose to human health using a deterministic point estimate approach to risk assessment. This approach looks at single values for input variables versus a range of input values (probabilistic approach using a Monte Carlo simulation), which some argue is needed (Harrison et al. 1999). Risk estimates based on ingestion of foods grown on biosolids-amended soils or consumption of meat from animals fed crops grown on biosolids-amended soils is an extremely challenging endeavor, given the wide range of variables that go into any risk assessment.

Direct Contact

The greatest direct exposure to biosolids is experienced by wastewater treatment plant operators and biosolids management facilities operating personnel. The greatest possible health risk associated with direct contact would probably involve a person having a cut or an exposed wound coming in direct contact with biosolids or contaminated operating equipment as the result of an unusual incident such as a fall or accident. Studies of the incidence of disease among wastewater personnel have indicated that they have no greater incidence of disease than the population in general (Clark et al. 1980, Cooper 1991). Farmers who have worked biosolids-amended soils have direct contact with biosolids and can get biosolids on their clothing. Studies have also been performed to compare the health of farm families from those farms using biosolids with the health of families on farms not using biosolids, and no health differences have been found (Dorn et al. 1985).

Pathogen Transport to Plants and Animals

When biosolids are applied to the land, pathogens that may be present in the biosolids can be deposited on plants, either directly from application operations or indirectly by vectors. Virus transport from soil to plants has been suggested as a possible route of exposure, but no definitive research has shown this to occur (Straub et al.1993). Planting restrictions are applied on biosolids-amended fields to ensure that contamination of plants is minimized until die-off of any residual pathogens have occurred and risks are reduced. Animals could be harmed by biosolids-derived pathogens if they were exposed to a high density of pathogens. Typically, domestic animals are not present on the sites where biosolids are applied and the sites contain little wildlife because of the farming activity or other agricultural activities that occur make the environment less attractive as habitat. Grazing animals could be exposed to pathogens, but restrictions are normally placed on such activities to allow time for pathogens to reach very low densities by die-off.

Potential bacterial and viral pathogens carried by animals that could be contracted by humans include tuberculosis, salmonella, lysteria, campylobacter, rotovirus, and toxoplasmosis. More than 50 animals can carry *Cryptosporidium.* Rats and mice in particular are vectors for serious illnesses—for example, rodents may drink treated wastewater containing *Salmonella* from a local waterway, and the *Salmonella* could be transferred to chickens that eat rodent droppings incidentally, which then transfer the pathogen to humans through eggs (Kinde et al. 1996).

Transport on Crops, Equipment, or Clothing

Inanimate objects (such as crops, soil, equipment, and the shoes or clothing of workers) may be contaminated with infectious organisms that can be transported from sites of biosolids application. Restricting the harvesting of crops until natural die-off of remaining pathogens occurs, combined with good sanitary practices and management practices for on-farm workers and biosolids transporters, has played a key role in minimizing the transport of pathogens offsite.

Vectors

Vectors are agents capable of transmitting a pathogen from one organism to another. Vectors can achieve this mechanically (simple transport by animals or insects such as flies) or biologically by playing a role in the life cycle of the pathogen (rodents). The traditional vectors are insects, particularly flies, but other vectors can include farm workers or biosolids workers who become ill and infect their families. Grazing animals can also be vectors. Parasite eggs from domestic animals have been demonstrated to have the ability to be transported by flies to grazing land and infecting livestock (Eastern Research Group 1992). Control of vectors has been an important element in the development of the Part 503 regulations (U.S. Environmental Protection Agency 1995, Eastern Research Group 1992), which include treatment and management practices that prevent conditions that attract vectors. Worker protection, good sanitation, and documentation of medical histories and sickness in workers' families can play an important role in preventing disease transmission should it occur.

Air Transport

Aerial dispersion of bacterial diseases such as tuberculosis, listeriosis, and legionnaires' disease have been documented (Szabo et al. 1982, al-Ghazali and al-Azawi 1988, Bigness 1999, and Rusin et al. 1997). Monitoring studies are limited, but studies indicate there is less risk associated with biosolids land application (unless it is a liquid spray operation) than with spray irrigation of wastewater which has not been disinfected. Studies of wastewater aerosol formation over a period of years showed little impact on air quality (Pahren and Jakubowski 1980). Studies in Texas showed that bacterial levels were highest around the sludge mixing and loading facilities where agitation occurred and showed that normal heterotrophic bacteria were present in air, but there was an absence of Salmonella, fecal coliforms or coliphages (Pillai et al. 1996) Pathogenic *Clostridia* were detected where physical agitation occurred. These researchers recommended wearing masks to minimize risk to operators. Monitoring of coliphage and enteroviruses in sewage and air adjacent to an activated sludge plant showed that coliphages were not necessarily a good indicator of enteroviruses (Carducci et al. 1995). This points out the difficulties in finding suitable indicators for environmental monitoring.

Dust and fine particles that can be inhaled and reach the deepest parts of the lung are of particular health concern. These fine particles (referred to as PM10) have been regulated for at least ten years with both federal and state standards (See Chapter 10). Also regulated are air toxics at both the federal and state level.

Measurements of bacteria in the air downwind of biosolids processing or application sites is limited (Pillai et al. 1996) and the data collected shows the presence of high numbers of bacteria when there is mixing or dispersal (like a manure spreader), but the risk of an infectious dose of a pathogenic bacterial species in an outdoor area appears to be negligible (Pillai et al. 1996). No reported cases of bacterial or viral illness derived from such an occurrence were found during the literature review including the work of Pillai et al. (1996).

There have only been a few reported cases of biosolids-related illnesses as a result of airborne transmittal of pathogens (see aspergillus discussions in this chapter). Nethercott (1981) reported illnesses from sludge incinerator dust, but this pathway is not applicable to this project. Most of these incidences are related to work in confined spaces such as sludge dewatering facilities, composting facilities (Clark et al. 1983, Millner et al. 1980), or processing facilities and not related to the transport, unloading or application of biosolids.

There have been reported cases of fungal allergies and possible outbreaks of asthma near composting operations that have generated large populations of *Aspergillus fungi* which thrive in the environment created during composting (Kramer 1992). Studies of composting operations and at farms where biosolids have been used show no unusual health effects compared to farms where no biosolids were applied (Dorn et al. 1985). These fungi are found everywhere where the right conditions exist (compost piles, wood chip piles, potted plants), not just in biosolids operations (Raper and Fenel 1965).

Those at risk in the areas immediately adjacent to such operations are immunosuppressed people such as organ transplant recipients, and people with cancer, AIDS, or leukemia (Rosenberg and Minimato 1996, Ampel 1996). Such operations have been regulated such that setbacks and restrictions on dust generation have been placed on them by the California Integrated Waste Management Board.

Transport of bacteria, viruses and other pathogens by air or by aerial vectors such as insects and birds has been hypothesized.

No reported cases of air-borne transmission of disease were identified in California as it relates to biosolids management.

Groundwater Transport

When biosolids are applied to the land surface, the particulates in biosolids typically combine with soil material to form a filter mat so that primarily, soluble and colloidal particles enter the soil. Larger organisms such as protozoans and helminth eggs are retained in the upper soil layers, while virus particles and small bacteria can be transported through the soil to groundwater. As discussed in Chapter 3 and Chapter 4, the mechanisms of pathogen removal in soil are primarily filtration (affects bacteria) and adsorption (for viruses).

Coarse sands and soils with gravel lenses are those most conducive to pathogen transport to groundwater (Kowal 1985, Woessner et al. 1998). Most other soils, particularly fine-grained soils, are effective at removing both bacteria and viruses. The most important consideration after the soil type is the depth to groundwater and proximity to wells used for water supplies, particularly those serving as drinking water which is not subject to treatment and disinfection after it is extracted. The separation between water supply sources and wastewater management facilities using setbacks has been an effective means of protecting public health and relying on the natural filtering qualities of soils.

- As described in Chapters 3 and 4, the study of the movement and transport of bacteria and viruses in soils and the transport to groundwater has been the subject of many studies. Most often these studies have focused on viral transport (or coliphage, viruses that are in bacteria) from wastewater and use tracers to simulate viruses due to the difficulty in obtaining permits to actually release viruses into the environment (McKay and Cherry 1993). The difficulty in such studies is the low concentrations that must be detected. Large amounts of water must be filtered to obtain a measurable amount of viruses in groundwater. Generally, this means that it would be extremely hard to obtain an infectious dose due to the large amounts of water that would have to be consumed. Studies on the transport of most viruses at biosolids land application sites has shown that adsorption and/or filtration have reduced viral density and prevented it from reaching groundwater (Straub et al. 1994). However, further research is needed due to the variety of viruses, differing soil conditions, and different climatic regimes. A typical maximum survival time for viruses in soil (at very low temperatures) is 170 days (Kowal 1985) (see Table 5-2) and the maximum distances traveled, even in sandy soils the is about 2 feet per day when a site is under intense recharge (Gerba et al. 1991). Only in instances where there has been significant contamination under unusual circumstances (fractured rock or very porous soils allowing wastewater from a septic tank to reach a drinking water well for example, such as occurred in an outbreak of gastroenteritis in 1991 [Lawson et al. 1991]) is it likely that viruses can pass through most soils to reach potable groundwater (Woessner et al. 1998). Setback and minimum distances between wastewater disposal or biosolids disposal operations and potable wells have been used to provide for safe management of human wastes. There have been no instances in the literature reviewed where biosolids land application has resulted in the measurable contamination of groundwater with pathogens that have contributed to an outbreak of disease.

Surface Water Transport

As discussed in Chapter 3, biosolids application has the potential to contribute to surface runoff and transport potential contaminants to local surface waters. Washoff into surface waters used for irrigation, stockwatering, potable supplies or recreation are all possible modes of exposure under extreme conditions, such as flooding during a high-intensity storm. The potential pathogens and diseases they cause have been discussed. Survival in surface water of various pathogenic microorganisms was presented in Tables 5-1 through 5-4 and indicate relatively short survival times compared to survival in groundwater. Risk assessments of virus in drinking water (Haas et al. 1993) and water (Crabtree et al. 1997 and Gerba et al. 1996) and other microbial risk assessment models (Teunis and Havelaar 1996, EOA 1995) have been evolving and refined to better estimate risks associated with various pathogens. Most of these efforts to conduct risk assessments have been limited to use with water because of the higher degrees of exposure that people have to water and the simple fact that there are disease outbreaks attributable to waterborne pathogens. No such outbreaks have been recorded for biosolids, so little attention has gone into the development of models for pathogen risk in recent years. Proper site management can preclude washoff of pathogens and particulates.

Potential Health Effects from Direct Ingestion or Intake of Foods Related to Biosolids

Health effects from contaminants that may be present in biosolids and have been found to be of human health concern (and thus have regulatory limits based on human health concerns) due to ingestion of foods grown in biosolids-amended soils or from direct ingestion (children less than 2 years of age) of biosolids are summarized in Table 5-9. Most of these health effects are uncommon and most have been noted in the literature when there is some form of severe contamination of food supplies by hazardous wastes, toxic chemicals, or industrial contamination from chronic discharges prior to implementation of pollution control regulations. All of these contaminants and many others have been addressed or are being addressed in on-going regulatory control programs to update or develop new standards for protecting public health. Development of the 503 regulations involved an extensive review of individual pollutants and the use of hazard indices and assessment of worst case exposure conditions to develop numerical limits for biosolids that would assure protection of public health under proper management conditions (U.S. Environmental Protection Agency 1985). Such standards include those related to drinking water, surface water, groundwater, food safety, fertilizer quality, consumer products, air quality, and biosolids through the 503 regulations development.

The health risks from biosolids land application were found to be the highest for a child directly ingesting biosolids for several of the trace metals (Pathway 3 for arsenic, cadmium, lead, mercury, and selenium) (see Appendix E, Part 2). For other regulated compounds, phytotoxicity was found to be the limiting pathway (chromium, copper, nickel and zinc). Molybdenum was limiting due to animal health concerns from consuming biosolids-amended feed. The reduction in risks to humans occurs as a result of the soil-plant barrier concept (described by Chaney 1980) which shows that if plants and/or animals are protected against toxicity from biosolids-applied metals (through natural processes), then humans are protected (plant phytoxicity would occur and thus it would not grow and be consumed or there would be less consumption because of reduced plant yield). For some conditions, risks from excessive selenium, molydenum and cadmium would not be prevented through this mechanism. However, antagonistic effects from zinc, calcium and iron present in biosolids and the soil may counteract toxic effects by acting to inhibit absorption in animals (U.S. Environmental Protection Agency 1995a).

Table 5-9.
Chronic Human Health Effects Associated with Regulated Contaminants Found in Biosolids

Contaminant	Health Effects	Exposure	Environmental Fate
Lead	Permanent neurological damage; endocrine system disruption	Mainly from fruits and grains, deposition from air to plants, livestock, children ingesting soil or biosolids	No known safe level persistent
Cadmium	Cancer, kidney disease, neurological disfunction, fertility problems; immune system changes; birth	Defects mainly through food, children ingesting soil or biosolids	Persistent, bioaccumulative
Dioxins	Cancer, endocrine disruption, immune system damage; negative effects seen at levels as low as ppt	Mainly through meat and dairy consumption	Persistent, bioaccumulative
Mercury	Neurological disfunction	Mainly through fish and food consumption	Persistent, bioaccumulative
Selenium	Toxicity in humans is rare, most effects in grazing animals	Children ingesting biosolids	Persistent, bioaccumulative
Arsenic	Malaise, fatique, gastrointestinal disturbances; peripheral neuropathy	Children ingesting soil or biosolids	Persistent, bioaccumulative
Salts (sodium)	Chronic effects such as carbiovascular	Water supplies, excessive intake in foods	Persistent
Nitrate	Methemoglobanemia	Contaminated groundwater	Persistent
Organics	Acute toxicity; hypersensitivity mutagenesis; carcinogenesis; other chronic effects[a]	Children ingesting soil or biosolids, consumption of contaminated food and water supplies, breathing air in confined biosolids processing areas	Persistent, bioaccumulative
Endocrine disruptors[c]	Breast cancer? teratogeneis?[b]	Contaminated food	Persistent

____

[a] Chronic effects could include those that are cardiovascular, immunological, hematological, neurological, etc.
[b] Alleged, not demonstrated.
[C] See listings and discussion in Appendix PE (Part 3) for more information.

Sources: Information from Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, and U.S. Environmental Protection Agency accessed on Centers for Disease Control Web page (Centers for Disease Control 1999).

There is increasing attention being given to the endocrine disruptors as discussed above under water and further in Part 3 of Appendix E. There are a number of chemicals used in agriculture (pesticides) and compounds which may be present in biosolids which are listed as suspected endocrine disruptors which are widespread in the environment. Actual effects on health from environmental levels of these compounds is still an area of controversy and direct links have yet to be established between chemicals and human health effects.

Regulatory Setting

The basic standards for the protection of public health from the land application of biosolids are the EPA's regulations adopted in February 1993 which are contained in 40 CFR 503 commonly referred to as the 503 regulations. These regulations establish ceiling concentrations for metals and pathogen and vector attraction reduction standards; management criteria for the protection of water quality and public health; and annual and cumulative discharge limitations of persistent pollutants, such as heavy metals, to land for the protection of livestock, crop, and human health and water quality protection. These criteria are based on a risk-based evaluation using 14 different pathways of potential exposure for humans and animals (see Appendix E, Part 2 for identification of the various pathways and the criteria used). The 503 regulations form the basic minimum standards contained in the GO being addressed by this EIR.

In addition, there are numerous Federal and State laws and regulations which apply to various aspects of the transport and distribution of biosolids for land application and govern all aspects of the operations involved in land application. A general discussion of key regulations governing the protection of public health is presented below. Details can be found in the various statutes. All of these laws and regulations are enforceable by various local, state and federal agencies charged with administering them.

Waste Discharge Requirements

See "State Programs—Role of RWQCBs" in Chapter 2, "Program Description", for a discussion of WDRs.

National Pollutant Discharge Elimination System Permits

All wastewater agencies that discharge effluent to the surface waters of the United States are issued NPDES permits by one of the RWQCBs under a program approved by the EPA and delegated to the State of California under provisions of the federal Clean Water Act.

Each NPDES permit contains a monitoring and reporting program that identifies the volume of solid material removed from the wastewater and the locations where this material was taken, including biosolids. The NPDES permit also requires periodic sampling of biosolids for priority pollutants and other constituents of concern in accordance with the provisions of the EPA Part 503 regulations.

California Hazardous Waste Control Law

In accordance with the California Hazardous Waste Control Law (HWCL), the California Department of Toxic Substances Control (DTSC) is responsible for determining whether sewage sludge/biosolids are a hazardous or nonhazardous material according to CCR Title 22, Article 11. Title 22 defines "sludge" as "any solid, semisolid, or liquid waste generated from a municipal, commercial, or industrial wastewater plant . . . exclusive of treated effluent from a wastewater treatment plant".

The DTSC uses various adopted criteria to determine whether a sludge is classified as a hazardous waste; these include testing for toxicity, persistent and bioaccumulative toxic substances, ignitability, reactivity, and corrosivity. Any waste that contains a substance that exceeds either a listed soluble threshold limit concentration (STLC) or a listed threshold limit concentration (TLC) is deemed a hazardous waste. Most municipal biosolids are classified as nonhazardous. Determining whether a particular biosolids product is hazardous is a key step in identifying available disposal and reuse options. If a sludge or biosolids product is hazardous, then the GO would preclude its application to land and may require the issuance of a Hazardous Waste Facilities Permit by the DTSC for certain operations.

Discharge of Waste to Land

The SWRCB administers CCR Title 23 and CCR Title 27 (Discharges of Waste to Land), which govern the disposal of wastes in a landfill or on dedicated land disposal sites. These regulations require that all wastes be classified to determine the appropriate type of waste management strategy to be used. As mentioned above, classification of materials as hazardous or nonhazardous is the responsibility of the DTSC. However, the SWRCB and its nine RWQCBs may further classify DTSC nonhazardous waste, such as wastewater sludge, as a designated waste. The solids content of nonhazardous sewage sludge determines the type of landfill that can be used for disposal. The Title 27 regulations also address the use of dried sewage sludge as daily landfill cover. RWQCBs play a role in issuing WDRs or waivers for land application sites, inspecting and monitoring such sites, and providing enforcement, as necessary. Any sewage sludge or biosolids that are not suitable for land application under the provisions of the GO and, hence, earmarked for disposal would be subject to provisions of Title 27 or further treatment, which could trigger additional requirements, such as compliance with regulations for composting operations.

Regulatory Requirements for Composting Operations

The IWMB administers solid waste regulations set forth in CCR Title 14 that pertain to composting operations and facilities. Title 14, Chapter 3.1, Composting Operations Regulatory Requirements, apply when biosolids are mixed with chipped green waste for composting. These regulations specify permitting, siting and design, operating standards, sampling requirements, metal concentrations, and pathogen reduction standards. IWMB regulations are implemented through its local enforcement agencies (LEAs), which issue solid waste facilities permits (SWFPs) for composting and dedicated disposal sites.

Source Reduction and Recycling

IWMB staff members oversee source reduction and recycling efforts of jurisdictions throughout California in accordance with Public Resources Code Section 40000 et seq. Under Section 41750, cities and counties were required to begin planning to achieve solid waste reduction immediately to manage remaining landfill space in an effective and environmentally sound manner. Section 40191 defines “solid wastes” as “all putrescible and non-putrescible solid, semisolid, and liquid wastes excluding hazardous waste”. Solid wastes by this definition include dewatered, treated, or chemically fixed sewage sludge.

Starting with Section 41000, the CCR mandates the use of source reduction, source separation, diversion, recycling, reuse, composting, and co-composting of solid waste to the maximum extent feasible to conserve water, energy, and other natural resources and to protect the environment. Section 41780.2 requires jurisdictions to divert 25% of their generated waste by 1995, increasing to 50% by the year 2000. For many jurisdictions in California, land application of biosolids serves as a means of achieving these diversion rates.

Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5)

Perhaps the most important long-term regulatory standards that govern biosolids are the Safe Drinking Water standards that apply to both surface and groundwaters which are used for public water supplies. Groundwater quality protection is one of the key areas of concern and the GO contains a prohibition against causing these standards to be exceeded as a result of biosolids land application.

Ambient Water Quality Criteria for the Protection of Human Health

For information on ambient water quality criteria, see Chapter 3, "Soils Hydrology, and Water Quality".

Ambient Air Quality and Air Toxics

There are no state policies or regulations that specifically address air quality issues related to biosolids land application. There are numerous state and local air quality regulations that govern compliance with transportation-related source emissions (from hauling equipment and incorporation equipment) and general provisions related to compliance with local air quality management district regulations for ambient air quality and specific source control which might have been adopted with regard to toxic air emissions. The federal and state ambient air quality standards of greatest concern with respect to land application of biosolids are the particulate matter standard for fine particulates (PM10). For more details see the air quality chapter (Chapter 10).

State Health and Safety Code and California Food and Agricultural Code

The California State Codes (Health and Safety, Title 22) and California Food and Agricultural Code contain numerous provisions related to public health and safety which would apply to farming operations that land apply biosolids. These provisions relate to water supply protection, sanitation, sewerage, and general sanitation and crop harvesting as well as pesticide residues and handling of toxic materials. All of these provisions are in addition to all the requirements contained in the GO related to protecting water quality.

Biosolids may contain toxic pollutants (heavy metals, organics, and inorganic compounds) and other chemicals (such as minerals and nutrients) which may be subject to regulation under one or more State laws or regulations governing hazardous materials (if concentrations were high enough). Biosolids that meet the 503 requirements are not subject to hazardous waste regulations because the maximum concentration levels (ceiling levels) are below the levels that would result in the material being classified as a hazardous waste. Section 14505 of the California Food and Agricultural Code classifies soil amendments derived from municipal sewage sludge as fertilizing material which is exempt from hazardous waste regulations. New studies are underway to assess the health hazards associated with different materials used in the manufacture of soil amendments that will further restrict and perhaps set numerical standards for fertilizers.

California Occupational Safety and Health Act Requirements

Worker safety is governed by the provisions of the California Occupational Safety and Health Act. These regulations govern workplace safety and health hazards for such things as exposure to hazardous chemicals and substances, excessive noise, and unsafe work conditions. These provisions apply to employers and are designed to provide a safe and healthy work environment.

Food Safety

The California Department of Food and Agriculture (CDFA) has started an open, facilitated process to develop regulations covering heavy metals in commercial fertilizers, biosolids, non-hazardous ash, and other soil amendments. This work is being done in conjunction with the University of California and will focus on both inorganic and organic fertilizers. The process will continue over the next year. The results of this effort will be reviewed by the SWRCB and adjustments in the proposed GO could be made if necessary to protect food safety.

There are numerous food safety and quality laws which apply to the quality and handling of foods which will apply to the growers using biosolids as a soil amendment. These are not part of the GO which addressed only water quality protection. These regulations include but are not limited to the following:

- Organic Foods Production Act of 1990
- Federal Food, Drug and Cosmetic Act (21 U. S. C. 301)
- Sanitary Food Transportation Act of 1990 (governs transportation of food products)
- Model Food Code (42 U. S. C. 243 and 311 and 31 U. s. C. 686 authorities)
- Inspection and certification of fresh fruits, vegetables and other processed foods (7 CFR 51-75P)
- Containers and their inspection (7 CFR 42)
- Food Processing (21 CFR 100-199)
- Labeling, standards of quality and contaminants (21 CFR 109)
- Good Manufacturing Standards (21 CFR 110)
- Enforcement policies (21 CFR 7)
- Production process and use of additives (21 CFR 184-186)
- Prohibited substances (21 CFR 186-189)

Note that uncooked food sold by retail establishments and food consumed at home by the public is not directly protected by the Model Food Code, which incorporates the latest and best scientifically based advice for preventing foodborne illness. This Code is used by local and state agencies responsible for inspecting and enforcing safe food handling practices at the retail level.

Also, it should be noted that neither the USDA nor the FDA have specific regulations for the use of biosolids in food production, but rely on existing regulatory programs involved with the consumption of animal products and foods that are commercially processed (general health and safety laws governing water and food sanitation) (National Academy of Sciences 1996).

Impacts and Mitigation Measures

The following public health impact analysis focuses on the potential for human contact with the pathogens and contaminants known to occur regularly in biosolids in the United States. The number of known foodborne and waterborne pathogens appears to be on the increase as new techniques are developed to detect previously unknown species. No information exists at this time indicating that any of the emerging pathogens pose any greater risk to the public than those that were considered during development of the Part 503 regulations and establishment of mandatory management practices to control pathogens and vectors. Furthermore, there is no indication that there is any more risk associated with biosolids than with other sources of these pathogens. To date, outbreaks of diseases have been associated with undercooked food, fecal-oral transmission, poor food handling practices and sanitation, and inadequate sewage facilities or water management at specific properties. Biosolids are generated under controlled and monitored conditions in a highly regulated environment.

Some pathogen-related issues will have to be addressed on an ongoing basis as more is learned about the presence and fate of disease-causing organisms referred to as "emerging pathogens", which are newly discovered or have new characteristics that make them of greater concern (e.g., antibiotic-resistant strains). Also of concern are possible effects on immunocompromised populations (particularly people with acquired immunodeficiency syndrome), which might have the potential for increased exposure, under certain unusual circumstances, to pathogens such as *Giardia* and *Cryptosporidium* that may be present in contaminated surface water supplies. Research on methods of detecting the pathogens responsible for emerging diseases and systems of reporting unusual outbreaks (Centers for Disease Control 1999) will have to be relied upon to guide health and regulatory officials toward appropriate regulations and preventive measures to keep disease outbreaks from occurring. Efforts are continuing for better ways to detect the presence of pathogens in wastewater, sludge, and biosolids (Water Environment Federation 1999). To date, no significant outbreaks of infectious disease have been associated with biosolids land application practices (Bastian, Starr pers. comms.).

Approach and Methods

The public health impact analysis presented below has been coordinated with other technical analyses (those for water quality, air quality, and land productivity) to determine the likelihood of the presence of pathogens or other constituents of concern in land-applied biosolids and the potential for their transport to human receptors. It was assumed for this assessment that any biosolids to be land applied or used for other purposes allowed under the GO would meet the minimum requirements of the EPA Part 503 regulations and the additional restrictions contained in the GO.

Impacts on public health that could result from land application of biosolids are difficult to quantify because of the difficulty of establishing a clear relationship between human exposure to pathogens or chemical contaminants and reported illness in humans. EPA undertook extensive efforts to evaluate potential disease risks associated with biosolids disposal and reuse practices in support of the development of the Part 503 regulations. The numerical limitations and management practices (for pathogens) specified in the Part 503 regulations were derived as a result of extensive scientific studies, reviews of scientific literature, collection of nationwide data on biosolids quality and experiences related to biosolids reuse, epidemiological studies, detailed risk assessments for each of the regulated constituents and many others (some 200 chemicals initially), and field studies to quantify the concentrations and environmental fate of pathogens and chemical contaminants in biosolids.

This assessment relies on all those studies and the EPA Technical Support Documents prepared for the Part 503 regulatory program. EPA's information was used to establish a baseline for identifying impacts in this analysis and to determine relative risks to individuals from biosolids reuse practices. Additional research was conducted to identify conditions specific to California, including disease incidence and physical (soil and hydrologic) conditions not anticipated in the Part 503 regulations. The analysis also assumes "worst-case" conditions, such as the use of Class B biosolids (with a higher allowable pathogenic microorganism content) and the maximum allowable application and cumulative loading rate (up to the limits allowed in the 503 regulations and GO).

Conclusions regarding the potential for impacts were drawn based on best professional judgment, given the available information and assuming worst-case conditions. The quantitative risk assessments performed by EPA (U.S. Environmental Protection Agency 1995) and others (Scarpino et al. 1988, Rusin et al. 1997, ABT Associates 1993), combined with reviews of the literature used to support the development of the Part 503 regulations, new scientific literature published or made available since 1995, and personal contacts with experts and officials around the state and elsewhere, were used in support of this impact assessment. The significance of potential impacts was evaluated based on the available data on the potential extent, duration, frequency, and intensity of effects.

The evaluation of impacts is supported by the information provided above under "Environmental Setting" and in Appendix E, which is referenced as necessary to support the environmental determinations.

Thresholds of Significance

According to thresholds established by existing public health regulations (federal, state, and county), a project may result in a significant impact if it would:

- create a public health hazard or involve the use, production, or disposal of materials that pose a hazard to people or to animal or plant populations in the area affected;

- violate federal, state, or local criteria concerning exposure to biosolids-derived contaminants or pathogenic microorganisms (including the Safe Drinking Water Act, federal Occupational Safety and Health Administration workplace standards, food safety laws, and other public health criteria); or

- violate any ambient air quality standard, contribute substantially to an existing or projected air quality violation, or expose sensitive receptors to substantial pollutant concentrations.

Impacts of Agricultural Use

Impact: Potential for Increased Incidence of Disease Resulting from Direct Contact with Pathogenic Organisms at Biosolids Land Application Sites

Under the GO, land application of biosolids could increase from 456,040 dry tons per year in 1998 to 576,690 dry tons per year in 2015 as the state's population increases and levels of wastewater treatment are improved. The amount of land on which biosolids are beneficially used is likely to increase, resulting in an increased probability of humans coming in direct contact with biosolids. Although it has been demonstrated over the years that anaerobic digestion is effective at reducing bacterial hazards associated with biosolids, concerns still exist over the survival of viruses or pathogens that encyst (such as *Cryptosporidium*, or *Ascaris* ova) and that could be transmitted to humans through direct contact.

Those people with the greatest potential for direct exposure to biosolids are equipment operators at wastewater treatment plants and land application sites, and farmworkers. Individuals in these categories could also cause incidental exposure of their families to biosolids if they carry biosolids home on their shoes and clothing. Risks to the general public also could increase as a result of increased exposure if land application activities occur at sites accessible to the general public.

The issue of the survival in biosolids of viruses or pathogens that encyst and their potential transmission to humans was reviewed by a panel of experts convened by the National Research Council and discussed in its report "Use of Reclaimed Water and Sludge in Food Crop Production" (National Academy of Sciences 1996). The panel noted, "There have been no reported outbreaks of infectious disease associated with a population's exposure—either directly or through food consumption pathways—to adequately treated and properly distributed reclaimed water or sludge applied to agricultural land." The report also noted that because there are many sources of infectious disease agents other than reclaimed water or biosolids used in land application, such as prepared food and person-to-person contact, the potential added exposure to pathogens resulting from the proper recycling of these materials is "minuscule compared to our everyday exposure to pathogens from other sources".

The issue of microbiological risks from contact with biosolids remains controversial, however, in part because epidemiologic evidence is very difficult to compile and any association between health problems and biosolids application (or other environmental exposure) is extremely difficult to document. Considering the concentrations of long-lived encapsulated forms of certain pathogens (such as *Giardia*, *Crytosporidium*, and *Ascaris*) that have been found in biosolids, it may be assumed that some risk to farmworkers and others working closely with biosolids will always exist. An infectious dose could be as low as one ovum for *Ascaris* and, although their viability remains in question, ova are found at concentrations in digested sludge of 2-10 per gram of dried biosolids. One would have to ingest only a small quantity of biosolids to get such a dose; however, the low probability of adult ingestion of biosolids must be taken into consideration as well.

The available data on workers exposed to biosolids do not support a conclusion that direct exposure to biosolids increases health risks. Wastewater treatment plant personnel, the workers having the greatest occupational exposure to biosolids, have been found to have no greater illness rates than the general public (Clark et al. 1983). To date, compost workers are the occupational group for whom the most evidence of potential effects from biosolids handling has been found; however, these workers, working within 100 meters of composting operations, were found to experience only minor effects (Jakubowski 1985). Furthermore, the observed effects may have been the result of irritants produced in the composting process (dust, *Aspergillus*) and related to wood chips rather than the sludge portion of the compost (see discussions under "Environmental Setting" above and in Appendix E for more details).

Incidental human contact and farmworker and family contact with biosolids were evaluated in an extensive study reported by Dorn et al. (1985). The 3-year study covered three geographical areas in Ohio and included 47 farms (164 persons in 78 families were evaluated) receiving annual applications of treated sludge (average of 2–10 dry metric tons/hectare/year; average of 20–90 wet tons per acre per year at 25% solids). These were compared with 46 control farms (130 persons from 53 families). All the participants completed monthly questionnaires concerning their health and their animals' health, underwent annual tuberculin testing, and provided quarterly blood samples for serological testing. The study found no differences in human or animal health effects. The estimated risks of respiratory illness, digestive illness, and general symptoms were not significantly different between the residents of the farms receiving sludge applications and the residents of the control farms. There were no observed differences in occurrence of diseases in domestic animals between the two groups of farms. The frequency of serological conversions (fourfold or greater rise in antibodies) to a series of 23 test viruses and the frequency of associated illnesses were similar between the persons in the two groups. The sludge application rates on the Ohio farms in the study were consistent with typical application rates for agricultural uses in California; therefore, the results of the study generally apply to land application of biosolids under the GO**.** However, if application rates are higher than 90 wet tons per acre, more land is treated, immunocompromised persons are working or living on a farm, or the pathogen levels are high, then health risks associated with biosolids use could be higher than shown in the results of the Ohio study. No subsequent studies have been performed because the risks were deemed to be low and the costs for such studies are very high.

In addition, results of the evaluation of reportable disease data for California on the known pathogens that could be present in biosolids (discussed above under "Environmental Setting") showed that there was no apparent association between disease incidence in the general public and the size and location of biosolids application operations. Those counties where the largest quantities of Class B biosolids are being beneficially reused either have no reported outbreaks or incidence of infectious disease associated with those pathogens that might be derived from direct contact with biosolids or have very low numbers of such reports or incidences. Discussions with various health and water quality officials revealed no known infectious illness that could be related to biosolids use (Shaw, Moise, and Starr pers. comms.).

The GO includes provisions requiring signage and setbacks to deter direct human contact with biosolids. There are also strict controls on the movement of biosolids off of the application site. There are no provisions to preclude human contact (such as fencing requirements), however, and some potential for human contact with biosolids will always exist.

Based on a review of the information presented above, no adverse impacts associated with direct human contact with biosolids at land application sites are expected. Thus, the risks of disease resulting from direct contact with biosolids are considered to be less than significant. Furthermore, the GO reinforces existing regulations and permit conditions and is intended to protect public health and the environment. Therefore, implementation of the GO is likely to result in fewer risks associated with direct contact because its monitoring and reporting provisions represent an increased level of regulatory oversight of land application. No mitigation is required.

Existing large land application operations using Class B biosolids are in remote areas away from housing, schools, water reservoirs, dairies, and food crop production areas. Thus, current exposure of the general public to biosolids is minimal. Signage and setbacks required under provisions of the GO serve to deter direct contact of the general public to biosolids. Therefore, this impact is considered less than significant. Mitigation Measure 5-1 is recommended, however, to further reduce this impact.

Mitigation Measure 5-1: Review Manual of Good Practices. Although no significant public health risk is expected from direct human contact with biosolids, it is recommended that all individuals or agencies receiving land application permits under the GO receive a manual of good practices that addresses measures to protect human health. The California Water Environment Association Manual of Good Practice— Agricultural Land Application of Biosolids is an example of such a manual (California Water Environment Association 1998).

Impact: Potential for Increased Incidence of Disease Resulting from Direct Human Contact with Pathogenic Organisms in Irrigation Runoff from Biosolids Land Application Sites

Surface waters can transport pathogenic microorganisms from various sources and infect humans who might ingest these waters or be exposed to waterborne parasites that enter wounds. Although this is a common mode of disease transmission in areas of the world with poor sanitation, irrigation waters in California have not been implicated in disease outbreaks associated with infectious agents or other contaminants because they are not typically an untreated drinking water source. Furthermore, the proposed project would not result in a significant increase in disease because irrigation runoff from land where biosolids have been applied must be controlled for 30 days following biosolids application. These controls would be effective in avoiding offsite movement of biosolids under all but the most extreme conditions. During such conditions, when low-probability storm events or widespread flooding occurs, the runoff entering waterways is likely to contain pathogens from sources other than biosolids-amended fields, and the incremental contribution from biosolids is expected to be minimal. As under normal conditions, unless there is a high degree of contamination (not expected from biosolids) and there is a mode of entry (cut or accidental ingestion), it is unlikely that an infectious dose can be delivered under such circumstances. Therefore, this impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential for Increased Incidence of Disease Resulting from Ingestion of Pathogenic Organisms in Crops Grown on Land Application Sites or Animals Fed with Crops Grown on Land Application Sites

Because an increased amount of biosolids will be applied to land as populations increase, there will be an increase in pathogens of human origin entering the soil. Such pathogens could be transmitted to humans through crops grown on biosolids-amended soils or in foods produced from animals fed on crops grown in these soils.

The GO includes various Class B biosolids site restrictions on the timing of planting and harvesting crops at application sites: no harvesting of food, feed, and fiber crops within 30 days of application; no planting of food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface within 14 months of application; no harvesting of crops with parts below the land surface within 20 months of application unless the biosolids have been exposed to kill pathogens for at least 4 months on the surface of the soil; and no harvesting of crops with parts below the land surface within 38 months after an application where biosolids have not been exposed to kill pathogens for at least 4 months on the soil surface. The GO also includes restrictions that apply to the harvesting of turf grasses and prohibits for 1 year following application of biosolids, the grazing of animals used to produce milk that will be marketed without being pasteurized. These restrictions act as a further buffer against potential contamination after the significant pathogen reductions achieved by biosolids treatment.

No cases of infectious disease related to food or animals being contaminated with pathogenic microorganisms have been noted in the literature reviewed for this analysis, and discussions with health officials indicate that no such cases have been reported (Starr, Shaw, Cook, and Isozaki pers. comms.). The greatest risk is probably from the transmission of helminth ova from biosolids to grazing animals. However, the concentrations of ova found in biosolids are low, and the risks of disease transmission from this source are low. Bacteria and viral diseases will be prevented if growers follow the provisions of the GO. This impact is considered potentially significant because of the survival times of potential pathogens. The following mitigation measure should be implemented to reduce this impact to a less-than-significant level.

Mitigation Measure 5-2: Extend Grazing Restriction Period to Allow for Pathogen Reduction. For grazing sites where application of biosolids is proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after application. The GO should also prohibit grazing animals from using a site for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF. These measures will promote maximum degradation of pathogens (and SOCs) before grazing animals are exposed to the soil. See also Mitigation Measure 4-2.

Impact: Potential for Increased Incidence of Chronic Human Disease Resulting from Ingestion of Biosolids-Derived Metals in Crops Grown on Land Application Sites or Animals Fed with Crops Grown on Land Application Sites

As populations increase, an increased amount of biosolids will be applied to land, and there will be an increase in loadings of trace metals to biosolids-amended soils. Potentially toxic levels of metals could be transmitted to humans through crops grown on biosolids-amended soils or in foods produced from animals fed on crops grown in these soils without proper control of biosolids application rates.

EPA extensively assessed levels of risk associated with biosolids-derived pollutants of concern (trace metals and PCBs) that might contribute to chronic diseases in the Part 503 risk assessments (U.S. Environmental Protection Agency 1995). The risk assessment used to establish the conservative national numerical limitations for toxic pollutants examined various pathways (see Appendix E) by which contaminants might become present on edible plant parts or bioaccumulated in animals consumed by humans that grazed or were fed crops grown on biosolids-amended soils. These detailed risk assessments relied on many assumptions about types and amounts of food ingested, number of years of exposure, and a host of other factors (U.S. Environmental Protection Agency 1995).

EPA reports conclude that heavy metals and dioxins have been extensively studied and that it has been shown that they do not have the potential to cause significant effects given the rates at which biosolids are applied and used (U.S. Environmental Protection Agency 1992b, 1995). EPA found that overall cancer risk associated with food ingestions would be reduced by implementation of the Part 503 regulations (U.S. Environmental Protection Agency 1995) from 0.9–5 cancer cases annually to 0.09–0.7 annually. This is an extremely small number of cancer cases and represents very low risk.

There are several issues of concern regarding the level of protection provided by the Part 503 regulations with regard to toxic pollutants. The assumptions used in calculating the risk and the level of risk chosen as appropriate for the development of regulatory levels are a continuing source of controversy. One of the greatest concerns is the choice of risk factors (10^{-4} versus 10^{-6}) for the development of allowable contaminant levels in land-applied biosolids under the 503 regulations. (Harrison et al. 1999.) Many argue that there is no safety factor in the established maximum contaminant levels and that there is not an adequate system to monitor long-term cumulative increases in soil contaminants that could contribute to bioaccumulation in plants and animals and that cumulative impacts could therefore occur over time as soil levels of contaminants build up.

Other issues of concern relate to the bioaccumulation of cadmium in plant tissues consumed by humans; ingestion by children of biosolids-amended soils containing trace metals and other toxic pollutants, particularly in the home garden setting where Class A biosolids may be used; and rates of dietary intake for various contaminants such as arsenic, synthetic organic compounds, and radioactivity (Harrison et al. 1999). Another area of controversy is the exclusion of certain individual pollutants (i.e., chromium) from the cumulative loading restrictions.

No epidemiological studies are available that evaluate biosolids practices in California and their relationship or contribution to the overall intake of various trace metals. EPA and the California Department of Health Services are evaluating risks associated with environmental exposures to various toxic pollutants in the state.

The analysis in Chapter 4, "Land Productivity", concluded that significant metal-related impacts on agricultural soils and land productivity could occur under the proposed GO program for some combinations of California soils and crops but would probably be rare. However, such impacts are not likely to lead to impacts on public health resulting from consumption of affected crops grown in these soils. The basis for this conclusion, as discussed in the environmental setting above, is the soil-plant barrier (Chaney 1980) (used as a basis for the Part 503 regulations), which is the manifestation of toxicity in plants accompanied by impairment of crop yield and desirability, reducing the chances of contaminated plants being consumed except in extremely unusual circumstances. The most notable exception is where crops are grown on cadmium-contaminated soil over an extended period and a high percentage of a consumer's diet is derived from these crops, as reported to have occurred in Japan over a 40-year period (National Academy of Sciences 1996). As stated in Chapter 3, arsenic, molybdenum, and cadmium in particular can be mobile in non-acidic soils and, under certain conditions, can accumulate in bioavailable forms and be potentially toxic to plants in low soil concentrations.

Copper, mercury, and selenium are the only trace metals in the 1998 CASA survey data for biosolids in California that, at maximum reported concentrations, exceed the ceiling concentration limits under the discharge prohibitions of the proposed GO regulation. The GO contains limitations in addition to those in the Part 503 regulations that would limit chromium and molybdenum application to land. None of these compounds is likely to pose a significant risk to health in association with biosolids land application subject to regulation under the GO because of the GO's restrictions on cumulative loadings. Some have argued that biosolids are a source of environmental mercury that can affect local waterways or be volatilized (Harrison et al. 1999). The GO contains provisions that would prohibit biosolids from affecting local waterways. Mercury emissions through volatilization remain a controversial issue, but such emissions pose no threat to public health because mercury is present in biosolids only at low levels (U.S. Environmental Protection Agency 1995).

Because the proposed GO contains the same or more stringent requirements than established under the EPA Part 503 regulations, the project should be protective of public health and pose minimal risk associated with the ingestion of various foods or animal products derived from biosolids-amended soils.

As long as source control programs are effective at keeping metals levels in biosolids below the EPA Part 503 limitations and the provisions of the GO regarding application rates (annual and cumulative or ceiling limits) are enforced, the risk of increased disease resulting from the presence of trace metals should be low and there will be no significant impact on public health. This impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential for Increased Risk of Chronic Disease Resulting from Ingestion of Biosolids-Derived Organic Compounds in Food, Soils, Animals, Dairy Products, or Wildlife

A number of SOCs, such as PCBs, pesticides, and detergent-derived organic molecules, are contaminants that may be present in biosolids. As the amount of biosolids applied to land increases, the levels of these compounds may increase in biosolids-amended soils. These contaminants could be transmitted to humans through various pathways. Because many of the compounds in this category have been suggested as being potential carcinogens or endocrine disruptors (see "Environmental Setting" and Appendix E), a potential increase in their levels may be an issue of public health concern.

There are no annual or cumulative loading limits established for SOCs in biosolids because the risks associated with the presence of these compounds in biosolids is considered to be very low. Concentrations of these compounds in biosolids are generally found to be below detection limits or very low; many of the compounds are highly volatile and do not accumulate in soils or plants (see Chapter 4). However, some compounds, particularly chlorinated hydrocarbons—PCBs and plasticizers such as bis (2-ethylhexyl)phthalate and dioxins—are of concern as cumulative contaminants that can undergo bioaccumulation.

The principal routes of exposure to toxic SOCs that may be present in biosolids include uptake by plants and consumption of the plants by humans, direct contact of edible plant parts with biosolids and subsequent consumption, direct contact by children who play in or ingest biosolids, uptake by plants used as animal feed and subsequent human ingestion of meat or animal products, and direct ingestion by grazing animals with subsequent human ingestion of animal products. Direct human ingestion is a remote possibility and is not considered a significant or likely source of disease. One major source of dioxins on the farm is wood treated with the wood preservative pentachlorophenol, used in constructing outdoor structures for livestock. Cattle chew on such wood periodically and this provides a source of dioxin in meat that could ultimately end up in biosolids used as a soils amendment (Chaney pers. comm.). The EPA risk assessment was based on those conditions considered to represent the worst-case conditions of exposure through various pathways (see Appendix E, Part 2).

Of all the SOCs, pesticides are probably the most researched. The levels found in biosolids, however, are minuscule compared with the levels of those used directly on farms and with typical environmental levels. The epidemiologic study of human exposure on 47 farms in Ohio to biosolids showed no significant differences in health that could be related to biosolids land application, including health effects that could be related to the presence of SOCs in biosolids (Dorn et al. 1985 and National Academy of Sciences 1996).

Currently, the Part 503 rules do not set standards or require testing of biosolids for SOCs. However, the proposed GO monitoring program would require testing of biosolids for PCBs, aldrin, dieldrin, and semivolatile organic compounds. EPA is in the process of proposing a dioxin limit for biosolids, however, and if and when such a limit is developed, it would be applicable to biosolids use. Until there is sufficient justification (i.e., a potentially significant health risk associated with biosolids is identified), it is unlikely that regulations will be developed to establish limitations on the SOCs in biosolids.

The potential for increased risk of disease resulting from the ingestion of SOCs present in biosolids used in land application is considered minor. Most SOCs are found in very low concentrations (U.S. Environmental Protection Agency 1995) and at levels that pose no excessive risk to human health through any of the potential exposure pathways. There are no reports of adverse human acute and chronic toxicity effects resulting from ingestion of plants grown in biosolids-amended soils (National Academy of Sciences 1996). Few adverse human health effects have been found in studies where treated biosolids were fed directly to animals (National Academy of Sciences 1996). This impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Health concerns regarding grazing animals are discussed above and in Chapter 4, “Land Productivity”. Mitigation Measures 4-2 and 5-2 would increase the period after biosolids application during which grazing is prohibited from 30 days to 90 days. These measures would also increase the level of human health protection associated with SOCs in biosolids.

Impact: Potential for Increased Incidence of Disease Resulting from Ingestion of Groundwater Contaminated by Biosolids-Derived Pollutants or Pathogens

As the amount of biosolids applied to land increases with population growth, the potential for leaching of biosolids-derived contaminants to groundwater will increase, potentially resulting in effects on public health. The pathogens that may be present in biosolids that have the greatest chance of reaching groundwater are viruses. As discussed in Chapter 3, "Soils, Hydrology, and Water Quality", the leaching of nitrates to groundwater is an issue of concern as well, but only on a very site-specific basis and in terms of cumulative effects. The analysis for Chapter 3 found that for certain geographical areas and geologic and climatic conditions, or in areas where groundwater aquifers are near sources of nitrates or already impaired by nitrates, the impacts from application of biosolids are considered potentially significant. As discussed in the setting and Appendix E, nitrates in drinking water can cause a disease in infants and young children called methemoglobinemia. Although the disease is rare, it is an issue of concern, particularly in areas where there are already high nitrate levels in groundwater.

As discussed in Chapter 3, programs are underway under the Safe Drinking Water program to address nitrates and other contaminants that may be introduced into drinking water supplies. The RWQCBs are involved in these programs and the GO will provide a further tool to protect drinking water supplies and provide monitoring data to assess environmental quality. Under the proposed application rates required under the GO, there should be no adverse impacts on public health related to nitrates and biosolids land application.

Contamination of groundwater with biosolids-related trace metals also should not be an issue of public health concern because of the restrictive provisions of the GO. If the groundwater is a part of a basin that is tapped for a potable water supply, public health will be protected by compliance of the water purveyor with existing drinking water standards for trace metals content. For other water users tapping the groundwater aquifer, the GO has protective provisions in the form of prohibitions against groundwater exceedances of drinking water standards, setback requirements, requirements for minimum depth to groundwater, specified application rates, and monitoring requirements.

Unless there are very porous soils with fractured rock underlying them, abandoned wells that are not properly sealed, and high rates of irrigation or rainfall to provide a means of transport, it is unlikely that any viruses present in biosolids will reach groundwater. The GO contains sufficient provisions to prevent such occurrences (setbacks, minimum distances to wells, minimum depth to groundwater, runoff controls, and prohibitions on long-term storage piles where concentrations of pathogens might be higher if leached to groundwater). The direct effect of biosolids application is considered less than significant.

Mitigation Measures: No mitigation is required.

Although the direct effect of land-applied biosolids on groundwater quality, and therefore public health, is considered less than significant, there are circumstances in California under which cumulative increases in groundwater nitrate levels could pose a significant health risk. See Chapter 13, "Cumulative Impacts", for a full discussion of this issue.

Impact: Potential for Increased Incidence of Acute or Chronic Disease Resulting from Human Exposure to Aerosols and Wind-Blown Particulates from Biosolids Stockpiling, Composting, or Land Application

As population growth occurs and the beneficial use of biosolids increases, stockpiling, composting, and land application of biosolids will increase, leading to potential increases in human exposure to aerosols and wind-blown biosolids. However, increased exposure is not expected to correlate with increases in disease for the reasons described below.

As described above under "Environmental Setting" and in Appendix E, various studies reported in wastewater aerosol symposium proceedings and other research have shown that aerosols from spray irrigation of treated wastewater do not pose a significant threat to public health. Research on aerosols from land-applied biosolids has shown similar results. For biosolids land application, recent research has been conducted at the Sierra Blanca Ranch in far west Texas in the Chihuahuan Desert, where rainfall is limited, summers are hot and dry, wind velocities are high, and relative humidities are low (Pillai et al. 1996). Temperatures range from 70EF in November to 84EF in August and mean wind speeds range from 2 to 5 mph. Anaerobically digested sludge from New York City is transported by rail to the site and applied as a cake at a rate of 3 dry tons per acre. Residents of the town of Sierra Blanca, about 4 miles from the closest sludge application site, expressed serious concerns about health effects that could result from the sludge-application operation.

This study found the highest levels of bacteria in the immediate vicinity of the hopper loading area, where the sludge was agitated during loading. The highest bacterial population densities were found during low-wind conditions, with counts ranging between 56 and 630,000 colony forming units (CFU) per cubic meter at the hopper loading area and 4,200–250,000 CFUs per square meter within 15–30 meters of the application site. The bacteria detected were aerobic heterotrophic bacteria; none were the pathogenic bacteria, such as salmonella, found in the biosolids. The absence of fecal coliforms and fecal streptococcus in the air samples was notable, considering that the levels measured in the sludge piles at the hopper loading area were 23,000 most probable number per gram (MPN/gm) of wet sludge for *Salmonella* spp., 1.1 x 10^8 MPN/gm for fecal coliforms and 3.5 x 10^6 MPN/gm for fecal streptococci (Pillai et al. 1996). None of the sites was positive for coliphage (representative of viruses).

The authors of the Sierra Blanca report concluded that, unlike spray irrigation sites, sludge application sites may have minimal potential for generating aerosols under low wind conditions; no aerosols were detected in the study at distances greater than about 30 meters (100 feet) from the hopper loading site. This study confirms the results of others that there is a lack of viruses in air found at wastewater application sites (Brenner et al. 1988, Fannin et al. 1985) under conditions of high agitation and high likelihood for aerosol formation. The results suggest that land application of municipal sludges at 3 dry tons per acre poses little risk of airborne transmission of bacterial pathogens (under geographical and weather conditions similar to those of parts of California) and the population center downwind (4 miles away in the Texas case) is not affected by airborne bacterial pathogens from the sludge application sites. Most biosolids that are land applied have a solids content of about 25% and do not form aerosols in the same volume as spray irrigation. Most liquid biosolids are injected. There are no spray irrigation operations of biosolids in California such as those in use in silvicultural operations in Washington.

Studies of dust generation at the Sierra Blanca site have shown that only 0.026 g of particulate matter had accumulated in samplers after 25 days of continuous sampling (Harris 1996). This is an extremely low level of particulate material.

Bacteria and viruses exposed to air have a much greater die-off rate than those in soils or water as a result of dessication and ultraviolet radiation; thus, any pathogens that may be present in air will not survive as long as those that are buried. The absence of bacteria in particulate samples at distances of more than 30 meters from the hopper loading site indicate minimal aerial transport of biosolids-derived aerosols or dust. Good site management practices, as suggested in Mitigation Measure 5-1, would be appropriate to minimize worker exposure to biosolids-related aerosols.

Isolation of the biosolids application sites from the general public is a major factor in minimizing any potential risk from aerosols and particulates. As the land application parcels are expanded under the GO, environmental commitments and operating criteria contained in the GO will protect public health. The GO acknowledges the concern over potential health effects of dust generated from biosolids. The GO specifies that biosolids application operations and biosolids incorporation activities cannot cause the release of visible airborne particulates from the application site. Because of the safeguards in provisions of the GO against exposure of humans to airborne particulates from biosolids and the scientific evidence available concerning the low probability of human effects associated with aerosols from biosolids, this impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Impact: Potential for Increased Risk of Disease Resulting from Contact with Biosolids Spilled during Transport from Point of Generation to Application Site

As more biosolids are transported from places of generation to application sites, the potential spills will increase. However, unless a spill results in an injury accident with subsequent human exposure to biosolids, it is unlikely that a spill of biosolids would result in any threat of humans contracting disease. The GO includes numerous provisions that ensure the safety of biosolids transport. The proposed GO requires that the biosolids hauler be trained in spill response procedures designed to prevent spilled biosolids from remaining on roads, being washed into storm drains or waterways, or contaminating groundwater. Specifications in the GO mandate that each truck carry a copy of an approved spill response plan. Therefore, this impact is considered less than significant. No mitigation is required.

Impacts of Other Activities

Silvicultural Use

The GO would regulate the beneficial use of biosolids for silvicultural activities. It is anticipated that in California this use would mainly occur in tree farming rather than in large-scale forestry operations as in Washington, where liquid biosolids application is conducted to promote silviculture. The information presented above regarding survival of pathogens and levels of trace metals and other contaminants in biosolids, the low probability of aerosol formation, and the lack of evidence of health effects associated with direct contact with biosolids or contact with wind-blown particulate matter from application sites applies to silvicultural uses of biosolids as well as agricultural uses.

The literature on biosolids management in the Pacific Northwest has been extensively reviewed by Henry (1997) for information on environmental effects related to silvicultural operations. Also, the health effects associated with silviculture have been addressed in detail by the Municipality of Metropolitan Seattle in Munger (1983). This work concluded, based on the known quantities of pathogens in Seattle area biosolids and information on infectious dose and level of environmental mobility of pathogens and other contaminants in forestland, that biosolids would pose little or no risk to public health.

Conditions in California (less rainfall and warmer, dryer weather with less humidity than in Seattle) are more conducive than conditions in Washington to pathogen die-off. It is therefore likely that the health risks associated with use of biosolids in silviculture in California would be less than those found for the Seattle area for similar pathogen levels.

The runoff control and stream buffers required by the GO would also apply to silvicultural sites, whether the particular use is a small tree farms or a large forestry operation. Based on the results of studies cited above and the controls contained in the GO, this impact is considered less than significant.

Mitigation Measures: No mitigation is required.

Horticultural Use

Horticultural operations may use biosolids to grow turfgrass, cut flowers, and container-grown landscape plants and live vegetable seedling plants for home garden transplanting. The impacts associated with such activities are similar to those cited above for direct contact and aerosols. Use of Class A biosolids for larger scale landscaping projects would be subject to the GO. Commercial sales of bagged product for smaller scale commercial and residential uses in horticulture would not be governed by the GO.

Use of composted biosolids in bulk can pose a health risk associated with exposure to high concentrations of *Aspergillus* fungal spores, which can cause allergies and pulmonary disease, particularly in susceptible or immunocompromised persons (see "Environmental Setting" and Appendix E for further discussion). However, the same effects can be found in gardeners working with composts that are not derived from biosolids (Zuk et al. 1989).

Because there would be little chance of ingestion of flowers or other ornamental plants, there is no health risk associated with consumption of such plants grown using soil amended with biosolids. In the worst case, someone may grow the seedlings to full size and eat the food grown in the biosolids-amended container plant; this is an issue of public health concern. This would be a one-time event, rather than chronic ingestion such as the long-term (70-year) exposure to foods grown with biosolids studied by EPA in its risk assessment, and would pose little risk to health.

Use of Class A material and the numerical limits placed on exceptional quality biosolids for unrestricted use should result in protection of the general public from adverse health effects. This impact is considered less than significant. No mitigation is required.

Land Reclamation

The GO would regulate the use of biosolids for reclamation activities. The reclamation uses could include rehabilitation of mined sites, one-time heavy applications to closed landfills to create a condition conducive to planting of a vegetative cover, or the restoration of lands for use as parks, ball fields, or even golf courses. Such intensive uses would normally not occur in areas where there is much public access until the sites are fully reclaimed. Pathogen exposures are assumed to be no greater than for agricultural sites (see "Impact: Potential for Increased Incidence of Disease Resulting from Direct Contact with Pathogenic Organisms at Biosolids Land Application Sites" above). There are no issues related to food grown on the sites, or grazing animals, or wells providing potable water. The same GO restrictions that apply to agricultural application sites would apply to reclamation sites except for limitations related to nitrogen. The proposed GO allows for biosolids application in excess of the nitrogen requirements of vegetation as part of an overall plan for site reclamation. Excess loading of nitrogen could create health risks through nitrate contamination of groundwater used for domestic consumption. The GO requires that, before land application begins, a report must be prepared demonstrating that unacceptable degradation would not occur in these situations. This report must be approved by an RWQCB Executive Officer before the project proceeds. With these controls in place, the public health impacts of biosolids use at reclamation sites are considered less than significant. No mitigation is required.

Chapter 6. Land Use and Aesthetics

Environmental Setting

Regional Settings

Typical regional settings for the evaluation of land use and aesthetic impacts are described below. These particular regions are described because land application of biosolids will most often be proposed under the GO in settings similar to these. The presentation of these descriptions is not intended to preclude the applicability of impact analyses to other regions of the state, however. Figure 6-1 depicts the regions discussed.

Central Valley

The Central Valley encompasses approximately 60,000 square miles extending from Kern County in the south to Shasta County in the north (Jensen pers. comm.). More than 90% of the land area of the flatter, lower elevation portions of the valley consist of irrigated agricultural land. The total population of the Central Valley is approximately 7 million people; most of that population is concentrated along State Route 99 from Bakersfield to Sacramento and along Interstate 5 and State Route 99 north of the Sacramento urban area (California Department of Finance 1998). Agricultural development in the southern portion of the valley varies from small farms in the east to enterprises of several thousand acres in the west; in the central and northern portions of the valley, agricultural operations are mostly small and medium sized.

Lahontan

This area encompasses the southern Sierra Nevada and the high desert of California. It is, in general, sparsely populated compared with many other portions of the state. The major population centers are the Lancaster/Palmdale urban area and the Victorville area. Smaller urban developments include Ridgecrest and Barstow.

The region is physically dominated by the eastern slopes of the southern Sierra Nevada and the White Mountains. Smaller ranges are interspersed throughout the region. The western portions of the region are in agricultural use, principally irrigated agriculture. In the Antelope Valley, north of Lancaster/Palmdale, scattered rural residential development has occurred.

Southeast

For purposes of this analysis, the southeast portion of the state is defined as the eastern, non-urbanized slopes of the Coast Ranges and the San Jacinto mountains, the undeveloped areas of the Perris Valley, the Coachella Valley, and the low desert extending to the Colorado River. Where irrigation water is available, intensive agricultural development has occurred. Population is concentrated in the Beaumont-Banning-Palm Springs-Indio corridor, in the Perris Valley-Hemet-Perris-Lake Elsinore area, and at El Centro/Brawley.

Northern California

This area is defined for purposes of this analysis as the Cascade Range, the Coast Ranges, and the intervening small valleys north of the San Francisco Bay/Delta, not including the Central Valley itself. The valleys in the southern portion of the region are partially to largely urbanized. The principal silviculture operations in the state are conducted in the region's mountains. Agricultural development in the region's valleys, including extensive viticultural development, is generally undertaken on smaller parcels than in the rest of the state. Cattle grazing operations dominate the non-irrigated foothill areas of the region.

Coastal

The "coastal" region of the state is defined, for purposes of this analysis, as the Coast Ranges from the northern San Francisco Bay area to the Mexican border, the Transverse Ranges of Southern California, San Francisco Bay and the San Francisco Bay/ Sacramento-San Joaquin River Delta (Bay-Delta) region, and the coastal valleys and watersheds. This area includes 80% of the state's population. Urban development occupies most of the region that is not mountainous. Agricultural operations, other than grazing in the foothills, typically are concentrated in small viticultural, dairy, truck garden and horticultural enterprises, rather than the several-thousand-acre holdings common in much of the Central Valley and in the Southeast and Lahontan regions.

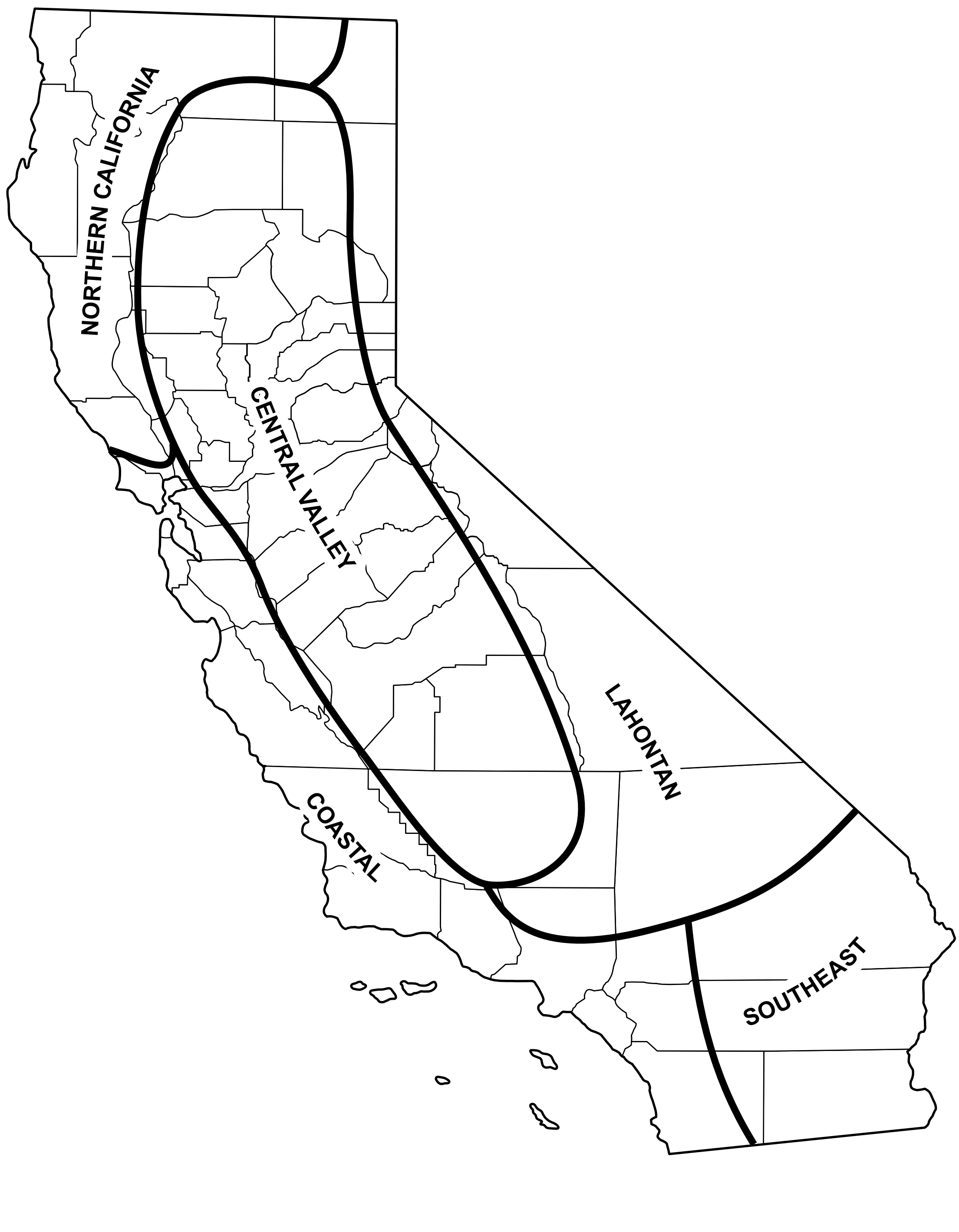


Figure 6-1
California Physiographic Regions

Physical Setting

Agriculture

Physical settings may vary widely with respect to agricultural site. Such physical setting variables may include, but are not limited to:

- distances to nearby residences;
- distances to sensitive receptors such as recreation or assembly areas, high-traffic streets or roads, restaurants, hospitals, and schools;
- prevailing wind conditions; and
- available access routes and near-site development along such routes.

Typical agricultural sites are level areas with relatively large landholdings that are remote from urban centers. The types of crops commonly grown on agricultural biosolids disposal sites are row crops that are not typically used for human or dairy animal consumption. Sites are generally reached by county roads with low traffic volumes. The visual impact of such sites is limited, and because they are located away from urban centers and major highways, most people are unaware of their status as biosolids disposal sites.

Silviculture

Physical variables for forested lands are similar to those for agricultural operations. Biosolids would typically be applied as a soil amendment between rows of maturing trees in a commercial tree farm. With respect to silvicultural applications, slope considerations may affect the discharger’s approach to preventing potential runoff onto adjacent parcels, including parcels with recreational or residential/urban land uses. Typical silvicultural sites are unlikely to be located on small landholdings or near urban centers.

Horticulture

Physical variables for horticultural uses are similar to those for agricultural operations. Such variables are of increased concern because of the possibility that horticultural use of biosolids may occur on sites in relatively urbanized areas. Horticultural sites are often located in transitional areas or on parcels that have been temporarily passed over during the urban expansion process. Slopes are typically gentle to almost flat. Residential uses, including numerous farmsteads, may be present nearby.

Land Reclamation

The physical setting for land reclamation could include landfills and mining reclamation sites. These operations are likely to occur in rural areas rather than in urban settings because landfills and mining operations are typically not compatible with urban environments.

Regulatory Setting

Current regulations pertaining to land use/aesthetics and land application of biosolids in California are contained in the ordinances adopted, or under consideration, by 17 of the state's 58 counties and in the site-specific WDRs that have been adopted by RWQCBs.

County Land Use Regulations and Ordinances

The land use and aesthetics regulations in county ordinances vary widely. Table 6-1 summarizes portions of these ordinances that are related to land use and aesthetics. Such ordinances typically contain the following specifications:

- minimum distances from biosolids application areas to occupied residences,
- minimum distances from biosolids application areas to property lines, and
- maximum wind velocities for application.

Site-Specific Waste Discharge Requirements

The land use and aesthetics provisions of typical site-specific WDRs, such as those of county ordinances and regulations, vary widely. The following sample provisions for land application of biosolids are from the WDRs for Pima Gro Systems, Inc., and Jerry Menefee, Merced County (Central Valley Region):

- sludge cannot be stockpiled or stored onsite,

- sludge cannot be applied within 25 feet of property lines,

Table 6-1.
Representative County Ordinance Conditions Pertaining to Land Use or Aesthetic Issues and Land Application of Biosolids

County	Minimum Distance to Nearest Residence (in feet)	Minimum Distance to Property Line (in feet)	Maximum Wind Velocities for Application (in mph)	Dust Restrictions	Maximum Storage Time on Site	Other
Kern	500[a]	50	39	Yes	—	
Merced	—	25	20	Yes	24 hours	
Riverside	—	—	—	—	24 hours	
San Bernardino	500[a]	—	—	—	—	
San Joaquin	—	—	—	—	—	Prohibits biosolids applications in unincorporated areas of the county.
Solano	500	50	20	—	7 days	Prohibits “nuisance”. Prohibits applications inconsistent with the Delta Protection Commission’s Land Use & Resource Management Plan for the Primary Delta Zone.
Stanislaus	—	—	—	—	—	Prohibits biosolids application.
Sutter	—	—	—	—	—	Prohibits biosolids applications in unincorporated areas of the county.
Tulare	500	25	20	Yes	24 hours[b]	Prohibited in or within 660 feet of areas designated as Urban Land Use areas.
Yolo	500	25	5	Yes	48 hr	Draft ordinance prohibits application in Primary Delta Zone.

[a] Owner residence excepted.
[b] Can be extended for good cause by agricultural commissioner.

- sludge cannot be applied within 500 feet of domestic water supply wells or occupied dwellings, and
- sludge cannot be applied within 50 feet of public roads.

Federal Part 503 Regulations

Part 503 regulations include provisions for the reduction of vector attraction (i.e., characteristics of sewage sludge that attract rodents, flies, mosquitos, or other organisms capable of transporting infectious agents) and setbacks from different land uses. Additional information on the Part 503 regulations is included in Chapter 2 and Appendix C.

Impacts and Mitigation Measures

Approach and Methods

Because biosolids application is ongoing in California, a considerable amount of information exists concerning the activity, its implications, and the public's reaction to present practices. The analysis of impacts on land use and aesthetic issues involved a review of current biosolids application practices and a review of WDRs for existing sites to identify the types of mitigation measures already in use. The GO and Part 503 regulations also were reviewed to identify the types of land use and aesthetic concerns addressed by the existing regulations. In addition, local ordinances regulating biosolids application were gathered, and land use and aesthetic concerns addressed in those ordinances were identified so that local concerns and responses could be assessed. Factors that could affect impact significance also were considered, including:

- distances to nearby residences;
- distances to other sensitive receptors, such as recreation or assembly areas, high-traffic streets or roads, restaurants, hospitals, and schools;
- prevailing wind conditions; and
- available access routes and near-site development along such routes.

Thresholds of Significance

Based on the State CEQA Guidelines and professional judgment, it was determined that implementation of the GO would result in a significant impact on land use and aesthetics if it would:

- conflict with local land use plans and ordinances;
- conflict with established land uses;
- substantially degrade visual quality in adjacent areas;
- result in objectionable odors, an increase in insects, or dust of biosolids origin in urban areas or at residences adjacent to the disposal site; or
- frequently result in spillage of biosolids on public roads for long periods of time or in large quantities.

Impacts of Agricultural Use

Land Use

Impact: Application of Biosolids in a Manner And/or in Locations in Conflict with Local Land Use Plans and Ordinances, Including Future Planned Land Uses

Several counties have adopted ordinances that specify locations and applicable setbacks for land application of biosolids. In addition, local land use plans designate areas for future growth. As that growth occurs, conflicts may develop between land applications and urbanizing areas. However, the GO states that it does not preempt or supersede the authority of local agencies to prohibit, restrict, or control the use of biosolids subject to those agencies' control, and the GO requires the discharger to obtain any necessary local governmental agency permits or authorizations prior to the application of biosolids at each application site. Therefore, this impact is considered less than significant because the GO would not conflict with any local land use plans or ordinances.

Mitigation Measures. No mitigation is required.

Impact: Application of Class B Biosolids at Locations That May Conflict with Existing Land Uses in Urban Areas; Recreation Areas; or Other Sensitive Areas, Including Schools, Hospitals, and Recreation/public Assembly Areas

The GO currently contains specifications, exclusions, and prohibitions designed to minimize conflicts with land uses adjacent to application sites. For example, it specifies areas of the state identified as "unique and valuable public resources" that are not regulated by the GO and for which site-specific permits would be required; it requires compliance with the provisions of Part 503 regulations regarding the land application of biosolids that meet provisions for vector reduction; it prohibits the dissemination from application sites of visible airborne biosolids particles; it stipulates the use of tillage procedures that minimize wind erosion; and it prohibits application within 500 feet of residential buildings. However, the GO does not include setbacks from facilities for recreation activities; places of public assembly; hospitals; or other sensitive receptors that could be included under the definition of "populated areas" provided under "High Potential for Public Exposure Areas" in the definitions section of the GO. (The application of Class A biosolids would not conflict with these potential adjacent land uses because Class A biosolids have been treated to meet more stringent pathogen reduction standards than Class B biosolids.) The application of Class B biosolids near these sensitive receptors could conflict with the land use (i.e., activities could be disturbed as a result of increased noise, traffic, etc.) This impact is considered potentially significant. To reduce this impact to a less-than-significant level, the SWRCB shall implement Mitigation Measure 6.1.

Mitigation 6-1: Require setbacks from areas defined as having a high potential for public exposure. The GO will be modified to state that:

(a) no application of Class B biosolids shall be permitted within an area defined in the GO as having a high potential for public exposure unless the biosolids are injected into the soil and

(b) educational facilities; facilities designated for recreation activities other than hunting, fishing, or wildlife conservation; places of public assembly; hospitals; or similar sensitive receptors shall be included in the definition of "populated area" as used in conjunction with the designation "High Potential for Public Exposure Areas."

Aesthetics

Impact: Reduced Visual Quality Resulting from Truck Transport of Biosolids Through Residential And/or Recreational Areas

If land application projects are approved under the GO, biosolids haulers may use roadways that traverse residential and/or recreational areas, resulting in the potential for reduced visual quality because of the potential increase in noise, dust, and traffic (see Chapter 11 for a discussion of noise impacts). This impact is considered significant. However, this impact is reduced to a less-than-significant level with the implementation of Mitigation Measures 10-2 (Control Fugitive Dust from Unpaved Roads) and 11-1 (Avoid the Use of Haul Routes near Residential Lands) included in the noise and air quality chapters.

Impact: Reduced Visual Quality Resulting From Land Application Activities Adjacent to Schools, Hospitals, or Recreation/public Assembly Areas

Land application projects approved under the GO could be conducted adjacent to schools, hospitals, or recreation and public assembly areas as long as the application site is set back 50 feet from roadways and 500 feet from non-agricultural buildings. Sites that would receive biosolids generally have previously been used for agriculture; however, it is possible for land application sites to be located near these sensitive receptors. This impact is considered less than significant because of the setbacks included in the GO and with the implementation of Mitigation Measure 10-2 (Control fugitive dust from unpaved roads).

Impact: Reduced Visual Quality Resulting from Spillage of Biosolids on Public Roads

Although the GO includes provisions requiring biosolids to be transported in leak-proof and covered trucks, there are no requirements for proper washdown, loading, and maintenance of transport vehicles. Therefore, if biosolids are loaded onto vehicles in a manner that results in their adhering to the outside or tires of the vehicle, they could be spilled on the roadways, resulting in a reduction in visual quality. This impact is considered significant. To reduce this impact to a less-than-significant level, the SWRCB shall implement Mitigation Measure 6-2.

Mitigation Measure 6-2: Require the Maintenance of Biosolids Transport Trucks after Biosolids Are Loaded in the Trucks. The GO will be modified to stipulate that dischargers ensure that any biosolids adhering to the outside of biosolids transport trucks and tires be removed before trucks leave the dischargers' sites or application areas. Implementation of this mitigation measure will prevent biosolids from being spilled in roadways.

Impacts of Other Activities

Horticultural Use

The use of biosolids for horticultural purposes would result in generally greater impacts on land use and aesthetics as those described above under "Agricultural Use" because biosolids could be transported through or used adjacent to areas where recreation or sensitive receptors are present. However, Mitigation Measure 6-1, described above; and Mitigation Measures 10-2 and 11-1, described in the Air Quality and Noise chapters, would reduce this potential impact to a less than significant level.

Silvicultural Use

The use of biosolids for silvicultural purposes would result in generally greater impacts on land use and aesthetics as those described above under "Agricultural Use" because biosolids could be transported through or used adjacent to areas where recreation or sensitive receptors are present. However, Mitigation Measure 6-1, described above; and Mitigation Measures 10-2 and 11-1, described in the Air Quality and Noise chapters, would reduce this potential impact to a less-than-significant level.

Land Reclamation

The use of biosolids for land reclamation would result in generally greater impacts on land use and aesthetics as those described above under "Agricultural Use" because biosolids could be transported through or used adjacent to areas where recreation or sensitive receptors are present. However, Mitigation Measure 6-1, described above, and Mitigation Measures 10-2 and 11-1, described in the Air Quality and Noise chapters, would reduce this potential impact to a less-than-significant level.

Chapter 7.
Biological Resources

Environmental Setting

A great diversity of vegetation and wildlife resources exist in California across a broad range of physiographic regions, from the coast, inland across mountain ranges and valleys, to the deserts along the eastern border. Each of these regions can be further subdivided into many habitats defined by the plant communities present and their associated wildlife species. Habitat types include coastal dunes and scrub, desert and valley riparian, mixed conifer, oak woodland, riverine, and annual grassland, and more human-influenced habitats such as agricultural land, pastureland, and urban areas.

The varied habitat types within California are conducive to a great diversity of plant and animal species, many of which are endemic to the state. As a consequence of habitat conversion to agriculture and residential and commercial development, many of these species have become rare, threatened, or endangered (California Department of Fish and Game 1998a, 1998b). For example, 216 plant species have been state listed as endangered, threatened, or rare under Section 1904 (Native Plant Protection Act of 1977) and Sections 2074.2 and 2075.5 (California Endangered Species Act of 1984) of the Fish and Game Code, 132 plant species have been federally listed as endangered or threatened under the Federal Endangered Species Act of 1973, and another 58 species are proposed or candidates for listing. Additionally, 137 species of animals have been state or federally listed as threatened or endangered and eight animal species are classified as candidates for state listing or proposed for federal listing. Many others are considered special-status species by local, state, and federal agencies but only listed species are included in the following discussion.

This section focuses on the habitat types and resources in areas where biosolids will be applied, including areas with large-scale agricultural, silvicultural, and horticultural uses and those where disturbed lands are being reclaimed. Most of the habitat in areas where biosolids would be applied is agricultural, although some natural terrestrial habitats could also be affected, such as annual grasslands. This analysis focuses on the effects the GO will have on biological resources on a programmatic level instead of on specific effects of individual projects. The following sections are subdivided into specific activities for which biosolids application would be used.

Agricultural Activities

Agricultural activities include soil cultivation for crop production and raising livestock. Agricultural activities usually take place on flat to gently rolling terrain, primarily in the Central Valley, coastal valleys, the Modoc Plateau, and in desert valleys where irrigation is available, such as the Imperial Valley and the lands adjacent to the Colorado River. Habitat types on agricultural lands include cropland, orchard-vineyard, and pasture.

Vegetation

Croplands typically comprise row crops, hay, or grains planted in monocultures. Natural vegetation and weeds are generally eliminated by flood irrigation, tillage, and herbicide application. Orchards and vineyards usually contain single tree, shrub, or vine species planted in rows. A low-growing herbaceous understory or cover crop may be present but is generally managed to control its growth. Pasture consists of perennial grasses and legumes planted for livestock forage, although the vegetation also may include native grasses and forbs and weedy non-natives. Pastures are managed to improve forage quality using irrigation, fertilizer application, and weed control. Many natural habitats occur adjacent to agricultural lands, the most common of which are annual grassland, seasonal wetlands, vernal pools, Great Basin grassland, coastal scrub, saltbush scrub, desert scrub, Great Basin scrub, riparian woodland, and oak woodland.

Wildlife

Although natural communities provide the highest value for wildlife, many of these natural habitats have been largely replaced by agricultural habitats throughout California with varying benefits to wildlife. The intensive management of agricultural lands, including disking, grazing, crop rotation, and the use of chemicals, further reduces the value of agricultural lands for wildlife. In spite of intensive management, however, many wildlife species have adapted to particular crop types and now use them for foraging and nesting. Compared to other agricultural crops, rice and grain are considered high-value crops for wildlife because many species forage on waste grain, and flooded rice fields provide habitat similar to some natural wetlands. Pasture also provides abundant forage and cover. Compared to rice and grains, row crops and orchards provide moderate-quality habitat because they provide only limited cover and foraging opportunities. Vineyards and cotton crops provide low-quality wildlife habitat because they are frequently disturbed and require many applications of herbicides, resulting in limited foraging and nesting opportunities and lack of cover.

Table 7-1 provides a list of representative common wildlife species that could occur in each habitat available for biosolids treatment. The composition of common wildlife species in each of the various habitat/treatment types will vary in each RWQCB region.

Special-Status Species

Plants. Special-status plants would not be expected to occur in croplands, orchards, or vineyards because they are typically eliminated by cultivation. They are also unlikely to occur in pastures because of habitat modification and intense grazing, although some plants could be present in pasture habitat where there is limited habitat alteration or less-intense grazing. Because pasture is not a habitat category used in the California Native Plant Society (CNPS) inventory or the Natural Diversity Data Base (NDDB), no specific information on the occurrence of special-status plant species in pastures was found. The habitat most similar to pasture is grassland and many special-status plants have been reported to occur in grassland habitats (coastal prairie, Great Basin grassland, meadows, and valley and foothill grassland) statewide (Table F-1 in Appendix F). Some endangered grassland species that were once widespread include Bakersfield cactus, California jewelflower, and Hartweg's adobe sunburst.

Wildlife. A number of special-status wildlife species could occur in agricultural habitats throughout California. Grain crops and pasture provide important habitat for species such as the Aleutian Canada goose, Swainson's hawk, and greater sandhill crane. Flooded rice fields provide habitat for the giant garter snake and rangeland provides habitat for a number of other listed species including San Joaquin kit fox, blunt-nosed leopard lizard, San Joaquin antelope squirrel, and desert tortoise, which are often in relatively high densities, such as those in the southern San Joaquin Valley (Table F-2 in Appendix F).

Silvicultural Activities

Silvicultural activities include managing, developing, and harvesting forests and trees for lumber, paper manufacturing, and other products. Silvicultural activities take place primarily in tree-dominated habitats in the northern Coast Ranges, Cascade Ranges, Modoc Plateau, and Sierra Nevada. General categories of tree-dominated habitats include broad-leaved upland forest, montane coniferous forest, north coast coniferous forest, and closed-cone coniferous forest. Tree-dominated habitats also include tree plantations, such as eucalyptus groves in the Central Valley.

Vegetation

Forest habitats are characterized by stands of trees. Coniferous forest habitats often comprise mixed associations of pines, firs, Douglas-fir, and other conifer species, although stands in closed-cone coniferous forest may be monotypic. In broad-leaved upland forest, conifer species occur in association with broad-leafed such as oaks, tan-oak, and madrone. The forest understory may consist of a dense shrub layer or may be open and parklike. The groundcover is often composed of sparse perennial herbs. In many areas where natural fires have been suppressed, forest stands are now dominated by dense stands of young conifers and support few herbs or shrubs.

Tree plantations are generally similar to orchards and are composed of single tree species planted in rows. A low-growing herbaceous understory or cover crop may be present but is generally managed to control its growth.

Wildlife

Table 7-1 provides a summary of common representative wildlife species that could occur in silvicultural sites throughout the state.

Special-Status Species

Plants. Special-status plants occur in forest habitats (broad-leaved upland forest, closed-cone coniferous forest, lower montane coniferous forest, upper montane coniferous forest, and North Coast coniferous forest) in California, although fewer than in grassland habitats (Table F-1 in Appendix F). Special-status plant species would not be expected to occur in tree plantations because they are usually eliminated by habitat conversion or cultivation.

Wildlife. Similar to agricultural habitats, forested habitats throughout California provide habitat for a variety of special-status wildlife species including California red-legged frog, both the California and northern spotted owls, marbled murrelet, and California condor (Table F-2 in Appendix F). However, special-status wildlife species would not be present during biosolids application in tree plantations that would occur after the site has been harvested.

Table 7-1.
Characteristics of Habitat Types Authorized for Treatment under the General Order

Common Habitat	Description	Representative Common Wildlife Species
Agricultural Activities		
Pasture	Irrigated and nonirrigated lands that are dominated by grasses and legumes. Vegetation composition varies with management practices; may include wild oats and alfalfa.	Black-bellied plover, killdeer, long-billed curlew, white-faced ibis, California voles, Botta's pocket gophers, California ground squirrels
Orchard-Vineyard	Cultivated fruit or nut-bearing trees and grape vines. Habitat uniform and intensively managed; understory vegetation usually sparse.	Mourning dove, American crow, scrub jay, northern flicker, Lewis' woodpecker, yellow-billed magpies, American robin, deer mouse, gray squirrel, black-tailed hare, racoon, and mule deer
Row Crops	Tomatoes, broccoli, artichokes, lettuce, sugar beets, and strawberries. Intensive management and use of pesticides limit use by wildlife.	Swainson's hawks, red-tailed hawks, black-shouldered kites, California vole, deer mouse, and California ground squirrel
Grain	Barley, wheat, corn, and oats. Intensive management and use of pesticides limit use by wildlife.	Greater white-fronted geese, tundra swans, red-winged black birds, Brewer's blackbirds, ring-necked pheasants, waterfowl, western harvest mice, wild pigs and tule elk
Rice	Has some of attributes of seasonal wetlands but is intensively managed and benefits are reduced. Provides nesting and foraging habitat for waterfowl and shorebirds. Irrigation ditches used to flood rice fields often contain dense cattail vegetation.	Mallard duck, Canada geese, sandhill crane, northern harriers, black-shouldered kites, Virginia rail, American bittern, snowy egret, marsh wren, common yellowthroat, song sparrow, California voles, and deer mice
Cotton	Cotton is of limited value to wildlife because of intensive management of the crop and use of chemicals to control pests and disease.	Mourning doves, killdeer, American pipet, horned lark, and house mice
Annual Grassland	Open stand of grasses primarily on flat plains to gently rolling foothills, ridges, and south-facing slopes.	Western toad, gopher snake, northern harrier, killdeer, western kingbird, loggerhead shrike, savannah sparrow, pocket gopher, American badger, and coyote

Table 7-1.
Continued

Common Habitat	Description	Representative Common Wildlife Species
Silvicultural Activities		
Montane-hardwood conifer and montane hardwood	Stands with overstory consisting primarily of California black oak, tanoak, Douglas-fir, and madrone with understory of shrubs and sparse herbaceous layer.	Sharp-tailed snake, western rattlesnake, scrub jay, band-tailed pigeon, western gray squirrel, mule deer, and black bear
Mixed conifer	Forest stands dominated by associations of ponderosa pine, Jeffrey pine, white fir, incense cedar, Douglas-fir, sugar pine, and black oak.	Ensatina, California mountain kingsnake, Steller's jay, western tanager, northern flying squirrel, and Allen's chipmunk
Douglas-fir	Forest stands dominated by Douglas-fir overstory and tanoak understory.	Pacific giant salamander, northwestern garter snake, western flycatcher, golden-crowned kinglet, varied thrush, Trowbridge's shrew, Douglas squirrel, and dusky-footed woodrat
Jeffrey pine, ponderosa pine and eastside pine	Open forest stands dominated by Jeffrey or ponderosa pine.	White-headed woodpecker, brown creeper, northern flying squirrel, American martin, and mule deer
Eucalyptus	Eucalyptus habitats range from single-species thickets with little or no shrubby understory to scattered trees over a well-developed herbaceous and shrubby understory. Usually eucalyptus forms a dense stand with a closed canopy.	Alligator lizard, gopher snake, crow, raven , barn owl, red-shouldered hawks, red-tailed hawks, and woodrat
Horticultural Activities		
Row crops	See Agricultural Activities above	
Orchard-Vineyard	See Agricultural Activities above	
Ornamental	Urban vegetation such as tree grove, street strip, shade tree/lawn, lawn, and shrub cover. Tree groves have a continuous canopy whereas street strip trees may have continuous or discontinuous canopies.	California slender salamander, rock dove, house sparrow, startling,, scrub jay, mockingbird, house finch, wrentit, chesnut-backed chickadee, California quail, plain titmouse, racoon, opossum, striped skunk

Horticultural Activities

Horticultural activities include the cultivation of fruits and vegetables as well as ornamental plants. Cultivation of fruits and vegetables is discussed above under agricultural activities. Ornamental plants are cultivated under similar circumstances and in the same general areas as fruits and vegetables. Habitat consisting of large-scale plantings of ornamental plants would be classified as cropland.

Vegetation

Ornamental plantings generally consists of single annual or perennial herb, shrub, or tree species planted in rows. Natural vegetation and weeds are generally eliminated by tillage and herbicide application.

Wildlife

Table 7-1 provides a summary of common representative wildlife species that could occur in horticultural sites throughout the state.

Special-Status Species

Plants. Special-status plant species would not be expected to occur in ornamental plantings because they are usually eliminated by cultivation.

Wildlife. Special-status wildlife species are not typically expected to occur in ornamental plantings because suitable habitat is not generally available (Appendix F). There are exceptions, however—ornamental trees can be used by raptors, including the state-listed Swainson's hawk.

Land Reclamation Activities

Land reclamation activities are carried out to revitalize or restore lands that are damaged from past or present land uses. Typical reclamation activities include establishing vegetation on mine tailings and revegetating rangelands degraded by severe grazing. Reclamation activities could take place anywhere in the state.

Vegetation

Vegetation present in reclamation areas depends on the type of activities that have disturbed the landscape. Mining activities remove the vegetation and soil and natural revegetation proceeds slowly, if at all. Other activities, such as heavy grazing, may alter the original composition of the plant community or promote colonization by disturbance-tolerant noxious weeds.

Wildlife

Table 7-1 provides a summary of common representative wildlife species that could occur on land reclamation sites throughout the state.

Special-Status Species

Plants. Special-status plants would not be expected to occur in areas where past disturbance has eliminated the vegetation or where vegetation did not previously grow, such as on mine tailings. In other circumstances, where the vegetation has been altered but not removed, such as in heavily grazed rangeland, it is possible that special-status plants species are present.

Wildlife. A number of special-status wildlife species have potential to occur in disturbed areas, including bats (under bridges and in abandoned mines), desert tortoise, blunt-nosed leopard lizard, and San Joaquin kit fox (Appendix F).

Regulatory Setting

Federal Endangered Species Act

USFWS (plants, wildlife, and resident fish) and the National Marine Fisheries Service (NMFS) (anadromous fish and marine fish and mammals) oversee the federal Endangered Species Act (ESA). Section 7 of the ESA mandates that all federal agencies consult with USFWS and NMFS to ensure that the federal agencies' actions do not jeopardize the continued existence of a listed species or destroy or adversely modify critical habitat for listed species. A federal lead agency under the National Environmental Policy Act (NEPA) is required to consult with USFWS or NMFS if it determines that the proposed action "may affect" a listed species. This determination is made through preparation of a biological assessment. USFWS or NMFS will subsequently provide a Biological Opinion on wildlife species that are federally listed, proposed, or candidates for listing as threatened or endangered.

Section 9 of the federal ESA prohibits the take of any wildlife species listed as endangered, including the destruction of habitat that prevents species recovery, without an incidental take permit. "Take" is defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, collecting, or attempting to engage in any such conduct. Wildlife federally listed as threatened are protected from take under Section 4 of the ESA.

The take prohibitions under Section 9 of the federal ESA apply to only fish and wildlife species; however, Section 9 does prohibit the unlawful removal, collecting, or malicious damage or destruction of any endangered plant from federal land. Section 9 prohibits acts to remove, cut, dig up, damage, or destroy any endangered plant in nonfederal areas in knowing violation of any state law or in the course of criminal trespass. Candidate species and species that are proposed or under petition for listing receive no protection under Section 9 of the federal ESA.

Federal Migratory Bird Treaty Act

The Migratory Bird Treaty Act states that without a permit issued by the U.S. Department of the Interior, it is unlawful to pursue, hunt, take, capture, or kill any migratory bird.

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act makes it illegal to import, export, take (which includes molest or disturb), sell, purchase, or barter any bald eagle or golden eagle.

California Endangered Species Act

The California ESA requires state agencies to seek and conserve threatened and endangered species (Section 2055) and restricts all persons from taking listed species. DFG administers the act and authorizes take under Section 2081 agreements (except for designated "fully protected species").

The California ESA defers to the California Native Plant Protection Act of 1977, which prohibits importing of rare and endangered plants into California, taking of rare and endangered plants, and selling of rare and endangered plants. State-listed species are protected mainly in cases where state agencies are involved in projects under CEQA. In this case, plants listed as rare under the California Native Plant Protection Act are not protected under the California ESA but can be protected under CEQA. The following activities are exempt from the California Native Plant Protection Act:

- agricultural operations;
- fire control measures;
- timber harvest operations;
- mining assessment work;
- removal of plants by private landowners on private land for construction of canals, ditches, buildings, roads, or other rights-of-way; and
- removal of plants for performance of a public service by a public agency or a publicly or privately owned public utility.

Clean Water Act, Section 404

The U.S. Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) regulate the placement of fill into "waters of the United States" under Section 404 of the Clean Water Act. Waters of the United States include lakes, rivers, streams and their tributaries, and wetlands. Wetlands are defined for regulatory purposes as areas inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (33 CFR 328.3, 40 CFR 230.3). Project proponents must obtain a permit from the Corps for all discharges of fill material into waters of the United States, including wetlands, before proceeding with a proposed action.

The Corps may either issue individual permits on a case-by-case basis or general permits on a program level. General permits are "prior-authorized"— issued to cover similar activities that are expected to cause only minimal adverse environmental effects. Nationwide Permits (NWPs) are a type of general permit that have been issued to cover particular fill activities. NWPs have a set of conditions (general and Section 404 only) that must be met for the permits to apply to a particular project, as well as specific conditions that apply to each NWP.

Impacts and Mitigation Measures

Approach and Methods

This section describes impacts on vegetation and wildlife and proposes mitigation measures to avoid, reduce, or minimize impacts to a less-than-significant level. The evaluation of impacts is supported by the information provided in the environmental settings and by the following assumptions about the GO:

- there would be no staging activities or biosolids applications within 100 feet of wetlands, streams, or water bodies and
- biosolids application could occur in any portion of the state except for the specified GO exclusion areas.

Because biosolids application could occur throughout the state, detailed site- and species-specific effects of biosolids application on native plants and wildlife were not evaluated; the following discussion focuses on general impacts to biological resources and the regulatory consequences of applying biosolids to land for use in agriculture, silviculture, horticulture, and land reclamation.

Thresholds of Significance

According to State CEQA Guidelines, a project is considered to have a significant impact on biological resources if it would:

- reduce the number of a special-status plant or animal species;
- substantially affect habitat for special-status plant or animal species;
- substantially disturb biologically unique or sensitive natural communities (e.g., riparian woodland, vernal pools, emergent wetland);

- cause long-term degradation of common plant communities or wildlife habitat because of substantial alteration of landform or site conditions (e.g., alteration of wetland hydrology);
- substantially reduce local population size due to direct mortality or habitat loss, lowered reproductive success, or habitat fragmentation;
- substantially interfere with the movement of any resident or migratory wildlife species;
- substantially fragment or isolate wildlife habitats; or
- substantially disturb wildlife by human activities.

Definition of Special-Status Species

Special-status species are plants and animals that are legally protected under state and federal ESAs or other regulations, and species that are considered sufficiently rare by the scientific community to qualify for such listing. Special-status plants and animals are species in the following categories:

- plants listed or proposed for listing as threatened or endangered under the federal ESA (50 CFR 17.12 [listed plants], 50 CFR 17.11 [listed animals], and various notices in the Federal Register [proposed species]};
- plants that are candidates for possible future listing as threatened or endangered under the federal ESA (62 FR 182:49397-49411, September 19, 1997);
- plants listed or proposed for listing by the State of California as threatened or endangered under the California ESA (14 CCR 670.5);
- plants listed under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.);
- plants that meet the definition of rare or endangered under CEQA (State CEQA Guidelines, Section 15380), including those considered by CNPS to be rare, threatened, or endangered in California (Lists 1B and 2 in Skinner and Pavlik 1994);
- animal species of special concern to DFG (Remsen 1978 [birds], Williams 1986 [mammals], and Jennings and Hayes 1994 [amphibians and reptiles]; and

- animals fully protected in California (California Fish and Game Code, Section 3511 [birds], 4700 [mammals], and 5050 [reptiles and amphibians]).

Impacts of Agricultural and Horticultural Use

Impact: Reduction in the Number of a Special-Status Plant or Wildlife Species

Part 503 in Title 40 of the CFR prohibits the placement of biosolids if it is likely to adversely affect a threatened or endangered species or designated critical habitat. The GO does not address threatened or endangered species in its prohibitions, nor does it require dischargers to disclose information about the actual or potential occurrence of threatened or endangered species in the NOI or direct the RWQCB to address potential effects of biosolids application on threatened or endangered species during its review of the NOI. Therefore, the proposed project has the potential to significantly affect special-status plant and wildlife species by authorizing activities that could result in the reduction in the number of individuals of these species.

Biosolids application in connection with most agricultural and horticultural activities would not have a significant effect on special-status plant species. In general, cultivation would have already removed any previously existing vegetation and altered the physical and biological environment such that natural reestablishment of the indigenous flora and plant community would be precluded.

Biosolids application could result in the loss of special-status plants or animals if it is applied to natural terrestrial habitats (i.e., rangelands) or any lands that have been fallow for more than 1 year. Although the constituents of the biosolids material (e.g., nitrates, trace metals) could have a physiological effect on plants, the primary effects of biosolids application on plants would be physical removal and habitat alteration. Disking to incorporate biosolids into the soil would remove the natural vegetation and alter soil structure, and the biosolids themselves would alter soil chemistry, further altering soil structure. Tilling could result in direct mortality to listed wildlife species that live in burrows (e.g., San Joaquin kit fox, blunt-nosed leopard lizard, and San Joaquin ground squirrel).

Depending on the individual species and the magnitude of the loss or reduction in number of special-status plant or wildlife species, this could be considered a significant impact. Implementation of Mitigation Measure 7-1 would reduce this impact to a less-than-significant level.

Mitigation Measure 7-1: Modify Pre-Application Report and Provide Biological Information. The pre-application report shall be revised to include a location for the discharger to indicate whether the land application site contains natural terrestrial habitat areas or whether it has been fallow for more than 1 year. The discharger must submit a report that states whether special-status species occur on the site. If special-status species occur on the site, the report must identify the measures that will be taken to mitigate or avoid impacts on these species. The report must be prepared by a qualified biologist.

Impact: Substantial Disturbance of Biologically Unique or Sensitive Natural Communities

The GO specifically excludes biosolids applications in several areas that have been recognized to contain unique and valuable public resources (See Chapter 2 for a description of these locations). The GO also prohibits biosolids applications in surface waters and on saturated soils, including wetlands. However, the GO does not address unique or sensitive natural communities that lie outside of the specified exclusion areas. Therefore, the proposed project has the potential to adversely affect biologically unique or sensitive natural communities, such as seasonal wetlands and vernal pools.

Biosolids application on cultivated lands would not have an impact on biologically unique or sensitive natural communities because cultivation would have already removed any previously existing vegetation and altered the physical and biological environment such that natural reestablishment of the indigenous flora and plant community would be precluded. However, the use of biosolids to enhance the fertility of lands considered to be of marginal value as range or cropland or to convert rangeland to pasture or cropland could have a significant impact on sensitive natural communities such as native grasslands, oak woodlands, and saltbush scrub.

The substantial disturbance of more than 10% or 10 acres of a biologically unique or sensitive natural community, whichever is less, would be a significant impact. Implementation of Mitigation Measure 7-2 would reduce this impact to a less-than-significant level.

Mitigation Measure 7-2: Modify Pre-Application Report and Provide Information on Biologically Unique or Sensitive Natural Communities. The pre-application report shall be revised to include a location for the discharger to indicate whether the land application site contains biologically unique or sensitive natural communities. If the application site contains these habitats, the discharger must submit a biological report with the pre-application report that indicates measures to mitigate or avoid impacts on these habitats. The report must be prepared by a qualified biologist.

Impact: Potential for Physiological Effects of Biosolids Application on Wildlife

Animals could potentially be affected by pathogens, organic compounds, or trace metals present in biosolids. Because sewage treatment processes are designed to reduce the concentrations of pathogens contained in biosolids, the risk to wildlife is low (Henry and Harrison 1991). Additionally, the limited research conducted on the possible effects of trace organic compounds in wildlife exposed to biosolids showed no effect on the reproductive success of bird species and deer mice (Martin et al. 1987). However, biosolids application may affect wildlife by introducing trace metals into the environment. Exposure pathways for wildlife include foraging on plants that have incorporated metals into their tissues, breathing small quantities of aerosol mist during overhead application, drinking contaminated water, breathing dust from dried sludge while foraging, and ingesting soils amended with biosolids (Fitzgerald 1980).

Metal accumulation in wildlife exposed to biosolids can vary with application rates, biosolids quality, and type and quantity of forage. Research does not show clear trends of accumulation; however, most metal accumulation tends to be in the livers and kidneys more than in other tissues. Of all the potential trace metals found in biosolids, cadmium appears to have the greatest potential for harm because of its toxicity and bioavailability (Henry and Harrison 1991).

Studies indicate that trace metals from biosolids application to forest land accumulate at differing degrees in different wildlife species (Henry and Harrison 1991). Small mammals, including meadow voles, deer mice, and cottontail rabbits, appeared to have the greatest exposure and subsequent higher levels of trace metals when compared to birds (Henry and Harrison 1991). However, large concentrations of wintering waterfowl and shorebirds forage in the Central Valley on crops such as rice and could be exposed to higher-than-normal levels of trace metals by eating invertebrates and vegetation. Because birds are highly mobile, can forage offsite, and are present for only part of the year, exposure to trace metals and risk of trace metal toxicity would be reduced.

The GO states that biosolids cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste. Additionally, the material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations on nine trace metals regulated under the Part 503 regulations and one additional metal (chromium) added under the GO. Therefore, discharge prohibitions in the GO for trace metals will keep any potential impact to a less-than-significant level. No further mitigation would be required.

Impacts of Other Activities

Silvicultural Use

The use of biosolids for silvicultural use could result in greater impacts on biological resources as those described above under “Impacts on Agricultural Use” because silvicultural sites could have more existing habitat than an agricultural site. Therefore, the potential exists for land application activities to affect special-status plant and wildlife species or biologically unique or sensitive communities. Mitigation Measures 7-1 and 7-2, described above, would reduce these potential impacts to a less-than- significant level.

Land Reclamation

Biosolids application could result in beneficial effects in areas where reclamation activities would restore the natural vegetation or where application enhances forage for herbivores. The purpose of biosolids application is to introduce or restore organic material and nutrients to the soil to promote soil fertility and water retention. Restoring the vegetation would provide cover for wildlife. Increasing the nutrients available to plants would enhance the value of forage for herbivorous species. Biosolids application could have an impact on special-status plants or wildlife or biologically unique or sensitive natural communities where reclamation activities would occur in natural terrestrial habitats, such as in degraded rangeland. These impacts will be addressed by Mitigation Measures 7-1 and 7-2. In general, however, biosolids application for reclamation activities would be a beneficial impact and would require no mitigation.

Chapter 8. Fish

Environmental Setting

Several of the nine California RWQCB regions (Figure 1-1) are similar in either fish species or aquatic habitat present; therefore, the fisheries setting is discussed according to three regional groupings: Pacific coast (Regions 1-4, 8, and 9); western Sierra Nevada and Central and San Joaquin Valleys (Region 5); and eastern Sierra Nevada, Great Basin, and Colorado River (Regions 6 and 7).

Regions 1-4, 8, and 9: Pacific Coast

Regions 1-4, 8, and 9 encompass all the Pacific coastal drainages in California. In addition, San Francisco, San Pablo, and Suisun Bay drainages are included in Region 2, as is part of the Sacramento-San Joaquin Delta. Coastal California streams, which usually have steep drainages and a high gradient, are characterized by extreme seasonal variation in flow (Moyle 1976). Many flood in winter but become intermittent in summer. Fishes native to these streams are adapted to these conditions. The northern regions (i.e., Regions 1 and 2) receive the most annual rainfall (see Chapter 3, "Soils, Hydrology, and Water Quality"), and streams in these regions are more likely to be colder and perennial compared to those in the southern regions (Moyle 1976). Despite the latitudinal differences, protected fish species in most of the coastal regions tend to include tidewater goby in the lower reaches of streams; anadromous chinook and coho salmon, steelhead, and lampreys in the middle reaches (anadromous species live most of their adult life in the ocean but return to fresh water to spawn); and a few suckers and minnows in the middle and upper reaches.

Special Considerations

The GO prohibits application of biosolids in three areas of Region 2: the Sacramento-San Joaquin Delta, as defined in Water Code Section 12220; Suisun Marsh, as defined in Public Resources Code Section 29101; and the jurisdiction of the San Francisco Bay Conservation and Development Commission, as defined in Government Code Section 66610. The GO also prohibits application of biosolids in the Santa Monica Mountains Zone of Region 4, as defined by the Government Code, Section 33105, and in the California Coastal Zone, which is generally defined in the Public Resources Code, Section 5093.5, as land extending 1,000 yards inland from the mean high tide line of the ocean. These prohibitions would avoid potential impacts on protected fishes located in these areas (e.g., Delta and longfin smelt and Sacramento splittail in the Sacramento-San Joaquin Delta [Region 2] and southern steelhead in Malibu Creek [Region 4]).

Region 5: Western Sierra Nevada and Central and San Joaquin Valleys

Streams of the western Sierra Nevada are included in the Sacramento-San Joaquin River drainage, which ultimately empties into San Francisco Bay. This large drainage is isolated by mountains on all sides and supports a variety of aquatic habitat types; consequently, it contains several endemic fish species (Moyle 1976). Streamflow depends primarily on snowmelt but is moderated by major dams on all large rivers except the Cosumnes River. Flow tends to be more constant than in coastal streams; it is greatest in winter and spring and least in summer and fall. Protected species inhabiting western Sierra Nevada and Central and San Joaquin Valley streams and rivers include steelhead, salmon, trout, minnows, suckers, sculpins, and Sacramento perch. Clear Lake (Lake County), the largest natural lake in California, is located in Region 5, as is part of the Sacramento-San Joaquin Delta. Clear Lake is important habitat for Sacramento perch and other native fishes.

Special Considerations

The GO prohibits application of biosolids in the Sacramento-San Joaquin Delta, as defined in Water Code Section 12220. Impacts on protected fish species (e.g., Delta and longfin smelt, Sacramento splittail) occupying this area therefore would be avoided.

Regions 6 and 7: Eastern Sierra Nevada, Great Basin, and Colorado River

Regions 6 and 7 encompass the portion of California that is drained internally. Except for water in the Colorado River drainage in Region 7, surface water from these regions does not flow to the sea. Streams tend to originate in mountainous areas and flow downstream into the Great Basin, where the water ultimately evaporates. This typically results in terminal lakes (e.g., Mono Lake) or sinks that are quite warm and saline (Moyle 1976). Many Great Basin fish (e.g., pupfish) are adapted to extreme conditions. Trout are present at higher elevations although steep gradients often result in cool water temperatures, and hence the presence of trout, at lower elevations (Moyle 1976). Lake Tahoe and Eagle Lake in Region 6 are cool, higher elevation lakes that are important habitat for native fishes. As with the Sacramento-San Joaquin River drainage (i.e., Region 5), isolation of many portions of the eastern Sierra Nevada and Great Basin areas of California has resulted in several endemic fish species. The Colorado River drains a large portion of the southwestern United States and empties into the Gulf of California. Historically, it was deep and sediment laden with areas of strong current and marshes (Moyle 1976). Fish species native to the California portion of the Colorado River are well adapted to these conditions. However, aquatic habitat in the Colorado River has been greatly degraded by construction of dams and use of water for irrigation, which has reduced fish populations; all the native fishes in the California portion are now protected. Overall, protected fish species found in Regions 6 and 7 include trout, minnows, suckers, and pupfish.

Special Considerations

The GO prohibits application of biosolids in specified locations within six areas of Region 6: Glenshire and Devonshire subdivisions, Town of Truckee; the area southwest of Piute Creek and north of the Susan River; Eagle Lake basin; the Mono-Owens Planning Area; the Antelope Valley Planning Area; and the Mojave River Planning Area. Impacts on protected fish species occupying these areas therefore would be reduced or avoided. Regions 6 and 7 contain several protected species that not only are endemic but have very small ranges or population sizes. These species are inherently at higher risk of extinction. In addition, in the internally drained areas of Regions 6 and 7, pollutants are more likely to become concentrated in terminal lakes and sinks because they are not flushed into the ocean.

Impacts and Mitigation Measures

Approach and Methods

The GO was reviewed to identify setbacks from water bodies and other provisions related to water quality. Chapter 3, “Soils, Hydrology, and Water Quality”, was reviewed to determine the GO’s effects on surface water quality. Impacts on fisheries were assessed based on water quality effects.

Thresholds of Significance

Impacts on aquatic resources were considered significant if they would:

- directly or indirectly reduce the growth, survival, or reproductive success of individuals or species listed or proposed for listing as threatened or endangered under the federal or California ESA;
- directly or indirectly reduce the growth, survival, or reproductive success of substantial proportions of rare or special-concern species populations, or regionally important commercial or game species; or
- substantially reduce the quality and quantity of important habitat for fish species or their prey.

Impacts of Agricultural Use

Impact: Potential for Acute Toxicity to Fish from Leaching of Biosolids Constituents from Application Sites to Surface Waters

Surface water increases in metals, organic compounds, and nitrates resulting from land application of biosolids could be acutely toxic to fisheries, depending on the quantity of the contaminant that enters the surface water and the susceptibility of the fish species to the increased level of metals, organic compounds, and nitrates. For these elements to enter the surface water, they would have to leach into the groundwater and travel laterally at least 100 feet (because the GO prohibits land application of biosolids within 100 feet of surface waters). As described in Chapter 3, “Soils, Hydrology, and Water Quality”, in most situations, land application of biosolids would not result in surface water quality degradation resulting from leaching of trace metals, organic compounds, or nitrates into the groundwater. In areas with sandy soils underlain by shallow hardpans (present in some desert regions of southern California), leachate could travel greater distances. Small water bodies with no external drainage that are habitat for protected fish species (such as pupfish) could be adversely affected. In these unique conditions, the effect could be potentially significant.

Mitigation Measure 8-1: Increase Setback from Enclosed Water Bodies If Pupfish Are Present. Proposed land applications in the habitat range of the pupfish should be reviewed for their proximity to enclosed water bodies that could be occupied by pupfish. If such water bodies are near the land application areas, setbacks of 500 feet should be required.

Impact: Potential for Reduced Fisheries Productivity Resulting from Runoff and Erosion

Land application of biosolids could increase soil erosion and thus increase sedimentation and turbidity of aquatic habitats. Temporary discharges of sediment and suspended solids could cause direct and indirect impacts on fisheries resources. Direct impacts on fish species could include increased mortality and reduced feeding opportunities for sight-feeding fish. Indirect impacts could include asphyxiation of developing eggs under sediments, degradation of spawning and rearing habitats, and decreased food production. However, land application is not expected to result in reduced fisheries productivity because increased sedimentation and water quality degradation in water bodies adjacent to land application sites would be controlled. Provisions in the GO require 100-foot setbacks from water bodies and require erosion control plans to be prepared if slopes exceed 10%. They also prohibit the land application of biosolids that could cause or threaten to cause pollution, as defined in Section 13050 of the California Water Code. Surface water runoff from a permitted application site must be controlled on-site for 30 days following application unless a 33-foot buffer strip of vegetation is present to filter the discharge. In addition, the GO prohibits the application of biosolids in areas where biosolids are subject to erosion or where washout offsite could occur. Generally, the proposed project is not expected to result in runoff and erosion. Runoff and erosion could occur in extreme situations (low-probability storm events, accidental spills), but the potential is low. This impact is considered potentially significant.

Mitigation 4-1. Mitigation Measure 4-1 in Chapter 4, “Land Productivity”, would reduce this impact to a less-than-significant level.

Impacts of Other Activities

Horticultural Use

The use of biosolids for horticultural purposes (e.g., road medians, parks, and golf courses) would result in impacts on fisheries resources similar to those described above under “Agricultural Use” because the same setback from the application site to water bodies (100 feet) would be required, erosion would not affect adjacent water bodies because Mitigation Measure 4-1 would be implemented (thus, no increase in turbidity would occur), and no degradation of water quality would occur. In addition, horticultural use of biosolids as a planting or potting medium in large nursery operations would not result in impacts on fisheries resources.

Silvicultural Use

The use of biosolids for silvicultural use generally would pose a risk of impacts on fisheries resources similar to those described above under "Agricultural Use" because the same provisions required for agricultural use would be required for commercial tree operations. In some cases, silvicultural use of biosolids could have a greater risk of impact than those described above for "Agricultural Use" because slopes may be greater at these sites and the application sites could be closer to coldwater fisheries that are less tolerant of eutrophication. Under the GO, if biosolids are applied to ground surfaces having a slope greater than 10%, a report would need to be prepared that identifies specific application and management practices necessary to ensure containment of the biosolids on the application site and to prevent soil erosion. These reports shall be prepared by a certified agronomist, registered agricultural engineer, registered civil engineer, or a certified professional erosion and sediment control specialist and submitted to the RWQCB for approval before the biosolids are applied. Because erosion control plans would be prepared for areas where slopes are greater than 10%, the potential for impacts on fisheries productivity is considered less than significant.

Land Reclamation

The use of biosolids for land reclamation would result in impacts on fisheries resources that are generally similar to those described above under "Agricultural Use" because the same setback from the application site to water bodies (100 feet) would be required, erosion would not affect adjacent water bodies (thus, no increase in turbidity would occur), and water quality would not be degraded. As described above under "Silvicultural Use", an erosion control plan would be prepared for application sites that have slopes greater than 10% (therefore, although mining reclamation sites could be located in more mountainous areas than agricultural sites, erosion would not affect adjacent water bodies and fish resources). In addition, the use of biosolids as a final cover material at landfills would not result in impacts on fisheries resources because these resources would not be present at the landfill.

Chapter 9. Traffic

Environmental Setting

State Highway System

The State of California has more than 15,000 miles of state highways (e.g., interstate highways, U.S. highways, and state routes). The existing state highway system accommodates an estimated 17.3 million automobiles and 5.5 million commercial vehicles that, combined, travel over 140 billion vehicle-miles annually (California Department of Transportation 1999a). Truck volumes along the state highway system have increased proportionately to the state's overall growth, particularly on rural roadways and roadways that provide access to seaports and border crossings.

Roadway Maintenance and Funding

The California Department of Transportation (Caltrans) is responsible for maintaining the state highway system through a rehabilitation program and a maintenance program. Pavement rehabilitation improves the roadway and is designed to extend its service life an additional 10 years. Maintenance activities keep the roadway safe and serviceable until rehabilitation is needed. Pavement maintenance activities include: routine maintenance (day-to-day maintenance of roadway), major maintenance (planned work that is generally done under contract) and preventive maintenance (treatments applied when pavement distress is minimal to extend its period of usefulness). Roadway maintenance is primarily funded through the state's tax on the sale of gasoline.

As described above, the California state highway system comprise over 15,000 center-line miles of highway, with over 49,000 lane miles of pavement. Currently, 14,000 lane miles of highway pavement require corrective maintenance or rehabilitation, which amount to nearly 30% of the state highway system (California Department of Transportation 1999b).

Local Roadway System

The local roadway system comprises roads that are under the jurisdiction of a particular city or county public works department. Local roads provide access to adjacent parcels and also provide a route for traffic from the urbanized areas of the county onto the state highway system.

The primary source of funding for roadway maintenance is also through the state's tax on the sale of gasoline; however, other funding sources such as local taxes (e.g., property taxes) may be allocated for roadway maintenance (Pope pers. comm.). Additionally, projects that involve the generation of large volumes of truck traffic on local roadways may be required to contribute a fee that is applied to maintenance costs resulting from the additional traffic's damage to the roadway surface. For example, Kern County assesses a roadway maintenance fee, on a per-ton basis, to transporters hauling hazardous material to a storage site in the county (Pope pers. comm.).

Regulatory Setting

The primary transportation-related regulatory issues that are described below involve weight and load limitations for trucks. Biosolids are not considered a "hazardous waste" material and consequently many local jurisdictions do not have regulations or controls regarding the transport of biosolids.

State highway weight and load limitations are specified in the California Vehicle Code, Sections 35550 to 35559. The following general provisions apply to the project:

- The gross weight imposed upon the highway by the wheels on any axle of a vehicle shall not exceed 20,000 pounds and the gross weight upon any one wheel, or wheels, supporting one end of an axle, and resting upon the roadway, shall not exceed 10,500 pounds.

- The maximum wheel load is the lesser of the following: a) the load limit established by the tire manufacturer, or b) a load of 620 pounds per lateral inch of tire width, as determined by the manufacturer's rated tire width.

For vehicles with trailers or semi-trailer, the following provision applies:

- The gross weight imposed upon the highway by the wheels on any one axle of a vehicle shall not exceed 18,000 pounds and the gross weight upon any one wheel, or wheels, supporting one end of an axle and resting upon the roadway, shall not exceed 9,500 pounds, except that the gross weight imposed upon the highway by the wheels on any front steering axle of a motor vehicle shall not exceed 12,500 pounds, according to California Vehicle Code Sections 35550-35559.

These weight and load limitations for state highways would also apply to county roadways if no limitations were specified by the county.

Impacts and Mitigation Measures

Approach and Methods

Traffic impacts associated with implementation of the GO have been evaluated at a program level of detail using available information from existing biosolids application operations. Assumptions regarding the types of transport used and the distances traveled were used to assess the overall significance of project impacts.

Project trip generation is based on an estimate of the number of trucks that would result from a typical daily application of biosolids at a given site. Typically, heavy trucks, with an 80,000-pound weight limit, are used to transport biosolids. With each truck capable of hauling about 25 tons of biosolids, it is estimated that an average per-acre application would generate two round truck trips (Harrison pers. comm.). The total area (number of acres) treated with biosolids on a daily basis at a given site will vary with the technical capabilities of the applicator. Some of the larger operations in the Central Valley have the ability to apply between 1,500 and 2,000 tons per day (Skinner pers. comm.); however, most applicators apply between 40 and 60 acres on a given day (Price pers. comm.). Assuming that biosolids can be applied to an average of 40-60 acres on any given day, it is estimated that an average of 80-120 average daily truck trips would be generated on a given roadway for a short period.

Thresholds of Significance

According to State CEQA Guidelines and professional judgment, a project is considered to have a significant impact on traffic if it would:

- cause an increase in traffic that is substantial in relation to the existing traffic load and capacity of the roadway system,

- substantially increase the traffic delay experienced by drivers,
- result in substantial deterioration of the roadway surface, or
- expose people to roadway safety hazards.

Additionally, the following screening criterion is recommended by the Institute of Transportation Engineers (1989) for assessing the effects of development projects that create permanent traffic increases:

- In lieu of other locally preferred thresholds, a traffic access/impact study should be conducted whenever a proposed development will generate 100 or more added (new) peak direction trips to or from the site during the adjacent roadway's peak hours or the development's peak hours.

For construction projects that create temporary traffic increases, this criterion is considered conservative. However, this criterion is intended to assess the effect of a traffic mix consisting primarily of automobiles and lightweight trucks. To account for the large percentage of heavy trucks associated with the proposed action, the threshold level would be reduced to 50 new peak-direction trips. Therefore, project-related traffic is considered significant if transporting biosolids to an application site would cause a substantial increase in traffic volumes, defined as the generation of 50 or more trips per hour.

Impacts of Agricultural Use

Impact: Potential Increase in Traffic Resulting from the Transport of Biosolids

Lands application projects permitted under the GO have the potential to generate an additional 80-120 or more average daily round trips on a given roadway. Project-related traffic would occur throughout the day and is not expected to exceed the threshold of 50 trips per hour. This impact is considered less than significant.

Mitigation: No mitigation is required.

Impact: Deterioration of Roadway Surfaces

Land application projects permitted under the GO have the potential to result in an additional 80-120 or more daily project-related truck trips on a given roadway. The increase in traffic generated in the area of a land-application site would be short term because the increased traffic would occur only when the biosolids are being delivered and applied. As described above, the number of average daily truck trips would not change significantly on existing state or local roadways (which are maintained and will continue to be maintained by Caltrans or local jurisdictions). Because the number of average daily truck trips will not change significantly on the roadway system, no additional maintenance requirements are anticipated for state or local roadways; therefore, this impact is considered less than significant.

Impact: Potential for Roadway Safety Hazards Resulting from Accidental Spills

The accidental spill of biosolids along project-related access roads could create potential safety hazards and traffic delays for other motorists. However, because under the GO trucks transporting biosolids are required to be leakproof and covered, the potential for accidental spill of biosolids is very low (it would occur only if there was a traffic accident). Additionally, a Spill Prevention Plan must be submitted with the NOI and each truck driver is required to know how to carry out the emergency measures described in the Spill Prevention Plan (therefore reducing roadway hazards if an accidental spill were to occur). Because of the low probability of accidental spills during the transport of biosolids, this impact is considered less than significant.

Mitigation. No mitigation is required.

Impacts of Other Activities

Horticultural Use

The use of biosolids for horticultural purposes would generally result in impacts on traffic similar to those described above under "Agricultural Use" because, although existing traffic conditions vary in the areas where horticultural activities would occur under the GO (the existing traffic levels could be greater if the site is closer to urban centers), the same amount of traffic would be generated for the transportation of biosolids to the horticultural sites (for large road medians, parks, and golf course projects) as described under"Agricultural Use". Therefore, the significance threshold of 50 trips per hour would not be exceeded. Additionally, the delivery of biosolids to large nursery operations would not result in exceedance of the significance thresholds for project-related traffic.

Silvicultural Use

The use of biosolids for silvicultural purposes would result in traffic impacts similar to those described above under "Agricultural Use". Existing traffic conditions in silvicultural areas would be similar to conditions where agricultural land application would occur, and the same amount of traffic would be generated for the transportation of biosolids to the silvicultural sites (commercial tree farms) as described under "Agricultural Use".

Land Reclamation

The use of biosolids for land reclamation would result in impacts on traffic similar to those described above under "Agricultural Use" because existing traffic conditions near of reclamation sites or soil borrow areas are expected to be similar to those for agricultural areas. Additionally, the same amount of traffic would be generated for the delivery of biosolids to a land reclamation site as to an agricultural site; therefore, the significance threshold of 50 trips per hour would likely not be exceeded.

Chapter 10. Air Quality

Environmental Setting

The environmental setting first identifies the air quality criteria pollutants of concern in California and compares them to pollutants that are emitted during biosolids transport and application. Nuisance pollutants, including odors and wind-blown dust, are also described. This discussion explains California's climate and meteorology and their effect on air quality.

Pollutants of Concern

The GO applies to lands in each of California's 15 air basins (See Figure 10-1). Except for the Lake County Air Basin, each of the 15 air basins has violated either the state or federal ambient air quality standards shown in Table 10-1.

Of the pollutants for which ambient air quality standards have been developed, those emitted in the greatest quantities by biosolids transport and application include carbon monoxide (CO), inhalable particulates (PM10 and PM2.5), and the ozone precursors (oxides of nitrogen [NO_x] and reactive organic gases [ROG]).

These pollutants are emitted primarily as exhaust from trucks used to transport biosolids from wastewater treatment plants to land application sites and by biosolids spreaders.

Fugitive dust is also generated from trucks traveling on paved and unpaved roads and by biosolids spreaders operating at farm sites.

Attainment/Nonattainment Status

Table 10-2 shows the attainment versus nonattainment status for the 15 California air basins with regard to the pollutants of most concern from biosolids application. In 1998, 76% of all biosolids application within California occurred in the Central Valley (64% within the San Joaquin Valley Air Basin and 12% within the Sacramento Valley Air Basin). Only 5% of total statewide biosolids application occurred within the San Francisco Bay Area Air Basin. The southern California air basins (South Coast Air District, San Diego Air Basin, Mojave Desert Air Basin, and Salton Sea Air Basin) were combined for 17.8% of statewide biosolids application. No other areas of California had more than 1% of total statewide biosolids application.

A comparison of the attainment/nonattainment status of the 15 air basins listed in Table 10-2 with the quantity of biosolids applied within California shows that each of the areas with substantial biosolids application are nonattainment for state and federal ozone standards. With the exception of the San Francisco Bay Area, those areas are also nonattainment for the state and federal PM10 standards. Consequently, the following analysis focuses on ozone and PM10. CO, which is also emitted in vehicle exhaust, is generally not a health concern in rural, agricultural areas where biosolids are typically applied.

Ozone

Ozone is a regional pollutant. It is not emitted directly into the air, but is formed by a photochemical reaction in the atmosphere. Ozone precursors, which include ROG and NO_x, react in the atmosphere in the presence of sunlight to form ozone. Both ROG and NO_x are emitted by motor vehicles. Because photochemical reaction rates depend on the intensity of ultraviolet light and air temperature, ozone is primarily a summer air-pollution problem and because photochemical reactions take time to occur, high ozone levels often occur downwind of the emission source. Ozone is a respiratory irritant that increases susceptibility to respiratory infections. Ozone is also an oxidant and can cause substantial damage to vegetation and other materials.

State and federal ozone standards have been set for 1-hour averaging times (see Table 10-1). In July 1997, the U.S. Environmental Protection Agency (EPA) also added an 8-hour averaging time for ozone.

Particulate Matter

Health concerns associated with suspended particulate matter focus on those particles small enough to reach the lungs when inhaled (i.e., 10 microns or less in diameter). Consequently, both the federal and state air quality standards for particulate matter apply only to particulate matter that fit this criteria (referred to as PM10).

State and federal PM10 standards have been established for 24-hour and annual averaging times (see Table 10-1). In July 1997, the EPA also added 24-hour and 8-hour standards for fine particulates defined as particulate matter 2.5 microns or less in diameter (PM2.5). Both PM10 and PM2.5 are present in motor vehicle exhaust and are released when dust is kicked up by moving vehicles.

Jones & Stokes Associates, Inc.

Figure 10-1
California Air Basins

Table 10-1.
Ambient Air Quality Standards Applicable in California

Pollutant	Symbol	Average Time	Standard, as parts per million: Californi a	Standard, as parts per million: National	Standard, as micrograms per cubic meter: Californi a	Standard, as micrograms per cubic meter: Nationa l	Violation Criteria: California	Violation Criteria: National
Ozone	O_3	8 hours	N/A	0.08	N/A	160	N/A	If 3-year average of annual third-highest daily 8-hour maximum exceeds standard
		1 hour	0.09	0.12	180	235	If exceeded	If exceeded on more than 3 days in 3 years
Carbon monoxide	CO	8 hours	9.0	9	10,000	10,000	If exceeded	If exceeded on more than 1 day per year
		1 hour	20	35	23,000	40,000	If exceeded	If exceeded on more than 1 day per year
(Lake Tahoe only)		8 hours	6	N/A	7,000	N/A	If exceeded	N/A
Nitrogen dioxide	NO_2	Annual average	N/A	0.053	N/A	100	N/A	If exceeded
		1 hour	0.25	N/A	470	N/A	If exceeded	N/A
Sulfur dioxide	SO_2	Annual average	N/A	0.03	N/A	80	N/A	If exceeded
		24 hours	0.04	0.14	105	365	If exceeded	If exceeded on more than 1 day per year
		1 hour	0.25	N/A	655	N/A	N/A	N/A
Hydrogen sulfide	H_2S	1 hour	0.03	N/A	42	N/A	If equaled or exceeded	N/A
Vinyl chloride	C_2H_3Cl	24 hours	0.010	N/A	26	N/A	If equaled or exceeded	N/A
Inhalable particulate matter	PM10	Annual geometric mean	N/A	N/A	30	N/A	If exceeded	N/A
		Annual arithmetic mean	N/A	N/A	N/A	50	N/A	If exceeded
		24 hours	N/A	N/A	50	150	N/A	If exceeded on more than 1 day per year

Table 10-1. Continued

Pollutant	Symbol	Average Time	Standard, as parts per million		Standard, as micrograms per cubic meter		Violation Criteria	
			California	National	California	National	California	National
Fine particulate matter	PM2.5	Annual arithmetic mean	N/A	N/A	N/A	15	N/A	If spatial average exceeded on more than 3 days in 3 years
		24 hours	N/A	N/A	N/A	65	N/A	If exceeds 98th percentile of concentrations in a year
Sulfate particles	SO_4	24 hours	N/A	N/A	25	N/A	If equaled or exceeded	N/A
Lead particles	Pb	Calendar quarter	N/A	N/A	N/A	1.5	N/A	If exceeded no more than 1 day per year
		30 days	N/A	N/A	1.5	N/A	If equaled or exceeded	N/A

Notes: All standards are based on measurements at 25EC and 1 atmosphere pressure.
National standards shown are the primary (health effects) standards.
N/A = not applicable.

Table 10-2
Air Quality Requirement Attainment Status by Pollutant and Air Basin

Air Basin	State Ozone	Federal Ozone	State PM10	Federal PM10	State CO	Federal CO
North Coast Air Basin	A	A	N	A	A	A
San Francisco Bay Area Air Basin	N	N	N	A	A	A
North Central Coast Air Basin	T	A	N	A	A	A
South Central Coast Air Basin	N	N	N	A	A	A
South Coast Air Basin	N	N	N	N	N	N
San Diego Air Basin	N	N	N	A	A	A
Northeast Plateau Air Basin	A	A	N	A	A	A
Sacramento Valley Air Basin	N	N	N	N	A	A
San Joaquin Valley Air Basin	N	N	N	N	A	A
Great Basin Valleys Air Basin	T	A	N	N	A	A
Mojave Desert Air Basin	N	N	N	N	A	A
Salton Sea Air Basin	N	N	N	N	N	A
Mountain Counties Air Basin	N	N	N	A	A	A
Lake County Air Basin	A	A	A	A	A	A
Lake Tahoe Air Basin	A	A	N	A	A	A

Notes: A = Attainment
N = Nonattainment
T = Transitional

Air basins classified as nonattainment areas have at least one area within that basin that has shown a violation of the relevant ambient standard.

Source: California Air Resources Board 1998.

Nuisance Pollutants

Nuisance pollutants that could potentially be released by implementation of the proposed project include odors and visible dust. These pollutants are regulated by nuisance rules incorporated into air district regulations. The purpose of nuisance rules is to protect the health and safety of the public by preventing the release of air contaminants that endanger the comfort, health, or safety of the public. However, nuisance rules are specifically written to exclude odors emanating from agricultural operations related to crop growing and maintenance.

California Climate and Meteorology

Because of the strong influence of the Pacific Ocean, the Coast Range, and the Sierra/Nevada Mountains, variations in climate in California run in a general east-to-west direction. California's climate varies from Mediterranean (most of the State) to steppe (scattered foothill areas), to alpine (high Sierra), to desert (Colorado and Mojave Deserts).

The Sierra Nevada and Cascade Ranges act as barriers to the passage of air masses. During summer, California is protected from much of the hot, dry air masses that develop over the central United States. Because of these barriers, and California's western border of the Pacific Ocean, summer weather in portions of the State is generally milder than that in the rest of the country and is characterized by dry, sunny conditions with infrequent rainfall.

In winter, the same mountain ranges prevent cold, dry air masses from moving into California from the central areas of the U.S. Consequently, winters in California are also milder than would be expected at these latitudes.

Regulatory Setting

Federal Regulatory Environment

The federal Clean Air Act (FCAA) was passed in 1963 by the U.S. Congress and has been amended several times, most recently in 1990. The FCAA required the EPA to establish national ambient air quality standards for air pollutants or air pollutant groups that pose a threat to human health or welfare. EPA established the National Ambient Air Quality Standard (NAAQS) for six criteria pollutants: ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead, particulate matter and CO (see Table 10-1). Two separate standards have been set for particulate matter, one for particulate matter 10 microns or less in diameter (PM10), the other for particulate matter 2.5 microns or less in diameter (PM2.5).

Air basins that have not violated an ambient air quality standard are considered to be in attainment for that standard. Conversely, air basins with recorded violations of an ambient air quality standard are classified as nonattainment areas for that pollutant. Most air basins are classified as nonattainment areas for one or more pollutants. Also, for specific pollutants such as PM10, California has more stringent standards than those imposed by federal regulations. Consequently, an air basin may be classified as a nonattainment area for the state PM10 standard although it is in attainment for the federal PM10 standard.

Air basins classified as nonattainment areas for the NAAQS must prepare state implementation plans (SIPs) that describe the specific steps that will be taken to bring the nonattainment area into compliance. Those steps primarily include rules and regulations to limit air emissions from specific stationary and mobile sources. The FCAA contains specific dates by which the NAAQS must be met before federal sanctions can be imposed.

California Regulatory Environment

The California Clean Air Act (CCAA) of 1988 differs from the FCAA in that there are no sanctions or specific deadlines for attainment of the California Ambient Air Quality Standards (CAAQS), also shown in Table 10-1. The CAAQS were enacted in response to the need for new air quality requirements. Under this act, air quality attainment is required at the earliest practicable date and reasonable progress toward attainment must be made each year.

Similar to the FCAA, the CCAA requires attainment plans for designated nonattainment areas, which are areas that currently violate the ambient air quality standards. The California Air Resources Board (ARB) is responsible for preparing the plans for meeting the NAAQS and CAAQS and has delegated to the California air districts the responsibility for preparing air quality attainment plans. The CCAA, unlike the FCAA, does not require an air quality attainment plan for areas designated as nonattainment for the PM10 CAAQS.

Local Air Quality Regulatory Environment

The ARB has delegated much of its air pollution control authority to local air pollution control districts and air quality management districts. California's 15 air basins are identified in Figure 10-1. For some air basins covering more than one county, a unified air district has been formed to manage air quality issues throughout the basin. In other multicounty air basins, individual county air districts manage air quality in only their county.

Individual air districts or groups of air districts prepare air quality management plans designed to bring an air basin into compliance for nonattainment area pollutants. Those plans are submitted to the ARB for approval and usually contain an emissions inventory and a list of rules proposed for adoption.

Impacts and Mitigation Measures

Methods

Air quality impacts associated with treating biosolids would result from the use of biosolids hauling and application equipment, odors resulting from biosolids storage and application, wind-blown emissions of particulate matter (PM10 and PM2.5) and toxic air pollutants, and fugitive dust resulting from vehicle operations.

Vehicle exhaust and fugitive dust emissions were estimated using the California Air Resources Board's EMFAC7G vehicle emission factor model included within the URBEMIS7G model. The vehicle emissions analysis was used to determine the number of vehicle miles traveled (VMT) per day that could be generated by biosolids operations without exceeding the air emission significance thresholds (described below).

To control odor associated with biosolids operations, the GO limits the maximum amount of onsite storage to 7 days and requires that storage areas be covered between October 1 and April 30. Additionally, biosolids must be transported in covered, leakproof vehicles. Both staging and application of biosolids must comply with several buffer-zone requirements that limit storage and application to 10 feet from property lines, 50 feet from public roads, and 500 feet from residential buildings.

The GO also prohibits the release of any visible airborne particles from the application site during biosolids application or during incorporation of biosolids into the soil. This requirement will prevent the release of PM10 and its constituents classified as hazardous air contaminants.

Thresholds of Significance

For site-specific projects, criteria established by the applicable air quality management district or air pollution control district are used to determine the significance of impacts on air quality. For this program air quality analysis, implementing the GO would result in a significant impact on air quality if it would:

- conflict with or obstruct implementation of the applicable air quality plan,
- violate any air quality standard or contribute substantially to an existing or projected air quality violation,
- result in a considerable net increase of any criteria pollutant for which the project region is in nonattainment under an applicable federal or state ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors),
- expose sensitive receptors to substantial pollutant concentrations, or
- create objectionable odors affecting a substantial number of people.

Emissions are considered significant if they exceed the most stringent significance thresholds for air districts where biosolids are applied in the greatest volumes (San Joaquin, Sacramento, South Coast, San Diego). The most stringent thresholds for those air basins are 55 pounds per day for ROG and NO_x, 550 pounds per day for CO and 150 pounds per day for PM10 (Sacramento Air Quality Management District 1994, South Coast Air Quality Management District 1993, San Joaquin Valley Unified Air Pollution Control District 1998, Reider pers. comm.).

Impacts of Agricultural Use

Impact: Generation of NO_x and PM10 from Biosolids Transport Vehicles and Biosolids Spreaders for Vehicle Travel Exceeding 4,800 VMT per day and/or 67 VMT per Day on Unpaved Roads

Transporting biosolids from wastewater treatment plants to farms and spreading and mixing biosolids into the soil would increase vehicle emissions and fugitive dust from the use of heavy-duty transport trucks and farm vehicles. As shown in Table 10-3, biosolids transport vehicle travel exceeding 4,800 VMT per day and/or 67 VMT per day on unpaved roads would exceed the significance thresholds for NO_x and PM10 for air districts where biosolids are applied in the greatest volumes (San Joaquin, Sacramento, South Coast, and San Diego). Vehicle trips that would generate less than 4,800 VMT per day or 67 VMP per day on unpaved roads would not exceed significance thresholds for the air districts where biosolids are applied in the greatest volumes.

Table 10-3.
Vehicle Emissions from Biosolids Operations (pounds/day)

	ROG	NO_x	CO	PM10
Vehicle Exhaust	7.8	55.7	82.8	2.5
Fugitive Dust	N/A	N/A	N/A	145.9
Totals	7.8	55.7	82.8	148.4

Notes: N/A = not applicable.

Emission estimates based on the California Air Resources Board's EMFAC7G model (California Air Resources Board 1999). Emissions shown are uncontrolled and assume 4,800 VMT per day of heavy-duty trucks with 98.6% of VMT on paved roads and 1.4% of VMT (67 miles) on unpaved roads.

Mitigation Measure 10-1: Properly Maintain Transport Vehicles in Good Operating Condition and Limit Truck Travel on Paved Roads to 4,800 VMT. Biosolids application projects require the use of heavy-duty trucks to haul biosolids from site generators to application sites. To keep daily NO_x emissions at or under the NO_x significance threshold, trucks must be properly maintained and kept in good operating condition. This mitigation measure will reduce NO_x emissions by 5%, thus reducing emissions to 52.9 pounds per day (assuming 4,800 VMT per day), which is below the significance threshold. This mitigation measure will reduce NO_x emission impacts to a less-than-significant level for projects generating 4800 VMT per day or less. For projects that substantially exceed 4,800 VMT per day, no mitigation is available and, therefore, truck travel must be limited to 4,800 VMT per day.

Mitigation Measure 10-2: Control Fugitive Dust from Unpaved Roads. Delivery of biosolids often requires the use of unpaved roads that can generate substantial amounts of fugitive dust. Biosolids application projects requiring truck travel in excess of 67 VMT per day on unpaved roads would result in significant PM10 impacts. The following mitigation measures would keep daily PM10 emissions at or under the PM10 significance threshold and therefore reduce PM10 impacts to a less-than-significant level:

- Limit truck travel on unpaved roads to 67 VMT per day.

OR

- Apply water or chemical stabilizers that have no secondary ecological effects to unpaved roads in sufficient quantities to prevent visible dust emissions and limit truck travel on unpaved roads to 134 VMT per day. Water and/or chemical stabilizers can reduce dust generation by 50% from uncontrolled levels. Travel on unpaved roads in excess of 134 VMT per day, even with the use of water or chemical stabilizers, will result in emissions exceeding the PM10 significance threshold.

Impact: Exposure of Sensitive Receptors to Odors

The storage and spreading of biosolids would result in the release of odors in the immediate vicinity of the application operations. For storage and application of biosolids, the GO requires a minimum buffer zone of 500 feet from residences and 50 feet from public roads. Additionally, biosolids cannot be stored more than 7 consecutive days before application. These restrictions tend to be more stringent than buffer-zone and biosolids storage requirements at most wastewater treatment plants, which have more and varied sources of odors. Unlike wastewater treatment plants, biosolids application projects represent short-term odor sources. Because of the stringent storage and buffer-zone requirements and the short time period during which odors would be generated at application sites, odor and/or odor complaints would be minimal; therefore, this impact is considered less than significant.

Mitigation Measure: No mitigation is required.

Impact: Biosolids Drift Associated with Wind-Blown Biosolids

The potential exists for wind-blown drift of PM10 and toxic constituents during application of biosolids and when biosolids are being incorporated into the soil; however, most application sites are in low-density agricultural areas where wind-blown dust is not a major issue. Additionally, several regulatory requirements of the GO would minimize biosolids drift. These requirements include the following:

- biosolids cannot be stored in piles for more than 7 days after delivery to the site,
- a minimum buffer zone of 500 feet from residences will be maintained, and
- the release of any visible air-borne particulates from the application site during biosolids application or subsequent to spreading onto the soil will be prohibited.

The prohibition against the release of any visible air-borne particulates from the site would limit biosolids application to periods of low winds and would consequently minimize the potential for biosolids drift. This impact is therefore considered less than significant.

Impacts of Other Activities

Horticultural Use

The use of biosolids for horticultural purposes would result in air quality impacts similar to those described above under "Agricultural Use" because the same amount of emissions and fugitive dust would be generated from transporting and spreading biosolids. Therefore, Mitigation Measures 10-1 and 10-2 would be required to reduce air quality impacts resulting from land application of biosolids to a less-than-significant level. Additionally, vehicle emissions generated from transporting biosolids to large nursery operations would be similar to those described above under "Agricultural Use".

Silvicultural Use

The use of biosolids for silvicultural purposes would result in similar impacts (although the magnitude of impacts could be less if the biosolids are not incorporated into the soil) on air quality as those described above under "Agricultural Use" because the same amount of emissions and fugitive dust would be generated from transporting and spreading biosolids. Therefore, Mitigation Measures 10-1 and 10-2 would be required to reduce air quality impacts resulting from land application of biosolids to a less-than-significant level.

Land Reclamation

The use of biosolids for land reclamation would result in similar impacts on air quality as those described above under "Agricultural Use" because the same amount of emissions and fugitive dust would occur from the transporting and spreading the biosolids. Therefore, Mitigation Measures 10-1 and 10-2 would be required to reduce air quality impacts resulting from land application of biosolids to a less-than-significant level.

Chapter 11. Noise

This chapter analyzes the noise impacts on noise as a result of the GO's regulation of the application of biosolids. Noise-sensitive land uses, existing noise conditions, and regulatory information are also described.

Technical terms and acronyms used in this chapter may not be familiar to the reader. Explanations of these terms, acronyms (including dBA, L_{dn}, and L_{eq}), and background information on environmental acoustics and State and federal noise regulations are provided in Appendix G.

Environmental Setting

Noise-Sensitive Land Uses

Land uses such as residences, health care facilities, public libraries, schools, and parks are typically considered sensitive to noise (sensitive receptors). Land application of biosolids would primarily involve the use of biosolids on traditional agricultural crops, silvicultural or horticultural operations, or in the reclamation of disturbed lands. Because the location of these operations are typically in rural or semirural areas, the primary land uses in the potential application areas would be rural residential and/or agricultural operations. Noise-sensitive land uses would primarily be residences; however, noise-sensitive land uses along the delivery routes may include schools, parks, and/or health care facilities.

Existing Noise Conditions

The noise in the potential application areas is expected to be typical of a quiet rural environment. The predominant sources of noise would include roadway traffic and equipment noise from existing agricultural operations. Other less-dominant sources of noise would include aircraft that occasionally fly overhead and animals such as birds and insects. Noise levels in these types of environments typically are in the range of 45-55 decibels above reference noise, adjusted (dBA).

Regulatory Setting

In California, most cities and counties have adopted noise ordinances, which serve as enforcement mechanisms for controlling noise, and general plan noise elements, which are used as planning guidelines to ensure that long-term noise generated by a source is compatible with adjacent land uses. The California Department of Health Services' (DHS's) Office of Noise Control has studied the correlation of noise levels and their effects on various land uses and has published land use compatibility guidelines for the noise elements of local general plans. The guidelines are the basis for most noise-element land use compatibility guidelines in California.

As more fully described in Appendix G, the noise-element guidelines chart identifies the normally acceptable range for several different land uses. The recommended maximum acceptable noise levels for various land uses are shown below in Table 11-1.

Table 11-1.
Maximum Allowable Ambient Noise Exposure for Various Land Uses

Land Use	Suggested Maximum L_{dn}
Residential - Low Density	60
Residential - High Density	65
Transient Lodging	65
Schools, Libraries, Churches, Hospitals	70
Auditoriums	70
Playgrounds, Parks	70
Commercial	70
Industrial	75

Note: L_{dn} = day-night average sound level.
Source: State of California, Office of Planning & Research 1990.

As shown in Table 11-1, persons in low-density residential settings are most sensitive to noise intrusion, with noise levels of 60 dBA community noise equivalent level (CNEL) and below considered “acceptable”. For land uses such as schools, libraries, churches, hospitals, and parks, acceptable noise levels go up to 70 L_{dn} CNEL. For persons in commercial and industrial settings, acceptable levels of noise go up to 70 and 75 L_{dn} CNEL respectively.

Impacts and Mitigation Measures

Approach and Methods

Noise impacts associated with implementation of the GO have been evaluated at a program level of detail using standard acoustical modeling techniques. Typical source noise levels for activities associated with the transport and application of biosolids and potential distances from these activities to noise-sensitive receptors were used to predict potential noise levels at these receptors. Potential noise levels were then compared to typical criteria to assess the significance of potential impacts.

The transport and application of biosolids would generate noise levels similar to those shown for backhoes and trucks in Table 11-2. Noise levels at 50 feet from the source would range from 80 to 88 dBA and would be similar to noise levels produced by existing agricultural operations. The GO states that application of biosolids would not be allowed within 500 feet of residential uses. Table 11-3 summarizes predicted noise levels at various distances from an application site based on a source noise level of 88 dBA at 50 feet. These estimates of noise levels take into account distance attenuation, attenuation from molecular absorption, and anomalous excess attenuation (Hoover 1996). At 500 feet from the source, application equipment is estimated to generate noise levels of up to 67 dBA (Table 11-3).

**Table 11-2.
Equipment Noise Emission Levels**

Equipment	Typical Noise Level (dBA)
Backhoe	80
Truck	88

Source: Federal Transit Administration 1995.

Table 11-3.
Estimated Project-Related Noise in the Project Area

Distance Attenuation

Distance to Receptor (feet)	Sound Level at Receptor (dBA)
50	88
100	82
200	76
400	69
500	67
600	65
800	63
1,000	60
1,500	56
2,000	53
2,500	50
3,000	47
4,000	43
5,280	39
7,500	32

Notes: The following assumptions were used:

Basic sound level dropoff rate: 6.0 dB per doubling of distance.
Molecular absorption coefficient: 0.7 dB per 1,000 feet.
Anomalous excess attenuation: 1.0 dB per 1,000 feet.
Reference sound level: 88 dBA.
Distance for reference sound level: 50 feet.

Thresholds of Significance

According to the environmental checklist from Appendix G of the State CEQA Guidelines, a project is considered to have a significant noise impact if it would:

- expose people to or generate noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
- expose people to or generate excessive groundborne vibration or groundborne noise levels;
- generate a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project; or
- generate a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

Section 15064 (I) of the State CEQA Guidelines states that a change in the environment is not a significant effect if the change complies with a standard that is a quantitative, qualitative, or performance requirement found in a statute, ordinance, resolution, rule, regulation, order, or other standard of general application. For the purposes of assessing the significance of noise impacts associated with the implementation of the GO, a noise impact would be considered significant if implementation of the GO has potential to result in an exceedance of noise ordinance criteria typically used in California.

Impacts of Agricultural Use

Impact: Exposure of Noise-Sensitive Land Uses to Noise Resulting from the Transport of Biosolids

Application of biosolids on agricultural lands would result in transportation-related noise impacts on sensitive receptors located along delivery or haul routes. As more fully described in Chapter 9, “Traffic”, a typical application of biosolids would generate between 80 and 120 round trips per 40- to 60-acre application site per day or approximately 10 to 15 round trips per hour (based on an 8-hour day). (The number of trips will vary significantly with the size of the application operation). Because the GO does not specify the use of specific transport routes, it is possible that transporters may use routes through existing residential areas. Because of the potential for project-related truck traffic to result in substantial noise increases to residential areas along transport routes, this impact is considered significant. To reduce this impact to a less-than-significant level, the project applicant will implement Mitigation Measure 11-1.

Mitigation Measure 11-1: Avoid the Use of Haul Routes near Residential Land Uses. The project applicant and or transporter will avoid the use of haul routes near residential land uses to the extent possible. If the use of haul routes near residential land uses cannot be avoided, the project applicant and or transporter will limit project-related truck traffic to daylight hours (8 a.m. to 6 p.m.).

Impact: Exposure of Noise-Sensitive Land Uses to Noise from the Land Application of Biosolids

Application of biosolids at agricultural sites would result in noise impacts associated with operation of the application equipment. Noise levels of the loudest application equipment would be expected to range from approximately 80 to 88 dBA at 50 feet. For the nearest potential residences at 500 feet from the application site, this corresponds to approximately 67 dBA. Because the application of biosolids on agricultural land would emit noise levels similar to those of existing agricultural equipment, application-related noise resulting from the proposed project would be similar to noise from existing agricultural operations. Additionally, potential impacts would be short-term. Therefore, application-related noise impacts are considered less than significant.

Mitigation: No mitigation is required.

Impacts of Other Activities

Horticultural Use

Although the use of biosolids for horticultural activities could be located in more urban areas than the sites where agricultural land applicant would occur, horticultural activities would generally result in the same type of noise impacts as described above under "Agricultural Use" because sensitive receptors also could be located along the delivery or haul routes or in the area where the land application would occur. These sensitive receptors could be affected by the potential increase in noise if the receptors are located adjacent to delivery or haul routes. No noise impacts would occur to sensitive receptors located adjacent to the application site because the use of biosolids for large landscaping projects would be indistinguishable from other noise generated from the project and would not be located within 500 feet of a residence.

Silvicultural Use

The silvicultural use of biosolids would result in similar impacts as described above under "Agricultural Use" because sensitive receptors also could be located along the delivery routes or in the area where the land application would occur and application-related noise would be similar to existing noise levels for silvicultural operations. Therefore, Mitigation Measure 11-1 would be required to reduce transportation-related noise impacts to a less-than-significant level.

Land Reclamation

The use of biosolids for land reclamation would result in similar noise impacts as described above under "Agricultural Use" because existing noise levels in areas of reclamation sites or soil borrow areas are generally similar to those for agricultural areas. Therefore, Mitigation Measure 11-1 would be required to reduce transportation-related noise impacts to a less-than-significant level. Additionally, the use of biosolids for a final cover material would not affect sensitive receptors because this activity would result in noise levels similar to those at the landfill.

Chapter 12. Cultural Resources

Setting

Prehistoric Setting

California has a long and complex cultural history with distinct regional patterns that extend back more than 11,000 years. The first generally agreed-on evidence for the presence of prehistoric peoples in California is represented by distinctive fluted spear points called Clovis points. The ancient hunters who used these spear points are presumed to have lived between 10,900 years before present (B.P.) and 11,200 B.P.

Approximately 8,000 years ago, many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering. Recent studies suggest, however, that this culture pattern is more widespread than originally described and is in fact found throughout the study area. Radiocarbon dates associated with this period vary between 8,000 B.P. and 2,000 B.P. but cluster in the range of 6,000-4,000 B.P. (Basgall and True 1985).

Cultural patterns reflected in the record, particularly specialized subsistence practices, became better defined within the most recent 3,000 years. The record becomes more complex as specialized adaptations to locally available resources were developed and populations expanded. Along the coast and in the Central Valley, evidence of social stratification and craft specialization is indicated by well-made artifacts such as charm stones and beads, which were often found with burials.

Ethnographic Setting

California encompasses lands occupied by more than 60 distinct Native American cultural groups. Although most California tribes shared similar elements of social organization and material culture, linguistic affiliation and territorial boundaries primarily distinguish them from each other. Before the European settlement of California, an estimated 310,000 native Californians spoke dialects of as many as 80 mutually unintelligible languages representing six major North American stocks (Cook 1976, 1978; Shipley 1978). Similar to today, California was demographically very dynamic in prehistoric times; the area had the highest population density of any area in

North America outside the Basin of Mexico and was home to perhaps one tenth of all people living in North America during the pre-Columbian era.

All native Californians followed a basic hunter-gatherer lifestyle, subsisting through a seasonal round of plant collecting, hunting, and fishing. Reliance on particular resources varied with location and season. For example, acorns were a staple throughout northern, central, and parts of southern California but were merely a supplement to the diet along the northwestern coast and the eastern desert, where they could be obtained only by trade.

Evidence indicates a general evolution from subsistence strategies based primarily on hunting large game to a broad-based economy that placed greater emphasis on diversity. Along with this diversification came population growth and a more settled way of life.

At the time of first contact with Spanish explorers and settlers, most groups inhabiting California had extremely well-developed social, ceremonial, and political structures supported by an elaborate and varied material culture.

Native Californian cultures were initially devastated by contact with Europeans, experiencing an unprecedented loss of population. This demographic collapse was brought on by exposure to new diseases to which the people had no immunity and was hastened by the loss of the land base on which various groups depended for their survival.

Historic Setting

The earliest European explorers to enter the California region were the Spanish, who traveled by ship along the Pacific coast during the 17th and 18th centuries. Intent on asserting their dominance over the new land, they established 21 missions, four presidios, and four pueblos between San Diego and Sonoma during 1769-1823 (Bean and Rawls 1983).

Following Mexican independence from Spain in 1822, the Mexican government gained control over California. As the power of the Franciscan missionaries weakened, political control of California fell into the hands of a small group of wealthy ranchero families. (Bean and Rawls 1983).

American explorations in California began in the late 18th century with the discovery of the lucrative market for sea otter and beaver pelts. The 1848 discovery of gold by James W. Marshall in the Coloma valley in modern-day El Dorado County, however, created a gold rush to the region that forever altered the course of California's history. The arrival of thousands of gold seekers in the territory contributed to the exploration and settlement of the entire state. Partly because of its newfound wealth, California attained statehood status in 1850. (Clark 1970).

The establishment of a transcontinental railroad linking the east and west coasts further contributed to California's growth and economic success. With the decline of gold mining in California, agriculture and ranching came to play a more prominent role in the economy of the state. California's natural resources and climate proved well suited for the production of a variety of fruits, nuts, vegetables, and grains. Sheep and cattle ranching also rapidly developed as a major industry in California.

Regulatory Setting

CEQA is the principal regulatory control addressing impacts on cultural resources in California. Projects with the potential to adversely affect significant cultural resources must be reviewed through the CEQA process. As the designated CEQA lead agency for approval of the GO, the SWRCB is responsible for complying with CEQA's requirements regarding the identification and treatment of historic and prehistoric cultural resources. The State CEQA Guidelines (Pub. Res. Code Section 5097) also specify the procedures to be followed in the event of the unexpected discovery of human remains on nonfederal land. The disposition of Native American burials falls within the jurisdiction of the Native American Heritage Commission.

Impacts and Mitigation Measures

Approach and Methods

To determine potential impacts of the project on cultural resources from land application projects under the GO, cultural resources specialists reviewed the requirements of the GO and identified impact mechanisms for cultural resources (i.e., lands that are actively farmed likely would not be subject to impacts on cultural resources).

Thresholds of Significance

According to CEQA, an impact is considered significant if it would disrupt or adversely affect a prehistoric or historic archaeological site or a property of historic or cultural significance to a community or an ethnic or social group. The State CEQA Guidelines define a significant historical resource as a resource listed or eligible for listing in the California Register of Historical Resources (CRHR) (Pub. Res. Code Section 5024.1). A historical resource may be eligible for inclusion in the CRHR if it:

- is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
- is associated with the lives of persons important in the state's past;
- embodies the distinctive characteristics of a type, period, region, or method of construction, represents the work of an important creative individual, or possesses high artistic values; or
- has yielded, or may be likely to yield, information important in prehistory or history.

If a project proponent agrees to avoid affecting cultural resources identified in the project area, evaluation of these resources for their potential to be listed in the CRHR is not required. If avoidance or protection of a significant cultural resource is not possible, mitigation measures must be implemented, as set forth in Public Resources Code 21083.2(c)-(l). A cultural resource that is not significant need be given no further consideration (Pub. Res. Code Section 21083.2[h]).

Impacts of Agricultural Use

Impact: Damage to or Destruction of Cultural Resources on Lands Not Previously Disturbed by Agricultural Activities

The application and incorporation of biosolids in areas where disturbance has already occurred (i.e., areas that are actively farmed) would not represent a new impact on cultural resources. (For agricultural lands, "disturbed" would be defined as lands where crops have been grown within the past 10 years.) Therefore, significant cultural resources, as defined by CEQA, would not be affected on lands currently under agricultural production. However, if biosolids are applied and incorporated into soil on lands not previously disturbed by agricultural activities, then cultural resources, either known or unknown, could be affected. This impact is considered significant because activities associated with land application of biosolids could affect significant cultural resources. To reduce this impact to a less-than-significant level, the project proponent shall implement Mitigation Measure 12-1.

Mitigation Measure 12-1: Conduct a Cultural Resources Investigation. A cultural resources investigation should be conducted before disturbance is permitted on land that has not been disturbed previously. The cultural resources investigation should include a records search for previously identified cultural resources and previously conducted cultural resources investigations of the project parcel and vicinity. This records search should include, at a minimum, contacting the appropriate information center of the California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation. In coordination with the information center or a qualified archaeologist, a determination can be made regarding whether previously identified cultural resources would be affected by the proposed project and if previously conducted investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey may need to be conducted. The purpose of this investigation would be to identify resources before they are affected by a proposed project and avoid the impact. If the impact is unavoidable, mitigation should be determined on a case-by-case basis.

Impact: Damage to or Destruction of Unknown Cultural Resources on Lands Currently in Agricultural Production

On lands currently in agricultural production, grading and tilling activities associated with biosolids use could result in the unearthing of previously unknown cultural resources. If human remains of Native American origin are uncovered, this impact could be significant. To reduce this impact to a less-than-significant level, the project proponent shall implement Mitigation Measure 12-2.

Mitigation Measure 12-2: Comply with State Laws regarding Disposition of Native American Burials, If Such Remains Are Found. If human remains of Native American origin are discovered during project activities, it is necessary to comply with state laws relating to the disposition of Native American burials, which are under the jurisdiction of the Native American Heritage Commission (Pub. Res. Code Section 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains will stop until:

- the county coroner has been informed of the discovery and has determined that no investigation of the cause of death is required; and

- if the remains are of Native American origin,

  – the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work, for means of treating or disposing of the human remains and any associated grave goods with appropriate dignity, as provided in Public Resources Code Section 5097.98, or

  – the Native American Heritage Commission is unable to identify a descendant or the descendant failed to make a recommendation within 24 hours after being notified by the commission.

According to the California Health and Safety Code, six or more human burials at one location constitute a cemetery (Section 8100) and disturbance of Native American cemeteries is a felony (Section 7052). Section 7050.5 requires that construction or excavation be stopped in the vicinity of discovered human remains until the coroner can determine whether the remains are those of a Native American. If the remains are determined to be Native American, the coroner must contact the California Native American Heritage Commission.

Impacts of Other Activities

Horticultural Use

The use of biosolids for horticultural purposes would result in similar impacts on cultural resources as those described above under "Agricultural Use" if the biosolids are used on areas that have not been previously disturbed (i.e., a new park site or road median) and the biosolids are incorporated into the soil. The incorporation of biosolids into the soil could result in disturbance to cultural resources. However, Mitigation Measure 12-1 included above under "Agricultural Use" would mitigate this impact to a less-than-significant level. Additionally, incorporation of the biosolids into the soil also could result in the potential for unknown cultural resources to be unearthed. Mitigation Measure 12-2, described above, would reduce this impact to a less-than-significant level. Horticultural use of biosolids as a planting or potting medium in large nursery operations would not result in cultural resources impacts.

Silvicultural Use

The use of biosolids for silvicultural use could result in similar impacts on cultural resources as those described above under “Agricultural Use” because grading in areas not previously disturbed could adversely affect cultural resources. Impacts on these resources would be dependant on the biosolids application method used and whether the biosolids are incorporated into the soil. If biosolids are incorporated into the soil, Mitigation Measures 12-1 and 12-2 described above would reduce these impacts to a less-than-significant level.

Land Reclamation

The use of biosolids for land reclamation would result in similar impacts on cultural resources as described above under “Agricultural Use” because most applications would occur to previously disturbed land. If applications occur on lands that were not previously disturbed, Mitigation Measures 12-1 and 12-2 would mitigate the impacts to a less-than-significant level. Additionally, the use of biosolids as a final cover material at landfills would not result in impacts on cultural resources because no cultural resources would be located in the landfill material.

Chapter 13. Cumulative Impacts

Overview of Cumulative Impacts Analysis

State CEQA Guidelines Section 15130 requires that an EIR discuss cumulative impacts of a proposed project when the incremental effect of the project is cumulatively considerable. Cumulatively considerable means that the incremental effects of an individual project are considerable when viewed in connection with the effects of past projects, the effects of current projects, and the effects of probable future projects. The discussion of cumulative impacts must reflect the severity of the impacts and their likelihood of occurrence, but the discussion need not provide as great detail as is provided for the effects attributable to the project alone.

Approach

The cumulative impact analysis must identify related projects through either a "list" or a "projection" approach, summarize effects of the related projects, and contain a reasonable analysis of cumulative impacts and mitigation measures. The list approach requires compiling a list of past, present, or probable future projects producing related or cumulative impacts, including, if necessary, those projects outside the control of the agency.

This cumulative impacts analysis is based on a list approach of similar types of projects that could contribute to cumulative impacts with the implementation of the GO for each resource topic. State CEQA Guidelines state that the lead agency should consider the nature of each environmental resource being examined and the location and type of the project to determine whether to include it as a related project when utilizing the list approach for a cumulative impacts analysis (State CEQA Guidelines Section 15130(b)(1)(B)(1).

Impacts

Implementation of the GO could result in cumulatively considerable impacts for groundwater, biological resources, air quality, and transportation. These cumulative impacts are discussed below.

Groundwater Quality

Impact: Cumulative Nitrate Contamination of Groundwater

As described in Chapter 3, "Soils, Hydrology, and Water Quality", land application of biosolids under the GO would result in less-than-significant impacts to surface water and groundwater hydrology because it is unlikely to cause changes in surface or groundwater use, and the GO requires surface runoff to be controlled at sites where biosolids have been applied. The potential impact to water quality from surface water runoff of contaminants is also less than significant because the GO requires a number of measures to minimize the risk of runoff, such as prohibiting direct discharge of biosolids to water, establishing minimum setback distances to streams, and prohibiting application under conditions that could result in surface runoff of biosolids. The potential impacts to surface and groundwater quality from leaching of trace elements and synthetic organic compounds are also less than significant because the regulatory performance standards established under the GO, operational requirements for a discharger applying biosolids under the GO, or naturally occurring conditions in California would result in low probabilities for water quality impairment to occur.

Widespread land application of biosolids resulting from many individual permits, in combination with certain environmental conditions, has the potential to contribute to groundwater impairment from nitrates. The impact has the greatest potential to occur in nitrate-sensitive areas, which include the many areas of California where nitrate concentrations are approaching or already exceeding drinking water standards, where beneficial uses have been impaired by nitrate contamination, or where naturally high levels of nitrate exist but may not be identified due to lack of monitoring or use for domestic supplies. Even if biosolids are applied at agronomic rates, groundwater could be significantly impaired by nitrates if the following conditions exist:

- other nitrogen inputs from unregulated applications of fertilizers occur, resulting in total applied nitrogen levels in excess of the assimilative capacity of the soil-cropping system;

- either timing of biosolids application, rate of mineralized nitrogen losses, or irrigation/rainfall water exceeds the soil water-holding capacity and results in nitrates leaching into groundwater;

- other sources of nitrogen are added to the groundwater in areas adjacent to the proposed biosolids applications areas, including dairy and feedlot operations, sewage treatment operations, industrial waste discharges, and on-site septic system leachate;

- long-term overdraft of shallow, unconfined aquifers reduces the existing groundwater assimilative capacity for nitrate contributions;

- biosolids are applied at the agronomic rate and monitoring is not conducted to ensure compliance in areas where depth to groundwater is greater than 25 feet; and

- biosolids are applied at the agronomic rate, but site-specific hydrogeology, groundwater assimilative capacity, or municipal and domestic well vulnerability are not considered.

In California, typical areas where cumulative impacts could occur include existing nitrate-impaired groundwater basins such as the Salinas Valley, Orange County, Upper Santa Ana River watershed, southern San Joaquin Valley, and the sandy soil areas of the central coast and southern California.

This cumulative impact is considered potentially significant because many of the environmental factors and actions described above are either unregulated or administered and regulated by more than one resource management agency. Implementation of the following mitigation measures would reduce the cumulative impact to a less-than- significant level.

Mitigation Measure 13-1. Minimize Contribution to Groundwater Nitrate Contamination from Land Application of Biosolids Conducted under the GO. As a condition for the review of each individual NOI submitted for a proposed biosolids application project under the GO, the RWQCB engineer responsible for issuing the NOA would:

- evaluate whether the proposed discharge would occur within an area designated as having existing nitrate contamination problems and

- evaluate whether the proposed discharge would pose an imminent threat of contributing to or causing exceedances of water quality standards for nitrate.

If the responsible engineer finds that either condition exists, the RWQCB would minimize the potential water quality impacts of the project by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the proposed discharge would not cause or contribute to violations of water quality standards. Verification that the proposed project would not cause or contribute to water quality degradation would require that sufficient information be submitted by a qualified civil engineer, agricultural engineer, or other professional hydrogeologist or water quality specialist such that the RWQCB engineer could make a finding that the proposed discharge would be in compliance with provisions of the GO. If the RWQCB finds that modifications to the proposed discharge are necessary for compliance with provisions of the GO, such modifications would consider, but would not be limited to, the following:

- requirements for the discharger to use the services of a certified agronomist, crop advisor, or agricultural engineer to develop additional management practices related to: 1) determining the agronomic rate for biosolids application projects that includes all sources of nitrogen applied to the application site; 2) developing overall farm water, cropping, and fertility management practices; and 3) evaluating the potential for nitrate leaching or impairment of offsite groundwater use;

- requirements of the discharger to provide additional groundwater monitoring in areas where groundwater is found at depths greater than 25 feet or there exist other identified local hydrogeologic conditions that could make the groundwater susceptible to contamination;

- requirements of the discharger to identify whether the proposed biosolids application site is within an area where Drinking Water Source Water Assessment and Protection (DWSWAP) Program setback requirements are implemented for municipal and domestic wells; and

- requirements of the discharger to consider the unique local site and hydrogeologic conditions in the design of the project and/or other groundwater quality management or regulatory programs that are currently active in the area.

Mitigation Measure 13-2: Reduce Sources of Nitrate Contamination. The SWRCB would continue to identify causes of cumulative nitrate loading in nitrate sensitive groundwater areas and develop an effective strategy for reducing those sources. An effective strategy may include, but would not be limited to, the following:

- Each RWQCB should continue to implement existing groundwater pollution protection permit programs and policies to prevent or reduce nitrate contamination of groundwater. Such a program may include evaluating increased enforcement procedure, or modifying the permitting programs for other agricultural activities (e.g., confined animal feeding operations, dairies, poultry farms), industrial and municipal NPDES-permitted discharges of wastes and reclaimed water to land, and NPDES storm water management regulations.

- Other local, state, and federal permitting authorities should evaluate, integrate, increase enforcement of, or modify their existing policies and procedures to reduce the cumulative contribution of nitrates to groundwater. Examples of other regulatory programs that should be evaluated and considered in areas that would have biosolids application include groundwater management programs, residential onsite septic tank system approval, municipal landfill management plans, agricultural cooperative extension programs, and forestry management programs.

Biological Resources

Impact: Cumulative Loss of Special-Status Plant and Wildlife Species or the Loss or Disturbance of Biologically Unique or Sensitive Natural Communities

Land application of biosolids would generally occur on lands that have previously been disturbed, such as existing agricultural operations. Some land application of biosolids could occur on lands that are not currently disturbed, such as the conversion of range land to more land intensive agricultural operations. In these cases, land application could result in the loss of special-status plant and wildlife species or the loss or disturbance of biologically unique or sensitive natural communities. Other past, present, or reasonably foreseeable future projects that involve the conversion of land from open space to other uses also could result in the loss of special-status plant or wildlife species or the disturbance or loss of biologically unique or sensitive natural communities. Refer to Chapter 7, "Biological Resources", for a discussion of impacts and recommended mitigation measures to reduce the effects of the proposed project to a less-than-significant level. If these mitigation measures are implemented, the project's effect on biological resources would be reduced to a minimum and the proposed project would not contribute to a significant cumulative impact.

Air Quality

Impact: Cumulative Increase in NO_x and PM10 Emissions

The proposed project could result in an increase in NOx and PM10 emissions resulting from transport of biosolids from POTWs to land-application sites and from the use of farm equipment to spread and incorporate biosolids into the soil during land application operations. Land application of biosolids is expected to increase over the next 15 years as the population increases. Increases in air quality emissions resulting from the project would be greatest in Kern, Kings, Merced, San Diego, Riverside, and Solano Counties, where the greatest amount of land application occurs. Other land development projects, industrial projects, and the increase in air quality emissions resulting from activities associated with population growth would also contribute to an increase in air quality emissions. Air quality management plans (AQMPs) include policies to reduce air emissions from industrial operations, auto and truck exhaust, increases in population, and other activities that could result in increased air emissions. This cumulative impact is considered less than significant because AQMPs include policies aimed at reducing vehicle emissions (such as those that would be generated by implementation of the GO) and direct air quality impacts would be reduced to a less-than-significant level with implementation of Mitigation Measures 10-1 and 10-2.

Transportation

Impact: Cumulative Deterioration of Roadways

Implementation of the GO would result in an increase in trips on roadways, some of which are currently deteriorated, for the delivery of biosolids to land application sites. As described in Chapter 9, "Traffic", this direct impact is considered less than significant. However, this cumulative impact is considered less than significant because the number of vehicles that use these roads for the delivery of biosolids is a small percentage of the overall volume of vehicles using these roads. Additionally, some counties have roadway management plans that include policies to repair deteriorated roadways and roadway impact fees to pay for roadway repairs.

Chapter 14. Alternatives Analysis

Alternatives to the Issuance of the General Order

In accordance with Section 15126.6 of the State CEQA Guidelines, a draft EIR must describe a reasonable range of alternatives to the proposed project that could feasibly enable the project's basic objectives to be met while reducing or eliminating any of the significant adverse impacts of the proposed project. As detailed in Chapter 2, "Program Description", the objectives of this project are to:

- comply with Section 13274 of the California Water Code and the judicial order by the Superior Court of California for the County of Sacramento by adopting statewide general WDRs for the discharge of dewatered, treated, or chemically fixed sewage sludge (biosolids) for beneficial use as a fertilizer and/or soil amendment;

- provide a regulatory framework for biosolids application to land that can be used by individual RWQCBs to act on NOIs filed by potential dischargers in a manner that avoids or mitigates potentially adverse environmental effects; and

- provide a flexible regulatory framework that allows implementation of a biosolids disposal program for land application operations at the regional level and contains requirements that are based on sound science and best professional judgment.

In this chapter, alternatives to the proposed project are described and the anticipated environmental impacts of the alternatives are compared with those analyzed for the proposed GO in Chapters 3-12 of this report. The alternatives analyzed in this chapter are described below.

No-Project Alternative

Under the No-Project Alternative, it is assumed that land application of biosolids would continue in its current form and be regulated by the RWQCBs through individual WDRs or exemptions and by county governments through local ordinances and regulations. Existing land application operations would continue and would be controlled by the conditions contained in their individual permits. Biosolids generation would continue to increase as described in Chapter 2, and the amount of material going to land application sites would increase proportionately. The types of conditions and prohibitions placed on existing and new land application operations would be similar to those imposed in existing permits from the RWQCBs. Because it is not possible to predict how county and city governments might alter their regulation of land application of biosolids in the future if a statewide GO were not in place, it is assumed that local regulation would remain in its current form.

The objectives of the proposed project would not be met under this alternative. There would be no statewide, unified approach to regulation of land application with a streamlined permit review and CEQA documentation process. Decisions on use of the federal Part 503 regulations and levels of environmental protection would be made on an individual-project basis by the RWQCBs.

Modified GO Provisions and Specifications Alternative

Land application of biosolids, as allowed under the proposed GO, has the potential to result in several significant impacts. To provide for addressing these impacts while still meeting the objectives of the proposed project, an alternative was developed that incorporates the mitigation measures identified in Table ES-1 that are necessary to address potentially significant effects as modified provisions and specifications. These added provisions and specifications would be as follows:

- Dischargers shall provide sufficient information in their Pre-Application Reports to determine the potential for soil degradation or reduced land productivity and shall ascertain, or use the services of a qualified soil scientist or qualified agronomist to ascertain, that no such soil degradation or reduced land productivity will occur as a result of biosolids application.

- After an application of Class B biosolids, the discharger shall ensure that animals are not grazed on that land for at least 90 days.

- Prior to application of biosolids to agricultural land, the discharger shall enter site assessor parcel numbers into a statewide tracking system, accessible to the public, that can identify whether a parcel of land has received an application of biosolids.

- Land application of Class B biosolids shall be prohibited within ½ mile of areas defined as having a “high potential for public exposure”.

- Dischargers shall ensure that biosolids transporters develop truck routing plans that avoid traffic in primarily residential neighborhoods.

- All biosolids shall be transported in trucks that have been adequately cleaned to remove biosolids from the exterior of the vehicles prior to leaving the site of generation and the site of land application.

- There shall be no discharge of biosolids to uncultivated land or land otherwise undisturbed, or lands left fallow for more than 1 year without a site assessment being conducted for special-status plant and wildlife species or biologically unique or sensitive natural areas.

- There shall be no discharge of biosolids within 500 feet of enclosed water bodies potentially occupied by desert pupfish.

- The transport of biosolids shall not generate daily emissions of nitrogen oxides or particulate matter in excess of daily thresholds included in the policies of California air districts responsible for achieving attainment status under the federal and state Clean Air Acts.

- Dischargers shall control fugitive dust on unpaved access roads to land application sites.

- There shall be no discharge of biosolids to uncultivated land or land otherwise undisturbed without a cultural resources investigation being conducted, and if significant resources are found, development of a mitigation plan.

All other elements of the proposed GO are assumed to remain as described in Chapter 2 of this EIR.

Land Application Ban Alternative

Under this alternative, land application of biosolids would not be facilitated by regulation. Regulation of land application for agricultural, horticultural, silvicultural, or land reclamation purposes would be sufficiently restrictive to make the activity economically uncompetitive. Biosolids generators would be encouraged to pursue other options, such as use of landfills, incineration, and development of dedicated disposal sites (monofills). Each of these disposal options was mentioned in the scoping process. It is assumed that this policy approach would result in an effective ban on land application for beneficial reuse. Although this alternative does not meet the objectives of the proposed GO, it does reflect numerous comments received from the public during the scoping process requesting that the SWRCB consider biosolids disposal options rather than land application for beneficial reuse. This alternative is not considered the environmentally superior alternative to the GO because it is not within the reasonable range of alternatives and it does not meet the project objectives.

This alternative would differ from the No-Project Alternative in that the current process of issuing individual WDRs through the RWQCBs (which is assumed under the No-Project Alternative) would be discouraged in favor of pursuit of other options. As stated above, individual WDRs would be discouraged through restrictive policies and permitting requirements.

Assuming that biosolids generation continues to increase as described in Chapter 2, the need for landfill space, new dedicated landfills (monofills), and incineration facilities are expected to increase. Biosolids treatment levels would be modified to meet the requirements for these disposal methods. The material would be transported by truck to the disposal facilities and it would be managed and disposed of according to current practice in the state.

Alternatives Considered but Rejected

A number of other potential project alternatives were considered through the EIR scoping process but were not selected for detailed evaluation in this EIR. CEQA guidelines Section 15126(d)(2) requires that these alternatives be briefly described and the reasons underlying their rejection be identified. The following alternatives were identified either by the SWRCB or individuals participating in the scoping process but have been rejected as infeasible.

- **Regulation through RWQCB General Orders.** This alternative would accomplish most of the proposed project objectives through issuance of GOs by each of the nine RWQCBs. These GOs might vary slightly from one region to the next, but would streamline the permitting process within each region. The alternative was rejected because it did not reduce any of the potential significant environmental effects of the proposed SWRCB GO.

- **Total Prohibition.** This alternative would place a total ban on the land application of biosolids in California. It was incorporated into the Land Application Ban Alternative, which is analyzed below.

- **Partial Prohibition (No Land Application over Enclosed Groundwater Basins).** This partial prohibition alternative would place lands overlying enclosed groundwater basins in the “exclusion area” category of the GO. The alternative was rejected because it did not reduce any of the potential significant effects of the proposed SWRCB GO. No evidence was found that indicated that enclosed groundwater basins in the state were any more likely to have significant adverse water quality effects than other groundwater basins.

- **Engineered Monofills.** This alternative would direct biosolids to monofills engineered exclusively to receive this material. The impacts of diverting biosolids to disposal sites (including monofills) rather than to land application sites are considered in the Land Application Ban Alternative analyzed below.

- **In-Vessel Composting.** In-vessel composting is a biosolids treatment process that reduces the number of pathogens that remain in the material after other more typical treatment processes. This treatment could be used to reduce the potential for health-related impacts resulting from the biosolids transport and spreading operations. The alternative was rejected because it did not reduce any of the potential significant effects of the proposed SWRCB GO.

- **Worm Casings.** This alternative would direct biosolids to worm farms to provide a food source for worms. The alternative was rejected as infeasible because there is no evidence that there are adequate worm farming operations in the state to accommodate the volume of biosolids going to land application. Also, it is not clear whether this alternative would reduce or eliminate any of the significant adverse effects of the proposed project.

- **Incineration.** Incineration is a biosolids disposal method used by some POTWs in California. The impacts of using this disposal method are described in the analysis of the Land Application Ban Alternative.

- **Disposal at Atomic Testing Sites.** This alternative assumes that biosolids would be disposed of on lands previously used to test atomic weapons. No specific location for this activity was identified in the scoping comments; most of these sites in the western United States are located in Nevada. Neither the SWRCB nor any of the RWQCBs have jurisdiction to approve or regulate the disposal of biosolids in Nevada; therefore, the alternative was rejected as infeasible.

- **Landfilling.** Landfilling of biosolids is a common practice in some regions of California; the effects of this disposal option are considered in the Land Application Ban Alternative.

- **Limit RWQCB Authority to Issue Waste Discharge Requirements for Land Application.** This alternative was identified during the informal discussion phase of the scoping process. The individual suggesting the alternative did not provide additional detail about the intent of limiting RWQCB authority over land application of biosolids. It is assumed that a narrower range of authority was being suggested, resulting in fewer approvals of land application operations. Because this alternative has not been described in sufficient detail for a meaningful analysis to be conducted and changing the permitting authority for the land application of biosolids would not reduce environmental impacts, it has not been considered in detail in the EIR.

- **Modified GO , Providing More Local Control in Determining Exclusion Areas.** This Modified GO alternative would allow for local citizens to have a greater voice in the location of land application activities by determining what are appropriate exclusion areas on a case-by-case basis. The objective of the proposed GO is to provide a statewide program under state regulatory control; the exclusion areas have been identified based on existing state laws and plans that identify significant resources that should be protected from certain land use activities. The GO would no longer provide its programmatic function if local decisions on exclusions were made on a case-by-case basis. Local governments have the authority to exclude certain land use practices, including land application of biosolids, through their general planning or ordinance processes. These vehicles would be more effective at serving local interests for exclusions. For these reasons, this alternative was rejected as infeasible.

- **Modified Prohibitions Alternative.** An alternative was proposed during the scoping process that added more prohibitions to the GO. These additional measures included prohibition of storage, staging, and bulk application on lands having the following: less than 60 feet of depth to groundwater; land where the elevation is not at least 3 feet above the 100-year floodplain elevation; areas protected from flooding by levees; areas within the inundation zone of any dam or dam failure; areas within 850 feet of any water well; and any area within 850 feet from surface waters, including creeks, ponds and marshes, water supply ditches, and canals that discharge into surface waters. Although this alternative would have the potential for reducing some of the potential adverse effects of the proposed GO, the alternative was not carried into the EIR for more detailed analysis. A similar modified GO alternative has been developed that addresses each of the potentially significant adverse effects of the proposed GO; it is discussed below. A second modified GO alternative would be repetitive and redundant.

- **Crop Limitation Alternative.** Several suggestions were made during the scoping process that would limit the types of crops that could be grown on land that has received a biosolids application. It was suggested that fresh fruits and vegetables should not be grown on land application sites; also, it was suggested that only fiber and cover crops be allowed on land application sites. These suggestions were not carried forward into the EIR as an alternative because this alternative would not reduce any significant impacts of the proposed GO. The proposed GO would not result in any public health impacts related to the consumption of fresh fruits and vegetables.

- **Food Processing Waste Alternative.** An alternative was suggested through the scoping process that would separate food processing waste from other wastes. It is assumed that the individual suggesting this action sought to limit land application to food processing waste only. This food processing waste could be applied to the land without the potential adverse effects of applying human-derived waste products. The alternative was rejected because it does not meet any of the objectives of the proposed project; it does not address the land application of all sewage sludge and other biological solids as required by the state Water Code (Section 13274). The suggestion that human-derived biological solids not be applied to the land has been addressed in this EIR in the Land Application Ban Alternative (discussed on following pages).

Impact Comparison

No-Project Alternative

As described above, under this alternative land application of biosolids would probably continue to be regulated by the RWQCBs through individual WDRs or exemptions and by county governments through local ordinances and regulations.

Soils, Hydrology, and Water Quality

The water quality effects of biosolids land application under current regulation would be greater than those anticipated with implementation of the proposed GO. Current regulatory practice does not place restriction on the use of EQ biosolids, and it does not include the runoff control and setback requirements of the proposed GO. The potential for surface water or groundwater contamination from temporary storage of biosolids is greater under current conditions. In addition, the heavy metals cumulative loading restrictions currently being used (the Part 503 limits) do not account for the heavy metals content of soils before land application. Therefore, the potential for accumulating heavy metals in soil that could eventually affect surface water or groundwater would be greater.

Land Productivity

This alternative would have a greater potential for impacts on land productivity because the ceiling thresholds of various heavy metals concentrations would be higher for applied biosolids under the No-Project Alternative. Current use of the Part 503 cumulative heavy-metals limitations does not require the inclusion of background soil levels. Additionally, this alternative does not provide a means to address the cumulative loading of molybdenum, which could result in greater impacts on grazing land productivity. The land application of EQ biosolids would remain unregulated, so long-term disposal operations could eventually affect land productivity through the creation of nutrient imbalances or heavy metals buildup to potentially phytotoxic levels.

Public Health

The No-Project Alternative has the potential to result in slightly greater impacts on public health because existing provisions designed to prevent groundwater contamination by biosolids (e.g., setbacks, minimum distance to wells, runoff controls, minimum depth to groundwater) are not as stringent as those included in the proposed GO. The RWQCBs could adopt stricter controls to protect public health in the future, but current practice does not include all of the controls mentioned above. In addition, current practice relies on the use of less reliable pathogen indicators (coliform bacteria) than are proposed in the GO (*Salmonella*). Therefore, higher levels of pathogens may be applied to the land under the No-Project Alternative than under the proposed GO.

Land Use and Aesthetics

The No-Project Alternative would result in land use impacts similar to those of the proposed GO because setbacks for all types of sensitive receptors (e.g., recreational areas, educational areas) are not defined. Aesthetic impacts (e.g., reduction in visual quality) associated with biosolid haulers using roadways through residential and recreational areas would also be similar under this alternative. Therefore, land use and aesthetic impacts would be considered significant because additional setbacks and defined truck access routes would not be required to help reduce visual and land use (e.g., traffic and noise) impacts on all types of sensitive receptors.

Biological Resources

This alternative would result in similar impacts on biological resources because the preparation of a specific site assessment for special-status plant and wildlife species and/or biologically unique or sensitive natural communities is not a requirement under the No-Project Alternative for areas that have not been disturbed within the last year. Therefore, biological resource impacts would be considered potentially significant because the appropriate site assessment (e.g., for special-status species, sensitive natural communities) would not be required to help identify and compensate for any potential impacts on biological resources in the application area before they are affected by land application.

Fish

Under this alternative, impacts on fisheries (e.g., acute toxicity) would be similar to those identified for the GO. Current practice provides for setbacks similar to those in the GO between land applications and water bodies with protected fish species. Because the land application of EQ biosolids is not regulated under current practice, there is some potential for adverse effects on fish where EQ material is applied or disposed of adjacent to streams.

Traffic

Under the No-Project Alternative, the potential for traffic safety hazards resulting from the accidental spill of biosolids on local and regional roadways would be slightly greater than those identified for the proposed GO. The No-Project Alternative does not require implementation of a Spill Prevention Plan. However, it should be noted that several counties currently require that transporters implement various emergency procedures, including those associated with an accidental spill of biosolids.

Air Quality

The No-Project Alternative would result in air quality impacts similar to those under the proposed GO because restrictions on the size and travel distance for specific biosolid application projects is not a requirement under either option. Air quality impacts could be significant because it is expected that application projects requiring more than 4,800 VMT daily would generate daily transportation and application-related NO_x emissions that would exceed significance thresholds for air districts where biosolids are applied in the greatest volumes.

In addition, current practice under the No-Project Alternative does not specifically restrict the movement of visible particulates from an application site. Therefore, it is possible that more nuisance particulates will escape land application sites under existing conditions than would occur under the proposed GO.

Noise

As described above under "Land Use and Aesthetics", the No-Project Alternative would result in noise impacts similar to those of the proposed GO because defined truck access routes would not be required to help reduce transportation-related noise impacts on residential land uses. Consequently, noise impacts would be considered significant because there would be no control on the use of delivery routes adjacent to residential land uses. Also, setback requirements between land application operations and individual residences would be expected to be the same under both alternatives.

Cultural Resources

This alternative would result in impacts on cultural resources similar to those of the proposed GO because cultural resource surveys would not be required for land applications in areas that had not been previously disturbed. Cultural resource impacts would be considered potentially significant because no cultural resource survey would be conducted to identify significant resources before ground disturbance begins.

Modified GO Provisions and Specifications Alternative

As described above, this alternative addresses all the significant or potentially significant impacts resulting from implementation of the proposed GO and incorporates the mitigation measures identified in Table ES-1 as additional provisions or prohibitions..

Soils, Hydrology, and Water Quality

The Modified GO Alternative includes measures that should improve groundwater and surface water protection compared with the level of protection provided by the proposed GO. Although implementation of the proposed GO is not expected to result in significant water quality or hydrology effects, the GO modifications would include a data collection and evaluation step as part of the application process; this step would be designed to avoid application of biosolids in those unique settings where soil structure and chemistry could lead to leaching of nutrients or heavy metals into the groundwater. The additional data and evaluation would be especially valuable where biosolids land application was being planned over impaired or degraded groundwater basins. Professional help, as deemed necessary, would be required to estimate nitrogen application rates and appropriate irrigation management in areas where nitrate contamination of groundwater was judged to be a significant issue.

Land Productivity

The Modified GO Alternative would result in fewer land productivity impacts than the proposed GO because the development and analysis of soils data would be required to avoid land application in those parts of California where existing soil conditions could contribute to declines in land productivity. Therefore, the ability of the land to support agricultural, horticultural, silvicultural, or land reclamation activities would be less likely to deteriorate over time because the implementation of these data collection and evaluation efforts would reduce the incidence of poor land management practices and minimize soil erosion. Additionally, under this alternative, biosolids application sites would be identified and monitored to address any potential public concerns regarding crop contamination.

Public Health

Even though land application under the proposed GO is not expected to result in significant health risks, application under the modified GO would reduce the risk of public health impacts compared with the risk under the proposed GO because the application of biosolids would be better controlled in regions of California where soil conditions could allow leaching of nitrates and metals into the groundwater. Collection and evaluation of soils data would be required as a condition of applying for WDRs under the modified GO. Consequently, public health impacts would be considered less than significant.

Land Use and Aesthetics

The Modified GO Alternative would result in fewer land use and aesthetic impacts than the proposed GO because the modified GO would include additional setbacks (up to 0.5 mile) for all sensitive land use areas and because the definition of an area having a "high potential for public exposure" would be expanded to include other sensitive land uses, such as hospitals and educational facilities. Consequently, land use and aesthetic impacts (i.e., disturbance through increased traffic and noise, odors, and visual impairment) would be considered less than significant because the setbacks would provide additional buffers to minimize these impacts.

Biological Resources

This alternative would be expected to result in fewer impacts on biological resources compared with the proposed GO because the preparation of a specific site assessment for special-status plant and wildlife species and/or biologically unique or sensitive natural communities would be a requirement under the Modified GO for areas that have not been disturbed within the last year. Therefore, biological resource impacts would be considered less than significant because the appropriate site assessment would help to identify and compensate for any potential biological resources in the project area before they were adversely affected.

Fish

Under this alternative, fisheries-related impacts would be less than those identified for the GO because additional setbacks would be required for land applications in the vicinity of internally drained water bodies with protected fish species.

Traffic

This alternative would result in traffic impacts similar to those of the proposed GO. No significant effects would be expected.

Air Quality

Under the proposed GO, the application of biosolids on sites that would require delivery truck traffic to exceed 4,800 vehicle miles per day would result in the generation of air emissions (e.g., combustion emissions, fugitive dust) that could exceed local air district thresholds for NO_x and PM10. The Modified GO Alternative would result in fewer air quality impacts because it includes provisions that restrict the amount of vehicle traffic that can be generated by an individual project. This restriction would ultimately reduce the potential for a specific project to exceed daily significance thresholds for emissions of NO_x, and PM10. Therefore, air quality impacts would be considered less than significant.

Noise

The application of biosolids has the potential to result in transportation-related noise impacts on sensitive receptors located along delivery routes. This alternative would result in fewer transportation-related noise impacts than the proposed GO because the modified GO would restrict the use of delivery trucks near residential land uses to the extent possible. Consequently, noise impacts would be considered less than significant.

Cultural Resources

This alternative would reduce the chance of damaging cultural resources because cultural resource surveys would be a prerequisite to applying biosolids in areas that had not previously been disturbed. Cultural resource impacts would be considered less than significant because the cultural resource investigation would help to identify any potential resources in the project area before they were adversely affected.

Land Application Ban Alternative

As more fully described earlier, the land application of biosolids would not be facilitated by regulation under this alternative. Biosolids generators would be encouraged to pursue other management options such as use of landfills, incineration, and development of dedicated disposal sites.

Soils, Hydrology, and Water Quality

Under the Land Application Ban Alternative, biosolids reuse would not have an effect on surface water or groundwater quality. Biosolids currently being applied to the land would eventually be diverted to disposal operations. Additional land application sites would not be developed. With these materials going to landfills, monofills, or incinerators, the potential for water quality effects would be reduced. Landfills and monofills are strictly regulated for contamination of surface water and groundwater. Most of these facilities have natural or manufactured liners that catch leachate, or they have extensive leachate collection systems that minimize percolation of contaminants to groundwater. Newly developed landfills or monofills would be expected to include state-of-the-art leachate control systems. Incinerators are enclosed facilities that do not generate a significant liquid waste stream. It is assumed that incinerator ash would be disposed of in an appropriate landfill.

Land Productivity

Under the Land Application Ban Alternative, adverse crop and soil productivity impacts associated with changes in soil nutrient levels and changes in heavy metal plant toxicity resulting from the application of biosolids would not occur. Additionally, public concerns over crop contamination from biosolids applications would not occur under this alternative. Other fertilization and soil amendment practices would continue to occur. These practices could include use of other organic fertilizers, such as manure. Use of chemical and manure-based fertilizers is not currently considered to have an effect on long-term land productivity. Studies are being undertaken, however, to determine the long-term effect of chemical fertilizer use on land productivity. Also, manure typically has a higher total dissolved solids content than biosolids, so changes in soil salinity could be more of an issue with manure use. Also, the loss of biosolids as a soil conditioner would have an adverse effect on land productivity in those situations in which there would be no option of using biosolids as an amendment on soils with low amounts of organic material.

Public Health

If biosolids reuse is abandoned in favor of disposal alternatives in the future, there would be additional demand for landfill or monofill space, or perhaps for added incinerators. If new facilities are placed in rural settings, as is normal, potentially productive land could be eliminated by construction of facilities. These losses would be more long term than is likely at land application sites. This indirect effect of facilities siting efforts could be avoided if low-productivity lands were sought for new facilities.

Under this alternative, there would be no risk of human or animal disease from the land application of biosolids in agricultural, horticultural, silvicultural, or land reclamation settings. Land application would be discouraged and the pathogens and other contaminants in biosolids would not be placed in settings with a significant risk of public exposure. Most biosolids generated in the state would be transported to and disposed of in landfills, monofills, or incinerators. These types of facilities generally have stricter control on public access, so the potential for direct human contact would be substantially reduced.

One potential for an adverse effect under this alternative would be related to air emissions from biosolids incinerators. The increased incidence of biosolids incineration would create increases in emission of particulates and other potential air contaminants, affecting residents in the vicinity of the incinerator (see “Air Quality” below). Emission control facilities on incinerators could be used to reduce the significance of this effect.

Agricultural sites currently using biosolids for soil conditioning and as a source of nutrients could, in the future, receive animal manures as an alternative. The public health implications of this change have not been investigated extensively, but the use of animal manures is not currently actively regulated. Some additional public health effects could result from this change in fertilizer source.

Land Use and Aesthetics

The Land Application Ban Alternative would result in land use (e.g., traffic, noise) and aesthetic impacts (e.g., reduction in visual quality) similar to or greater than those of the proposed GO because of the need for increased Class II and Class III landfill space and more incinerators for biosolids disposal. This increased need for facilities has the potential to create greater land use and aesthetic impacts than the proposed GO because landfills and incinerators are much more visible elements of the landscape and have a much greater life expectancy than periodic land application.

Biological Resources

This alternative would be expected to result in similar but much less extensive impacts on biological resources than the proposed GO because the potential need to expand existing landfill and incineration areas might also affect special-status plant or wildlife species or biologically unique or sensitive natural communities located within the expansion areas. These areas would be much smaller than land application sites in general, but may be similar in size to previously undisturbed areas that might be affected under the proposed GO. Biological resource impacts would be potentially significant under this alternative, and the appropriate site assessments (e.g., for special-status species, sensitive natural communities) would be required to help identify and compensate for any potential biological resources in the expansion areas before they are adversely affected.

Fish

This alternative has the potential to result in fisheries impacts similar to those of the proposed GO because the potential need to expand existing landfill areas might also affect special-status fish species or biologically unique or sensitive natural communities located within the expansion areas. Fisheries impacts would be considered potentially significant under this alternative, and the appropriate site assessments (e.g., for special-status species, sensitive natural communities) would be required to help identify and compensate for any potential fisheries resources in the expansion area before they are adversely affected.

Traffic

Under the Land Application Ban Alternative, most biosolids would no longer be transported to agricultural, horticultural, silvicultural, or land reclamation areas as a source of nutrients and soil conditioning. Instead, this material would be transported to landfills, monofills, or incinerators for disposal. The truck traffic associated with moving this material to disposal sites rather than reuse sites may be greater or lesser than under the proposed GO, depending on the relative distances between these sites and the degree of dewatering that would take place before transport. However, with the effective ban on land application, those lands currently receiving biosolids would require other sources of nutrients and soil conditioners. Some level of truck traffic would be associated with supply of this replacement material. Consequently, it is likely that traffic related to switching from land application to disposal of biosolids would be greater than under the proposed GO. Also, a land application ban would not stop generators from using highways to transport biosolids out of the state.

Air Quality

This alternative would result in greater air quality impacts than the proposed GO. With an effective ban on land application, incineration of biosolid materials would be expected to increase, resulting in NO_x and PM10 emissions that could exceed local air district significance thresholds. Additionally, the incineration of biosolid materials may result in the release of minimal amounts of hazardous materials emissions, which may create a public health hazard. The transportation of fertilizers to existing agricultural operations and the delivery of biosolids materials to landfill areas would also result in elevated levels of transportation-related NO_x and PM10 emissions. Consequently, because of the increase in both incineration and transportation-related emissions and the potential to exceed local air district significance thresholds under the Land Application Ban Alternative, air quality impacts are expected to be greater under this alternative. Also, a land application ban would not stop generators from using highways to transport biosolids out of the state.

Noise

As described above in the traffic analysis, agricultural operations would continue to receive a source of nutrients and soil conditioning, resulting in a similar number of truck trips and resultant noise impacts. Additionally, under this alternative a number of truck trips associated with the transport of biosolids materials to out-of-state landfills and incineration sites would be generated, resulting in additional transportation-related noise impacts on sensitive receptors located along landfill access routes. Consequently, because of the increased noise levels caused by the additional number of trucks generated by the Land Application Ban Alternative, noise impacts are expected to be greater than for the proposed GO.

Cultural Resources

This alternative could result in cultural resource impacts similar to those described for the proposed GO. Previously undisturbed land could be used for construction of additional landfill, monofill, or incineration facilities as biosolids are diverted from land application. The size of lands needed for new facilities would be smaller than the total acreage used for land application, but the size may be similar to the amount of undisturbed land that would be used under the proposed GO. Significant cultural resource impacts could occur as new disposal facilities are constructed, making it necessary to conduct appropriate site surveys to avoid or develop compensation for cultural resources lost or damaged in the process.

Chapter 15. Mitigation Monitoring Program

Mitigation measures are a wide range of conditions and controls placed on a project to reduce its impacts on the environment. CEQA requires the use of mitigation measures to reduce the magnitude of impacts.

When an agency approves a project and adopts mitigation measures for potentially significant impacts disclosed by an EIR, the project proponent is required by California state law (Pub. Res. Code Section 21081.6) to establish a monitoring and reporting program to ensure that the mitigation measures are implemented. This Mitigation Monitoring Program will be considered for adoption by the SWRCB at the time the EIR is adopted.

The Mitigation Monitoring Program identifies mitigation measures reduce impacts to a less-than-significant level for the proposed project. For each mitigation measure, Table 15-1 identifies the monitoring and enforcement action, timing for implementing the measure, the entity responsible for implementing the measure, and the entity responsible for monitoring and enforcing implementation.

Table 15-1.
Mitigation Monitoring Program

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
Land Productivity				
4-1: Provide Soil- and Site-Screening Information with the Pre-Application Report. The GO Pre-Application Report should be revised to require that WDR applicants provide sufficient soil and site information such that RWQCB staff can determine whether soils would be degraded and/or land productivity would be reduced as a result of biosolids application. In particular, providing the information is intended to ensure that 1) essential soil nutrients other than nitrogen are applied so that significant nutrient imbalances do not occur, 2) metals-related phytotoxicity does not occur, 3) increases in salinity do not occur to the point that the yields of the crop(s) typically grown at the site is appreciably reduced, and 4) appreciable accelerated soil erosion does not occur. The Pre-Application Report already requires sufficient information with which effects of potential nutrient imbalances, metals phytotoxicity, and excessive salinity can be analyzed. This information should be used by the applicant, a qualified soil scientist, or a qualified agronomist to evaluate the above potential effects on producitivity. The GO Pre-Application Report also should be amended to include the erosion hazard (derived)	The GO will be revised to include the development and use of a screening tool to identify sites where management of soil fertility, heavy metals phototoxicity, and nutrient and heavy metals bioavilability and mobility may become a problem if biosolids are appliced	Before adoption of GO	SWRCB	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
4-1. Continued				
from USDA soil survey reports[1]) of the proposed application site. As is currently done for the recognition of potential hydric (i.e., wetland) soils under Section 404 of the Clean Water Act, the soil screening tool could be developed based on existing U.S. Natural Resources Conservation Service (NRCS) soil survey information and a list of possible problem soil-series types. Alternatively, the screening criteria could be based on Soil Taxonomy, using, for example, the taxonomic Great Group and family-differentiating criteria such as particle size, reaction class, and mineralogy classes (e.g., Psamments or Aquents				

[1] Where a soils survey report is not available for a proposed application site, the applicant should have a qualified soil scientist determine the erosion hazard (using NRCS guidelines), unless the slope of the site is 3% or less. Sites with slopes of 3% or less will be considered to have a slight erosion hazard.

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
4-1. Continued Additionally, the Limitations to Land Application table should be added to the GO Pre-Application Report. Applicants or qualified soil scientists or agronomists should use the table to further determine whether soils could be degraded or land productivity reduced. Sampling of biosolids and soils should follow the procedures and protocols currently approved by the EPA/DHS. Provided that the applicant, a soil scientist, or agronomist has provided written confirmation to the RWQCB that soils would not be degraded and/or land productivity would not be reduced as a result of nutrient imbalances, metals-related phytotoxicity, or adverse salinity effects, biosolids may be applied on any site having a "slight" limitation as defined in the table. At sites having a "moderate" limitation, biosolids may be applied only where the crop is not particularly sensitive to metals and nutrient imbalances. Sites having a "severe" limitation are excluded from eligibility under the GO and a site-specific waste discharge investigation and planning study should be conducted by a qualified soil scientist or agronomist to provide, in writing to the RWQCB, written confirmation that biosolids application would not cause soil degradation and would not reduce crop yield. The GO and the Pre-Application Report also should be amended to specify an absolute upper slope limit of 20% at sites in which the biosolids would not be immediately covered by sod or a sufficient mulch cover to control erosion.				

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
4-2: Extend Grazing Restriction Period to Allow for SOC Biodegradation. For grazing sites where biosolids applications are proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after land application. The GO should also be revised to prohibit grazing animals from using a site for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF. These measures will promote maximum biodegradation of SOCs and pathogens before grazing animals are exposed to the soil.	The GO will be revised to extend the grazing restriction period to allow for SOC biodegradation.	Before adoption of GO	SWRCB	RWQCB
4-3: Track and Identify Biosolids Application Sites. A program to identify and track applications of biosolids on agricultural lands should be established to mitigate the potential perception by produce buyers and consumers that crops have been contaminated or damaged by biosolids applications. The program should allow for public access to information. The program should also identify previous biosolids incorporation sites and add them to the tracking system.	A program to track and identify biosolids application sites will be established	Following adoption of GO	SWRCB	RWQCB
Public Health				
5-1: Review Manual of Good Practices. Although no significant public health risk is expected from direct human contact with biosolids, it is recommended that all individuals or agencies receiving land application permits under the GO review a manual of good practices that addresses measures to protect human health. The California Water Environment Association Manual of Good Practice—Agricultural Land Application of Biosolids is an example of such a manual (California Water Environment Association 1998).	Manual of Good Practices will be reviewed	Before land application	Discharger	SWRCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
5-2: Extend Grazing Restriction Period to Allow for Pathogen Reduction. For grazing sites where application of biosolids is proposed, the GO should be revised to require that grazing of animals be deferred for at least 90 days after application. The GO should also prohibit grazing animals from using a site for at least 60 days after application of biosolids in areas with average daily (daytime) air temperatures exceeding 50ºF. These measures will promote maximum degradation of pathogens (and SOCs) before grazing animals are exposed to the soil. See also Mitigation Measure 4-2	The GO should be revised to state that the grazing of animals be deferred for at least 90 days following application and include grazing restrictions based on daily temperatures	Before adoption of the GO	SWRCB	RWQCB
Land Use and Aesthetics				
6-1: Require setbacks from areas defined as having a high potential for public exposure. The GO will be modified to state that: (a) no application of Class B biosolids shall be permitted within an area defined in the GO as having a high potential for public exposure unless the biosolids are injected into the soil and (b) educational facilities; facilities designated for recreation activities other than hunting, fishing, or wildlife conservation; places of public assembly; hospitals; or similar sensitive receptors shall be included in the definition of "populated area" as used in conjunction with the designation "High Potential for Public Exposure Areas."	The GO will be modified to require setbacks from areas defined as having a high potential for public exposure (for Class B biosolids	Before adoption of GO	SWRCB	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
6-2: Require the Maintenance of Biosolids Transport Trucks after Biosolids Are Loaded in the Trucks. The GO will be modified to stipulate that dischargers ensure that any biosolids adhering to the outside of biosolids transport trucks and tires be removed before trucks leave the dischargers' sites. Implementation of this mitigation measure will prevent biosolids from being spilled in roadways.	The GO will be modified to require the maintenance of biosolids transport trucks	Before adoption of GO	SWRCB	RWQCB
	Biological Resources			
7-1: Modify Pre-Application Report and Provide Biological Information. The pre-application report shall be revised to include a location for the discharger to indicate whether the land application site contains natural terrestrial habitat areas or whether it has been fallow for more than 1 year. The discharger must submit a report that states whether special-status species occur on the site. If special-status species occur on the site, the report must identify the measures that will be taken to mitigate or avoid impacts on these species. The report must be prepared by a qualified biologist.	The pre-application report will be modified to include biological information and information regarding whether the application site has been fallow for more than 1 year. A biological report will be submitted, if necessary	Before adoption of GO and before submittal of pre-application report	SWRCB Discharger	RWQCB
7-2: Modify Pre-Application Report and Provide Information on Biologically Unique or Sensitive Natural Communities. The pre-application report shall be revised to include a location for the discharger to indicate whether the land application site contains biologically unique or sensitive natural communities. If the application site contains these habitats, the discharger must submit a biological report with the pre-application report that indicates measures to mitigate or avoid impacts on these habitats. The report must be prepared by a qualified biologist.	The pre-application report will be modified to include biological information. If necessary, a biological report will be submitted with the pre-application report	Before adoption of GO and during submittal of pre-application report	SWRCB Discharger	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
	Fish			
8-1: Increase Setback from Enclosed Water Bodies If Pupfish Are Present. Proposed land applications in the habitat range of the pupfish should be reviewed for their proximity to enclosed water bodies that could be occupied by pupfish. If such water bodies are near the land application areas, setbacks of 500 feet should be required.	NOI will be reviewed to determine if proposed land applications are within the habitat range of the pupfish. If pupfish are present, 500-foot setbacks from water bodies will be established	Before issuance of Notice of Applicability and during land application	RWQCB	RWQCB
	Air Quality			
10-1: Properly Maintain Transport Vehicles in Good Operating Condition and Limit Truck Travel on Paved Roads to 4,800 VMT. Biosolids application projects require the use of heavy-duty trucks to haul biosolids from site generators to application sites. To keep daily NO_x emissions at or under the NO_x significance threshold, trucks must be properly maintained and kept in good operating condition. This mitigation measure will reduce NO_x emissions by 5%, thus reducing emissions to 52.9 pounds per day (assuming 4,800 VMT per day), which is below the significance threshold. This mitigation measure will reduce NO_x emission impacts to a less-than-significant level for projects generating 4800 VMT per day or less.	Truck travel to and from biosolids land application sites will be restricted to 4,800 VMT to reduce NO_x emissions	Before issuance of Notice of Applicability	RWQCB	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
10-2: Control Fugitive Dust from Unpaved Roads. Delivery of biosolids often requires the use of unpaved roads that can generate substantial amounts of fugitive dust. Biosolids application projects requiring truck travel in excess of 67 VMT per day on unpaved roads would result in significant PM10 impacts. The following mitigation measures would keep daily PM10 emissions at or under the PM10 significance threshold and therefore reduce PM10 impacts to a less-than-significant level: g Limit truck travel on unpaved roads to 67 VMT per day. OR g Apply water or chemical stabilizers that have no secondary ecological effects to unpaved roads in sufficient quantities to prevent visible dust emissions and limit truck travel on unpaved roads to 134 VMT per day. Water and/or chemical stabilizers can reduce dust generation by 50% from uncontrolled levels. Travel on unpaved roads in excess of 134 VMT per day, even with the use of water or chemical stabilizers, will result in emissions exceeding the PM10 significance threshold.	Fugitive dust will be controlled on unpaved roads	During land application	Discharger	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
Noise				
11-1: Avoid the Use of Haul Routes near Residential Land Uses. The project applicant and or transporter will avoid the use of haul routes near residential land uses to the extent possible. If the use of haul routes near residential land uses cannot be avoided, the project applicant and or transporter will limit project-related truck traffic to daylight hours (8 a.m. to 6 p.m.).	Haul routes near residential land uses will be avoided to the extent possible	During biosolids transport	Discharger	RWQCB
Cultural Resources				
12-1: Conduct a Cultural Resources Investigation. A cultural resources investigation should be conducted before disturbance is permitted on land that has not been disturbed previously. The cultural resources investigation should include a records search for previously identified cultural resources and previously conducted cultural resources investigations of the project parcel and vicinity. This records search should include, at a minimum, contacting the appropriate information center of the	A cultural resources investigation will be conducted on undisturbed lands	Before issuance of Notice of Applicability	Discharger	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
12-1. Continued California Historical Resources Information System, operated under the auspices of the California Office of Historic Preservation. In coordination with the information center or a qualified archaeologist, a determination can be made regarding whether previously identified cultural resources would be affected by the proposed project and if previously conducted investigations were performed to satisfy the requirements of CEQA. If not, a cultural resources survey may need to be conducted. The purpose of this investigation would be to identify resources before they are affected by a proposed project and avoid the impact. If the impact is unavoidable, mitigation should be determined on a case-by-case basis.				
12-2: Comply with State Laws regarding Disposition of Native American Burials, If Such Remains Are Found. If human remains of Native American origin are discovered during project activities, it is necessary to comply with state laws relating to the disposition of Native American burials, which are under the jurisdiction of the Native American Heritage Commission (Pub. Res. Code Section 5097). If human remains are discovered or recognized in any location other than a dedicated cemetery, excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent human remains will stop until:	State laws regarding disposition of Native American burials will be complied with	During land application	Discharger	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
12-2. Continued g the county coroner has been informed of the discovery and has determined that no investigation of the cause of death is required; and g if the remains are of Native American origin, – the descendants of the deceased Native Americans have made a recommendation to the landowner or the person responsible for the excavation work, for means of treating or disposing of the human remains and any associated grave goods with appropriate dignity, as provided in Public Resources Code Section 5097.98, or – the Native American Heritage Commission is unable to identify a descendant or the descendant failed to make a recommendation within 24 hours after being notified by the commission.				

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
12-2. Continued				
According to the California Health and Safety Code, six or more human burials at one location constitute a cemetery (Section 8100) and disturbance of Native American cemeteries is a felony (Section 7052). Section 7050.5 requires that construction or excavation be stopped in the vicinity of discovered human remains until the coroner can determine whether the remains are those of a Native American. If the remains are determined to be Native American, the coroner must contact the California Native American Heritage Commission.				
Cumulative Impacts				
13-1. Minimize Contribution to Groundwater Nitrate Contamination from Land Application of Biosolids Conducted under the GO. As a condition for the review of each individual NOI submitted for a proposed biosolids application project under the GO, the RWQCB engineer responsible for issuing the NOA would:	RWQCB to review application and discharger to modify discharge activities or provide additional information on potential violation of water quality standards	Before issuance of NOA	RWQCB Discharger	RWQCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
13-1. Continued g evaluate whether the proposed discharge would occur within an area designated as having existing nitrate contamination problems and g evaluate whether the proposed discharge would pose an imminent threat of contributing to or causing exceedances of water quality standards for nitrate. If the responsible engineer finds that either condition exists, the RWQCB would minimize the potential water quality impacts of the project by requiring the applicant to modify the proposed discharge activities or provide additional information to verify that the proposed discharge would not cause or contribute to violations of water quality standards. Verification that the proposed project would not cause or contribute to water quality degradation would require that sufficient information be submitted by a qualified civil engineer, agricultural engineer, or other professional hydrogeologist or water quality specialist such that the RWQCB engineer could make a finding that the proposed discharge would be in compliance with provisions of the GO. If the RWQCB finds that modifications to the proposed discharge are necessary for compliance with provisions of the GO, such modifications would consider, but would not be limited to, the following:				

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
13-1. Continued g requirements for the discharger to use the services of a certified agronomist, crop advisor, or agricultural engineer to develop additional management practices related to: 1) determining the agronomic rate for biosolids application projects that includes all sources of nitrogen applied to the application site; 2) developing overall farm water, cropping, and fertility management practices; and 3) evaluating the potential for nitrate leaching or impairment of offsite groundwater use; g requirements of the discharger to provide additional groundwater monitoring in areas where groundwater is found at depths greater than 25 feet or there exist other identified local hydrogeologic conditions that could make the groundwater susceptible to contamination; g requirements of the discharger to identify whether the proposed biosolids application site is within an area where Drinking Water Source Water Assessment and Protection (DWSWAP) Program setback requirements are implemented for municipal and domestic wells; and				

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
13-1. Continued g requirements of the discharger to consider the unique local site and hydrogeologic conditions in the design of the project and/or other groundwater quality management or regulatory programs that are currently active in the area.				
13-2: Reduce Sources of Nitrate Contamination. The SWRCB would continue to identify causes of cumulative nitrate loading in nitrate sensitive groundwater areas and develop an effective strategy for reducing those sources. An effective strategy may include, but would not be limited to, the following: g Each RWQCB should continue to implement existing groundwater pollution protection permit programs and policies to prevent or reduce nitrate contamination of groundwater. Such a program may include evaluating increased enforcement procedure, or modifying the permitting programs for other agricultural activities (e.g., confined animal feeding operations, dairies, poultry farms), industrial and municipal NPDES-permitted discharges of wastes and reclaimed water to land, and NPDES storm water management regulations.	Sources of nitrate contamination will be controlled	Ongoing	RWQCB	SWRCB

Mitigation Measures	Monitoring and Enforcement Action	Timing of Action	Implementation	Monitoring and Enforcement Responsibility
13-2. Continued				
g Other local, state, and federal permitting authorities should evaluate, integrate, increase enforcement of, or modify their existing policies and procedures to reduce the cumulative contribution of nitrates to groundwater. Examples of other regulatory programs that should be evaluated and considered in areas that would have biosolids application include groundwater management programs, residential onsite septic tank system approval, municipal landfill management plans, agricultural cooperative extension programs, and forestry management programs.				

Chapter 16. Citations

Executive Summary

California Association of Sanitation Agencies. 1991. 1991 update - sludge disposal practices in the State of California. Prepared by James M. Montgomery Consulting Engineers in association with East Bay Municipal Utility District. Sacramento, CA.

__________. 1999. January 17, 1999 - file transfer of Microsoft Access database containing California Association of Sanitation Agencies sewage sludge survey information.

California Department of Finance. 1998a. California demographics. Winter 1998 edition. Sacramento, CA.

__________. 1998b. Interim county population projections - estimated July 1, 1996 and projections for 2000, 2010, and 2020. April 1997. Internet data downloaded on September 25, 1998. URL: www.dof.ca.gov/html/ demograp/p1netar.htm. Sacramento, CA.

California Department of Health Services. 1983. Manual of good practice for land spreading of sewage sludge. Sacramento, CA.

Cornell Waste Management Institute. 1999. The case for caution: recommendations for land application of sewage sludges and an appraisal of the U.S. EPA's Part 503 sludge rules. Working Paper August 1997; revised February 1999. Prepared by E.Z. Harrison, M.B. McBride, and D.R. Bouldin. Center for the Environment, Cornell University, Ithaca, NY.

Goldstein, N. 1998. National overview of biosolids management. BioCycle, December 1998, pages 64-68.

Chapter 1. Introduction

Printed References

California Department of Health Services. 1983. Manual of good practice for land spreading of sewage sludge. Sacramento, CA.

Goldstein, N. 1998. National overview of biosolids management. BioCycle, December 1998, pages 64-68.

U.S. Environmental Protection Agency. 1994. A plain English guide to the EPA Part 503 Biosolids Rule. EPA/832/R-93/003.

Chapter 2. Program Description

Printed References

California Association of Sanitation Agencies. 1991. 1991 update - sludge disposal practices in the State of California. Prepared by James M. Montgomery Consulting Engineers in association with East Bay Municipal Utility District. Sacramento, CA.

__________. 1999. January 17, 1998 - file transfer of Microsoft Access database containing California Association of Sanitation Agencies sewage sludge survey information.

California Department of Finance. 1998a. California demographics. Winter 1998 Edition. Sacramento, CA.

__________. 1998b. Interim county population projections - estimated July 1, 1996 and projections for 2000, 2010, and 2020. April 1997. Internet data downloaded on September 25, 1998. URL: www.dof.ca.gov/html/ demograp/p1netar.htm. Sacramento, CA.

California Water Environment Association. 1996. Biosolids land application training course. December 1996. Visalia, CA.

Personal Communications

Brisco, Jim. President. Brisco Enterprises, Modesto, CA. January 7, 1999 - meeting.

Fondahl, Lauren. California biosolids coordinator. U.S. Environmental Protection Agency, Region IX, San Francisco, CA. January 27, 1999 - memorandum to Mike Harrison on biosolids quantities.

Thurber, Jeff. Technical specialist. Bio Gro, Oakland, CA. January 13, 1999 - meeting.

Chapter 3. Soils, Hydrology, and Water Quality

Printed References

Alexander, M. 1995. How toxic are toxic chemicals in soil? Environmental Science and Technology 29(11):2713-2717.

California Association of Sanitation Agencies. 1999. January 17, 1998 - file transfer of Microsoft Access database containing California Association of Sanitation Agencies sewage sludge survey information.

California Department of Food and Agriculture. 1989. Nitrates and agriculture in California. February 1989. Sacramento, CA.

__________. 1998. Fertilizer Research and Education Internet home page: URL:www.cdfa.ca.gov/inspection/frep/docs/about_frep.html

California Department of Health Services. 1999. Drinking water source assessment and protection program. Division of Drinking Water. January 1999. Sacramento, CA.

California Department of Water Resources. 1975. Bulletin 118-75. California's ground water. California State Resources Agency. Sacramento, CA.

__________. 1994a. Bulletin 160-93. California water plan update. Sacramento, CA.

__________. 1994b. Five-year report of the Municipal Water Quality Investigations Program. Division of Local Assistance. Sacramento, CA.

__________. 1994c. AB 3030 Ground water management manual, elements of a ground water management plan. Produced in association with the Ground Water Committee, Association of California Water Agencies. Sacramento, CA.

California State Water Resources Control Board. 1988. Nitrates in drinking water, report to the Legislature. Report No. 88-11WQ. Division of Water Quality. October 1988. Sacramento, CA.

__________. 1994. Report of the Technical Advisory Committee for Plan Nutrient Management. November 1994. Sacramento, CA.

__________. 1995a. Nonpoint source assessment. Sacramento, CA.

__________. 1995b. Initiatives in nonpoint source management. Sacramento, CA.

__________. 1996a. Water quality assessment report. California State Resources Agency. Sacramento, CA.

__________. 1996b. California 305(b) report on water quality. August 1996. Sacramento, CA.

Camobreco, V.J., B.K. Richards, T.S. Steenhuis, J.H. Peverly, and M.B. McBride. 1996. Movement of heavy metals through undisturbed and homogenized soil columns. Soil Science 161(11):740-750.

Chaney, R.L. Twenty years of land application research. Biocycle September 1990: 54-59.

Clapp, C.E., W.E. Larson, and R.H. Dowdy. 1994. Sewage sludge: land utilization and the environment. In O'Connor, G.A. Sewage sludge: toxic organic considerations. pp. 33-34. Published by American Society of Agronomy Inc., Crop Science Society of America Inc., and Soil Science Society of America Inc., Madison, WI.

Colwell, W.L. 1979. Forest soils of California. *In* California Forest Soils: a guide for professional foresters and resource managers and planners. Division of Agricultural Sciences, University of California.

Cornell Waste Management Institute. 1999. The case for caution: recommendations for land application of sewage sludges and an appraisal of the U.S. EPA's Part 503 sludge rules. Working Paper August 1997; revised February 1999. Prepared by E.Z. Harrison, M.B. McBride, and D.R. Bouldin. Center for the Environment, Cornell University, Ithaca, NY.

Demirjian, Y.A., A.M. Moshi, and T.R. Westman. 1987. Fate and organic compounds in land application of contaminated municipal sludge. Journal Water Pollution Control Federation 59(1): 32-38

Donahue, R.L., R.W. Miller, and J.C. Shickluna. 1983. Soils: An introduction to soils and plant growth. Fifth Edition. Prentice-Hall, Inc. Englewood Cliffs, N.J.

Dowdy, R.H., J.J. Latterell, T.D. Hinesley, R.B. Grossman, and D.L. Sullivan. 1991. Trace metal movement in an aeric Ochraqualf following 14 years of annual sludge applications. J. of Environmental Quality 20:119-123.

Emmerlich, W.E., L.J. Lund, A.L. Page, and A.C. Chang. 1982. Movement of heavy metals in sewage sludge treated soils: solid phase forms of heavy metals in sewage sludge-treated soils - predicted solution phase forms of heavy metals in sewage sludge-treated soils. J. Environmental Quality 11:174-186.

Holmgren, G.G.S., M.W. Meyer, R.L. Chaney, and R.B. Daniels. 1993. Cadmium, lead, zinc, copper, and nickel in agricultural soils of the United States of America. Journal of Environmental Quality 22:335-348.

Krogman, U., L.S. Boyles, C.J. Martel, and K.A. McComas. 1997. Biosolids and sludge management. Water Environment Research. 69: 534-550.

McGrath, S.P., and P.W. Lane. 1989. An explanation for the apparent losses of metals in a long-term field experiment with sewage sludge. Environmental Pollution 60:235-256.

Mount, Jeffrey F. 1995. California Rivers and Streams. University of California Press. Berkeley, CA.

National Academy of Sciences. 1996. Use of reclaimed water and sludge in food crop production. Committee on the Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption, Water Science and Technology Board, Commission on Geosciences, Environment and Resources, National Research Council. National Academy Press, Alexandria, VA

Northwest Biosolids Management Association, 1998. Literature review on runoff water quality from biosolids applications. Grey, M, Henry C., Thompson, D. University of Washington College of Forest Resources. Seattle, WA.

Phung, T, L. Barker, D. Ross, and D. Bauer. 1978. Land cultivation of industrial wastes and municipal solid wastes: state-of-the-art study, Volume I, Technical Summary and Literature Review. SCS Engineers. EPA-600/2-78-140a. Municipal Environmental

Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Cincinnati, OH.

Rappe, C., R. Andersson, C. Nilsson, and P. Nilsson. 1997. A field study on the use of sewage sludge as soil amendment. Organohalogen Compounds 32: 45-50

Reed, S.C. and R.W. Crites. 1984. Handbook of land treatment systems for industrial and municipal wastes. Noyes Publications, Park Ridge, NJ.

Sidle, R.C., and L.T. Kardos. 1977. Transport of heavy metals in a sludge-treated forested area. J. of Environmental Quality 6:431-437.

Sommers, L.E., D.W. Nelson, R.E. Terry, and D.J. Silviera. 1976. Nitrogen and metal contamination of natural waters from sewage sludge disposal on land. Technical Report No. 98. Purdue University Water Resources Research Center. West Lafayette, IN.

Tucker, G.B., W.A. Berg, and D.H. Gentz. 1987. pH. *In* Reclaiming mine soils and overburden in the western United States - analytic parameters and procedures. R. D. Williams and W.E. Schuman, eds. Soil Conservation Society of America, Ankeny, IA.

U.S. Department of Agriculture. 1993. Soil survey manual. (United States Department of Agriculture Handbook No. 18.) [Prepared by] Soil Survey Division Staff. Washington, DC.

U.S. Environmental Protection Agency. 1988. Sampling procedures and protocols for the National Sludge Sewage Survey. (Contract No. 68-03-3410.) Office of Water Regulations and Standards. Washington, DC.

__________. 1990. Technical support documentation for Part 1 of the National Sewage Sludge Survey Notice of Availability. Analysis and Evaluation Division. October 31, 1980. Washington, D.C.

___________. 1992. Technical support document for land application of sewage sludge. Volume 1. Prepared for Office of Water by Eastern Research Group, Lexington, MA. November 1992. Washington, D.C.

__________. 1995. A guide to the biosolids risk assessments for the EPA Part 503 rule. EPA832-B-93-005. Office of Wastewater Management. September 1995. Washington, D.C.

University of California. 1995. Department of Land, Air, and Water. Fogg, G., Rolston, D., LaBolle, E., Burow, K., Maserjian, L., Decker, D., Carle, S. Matrix Diffusion and Contaminant Transport in Granular Geologic Materials with Case Study of Nitrate Contamination in Salinas Valley, California. Davis, CA.

U.S. Soil Conservation Service. 1993. National soil survey handbook. 430-VI-NSSH, 1993). U.S. Government Printing Office, Washington, DC.

Wallace, A. and G.A Wallace. 1994. A possible flaw in EPA's 1993 new sludge rule due to heavy metal interactions. Community Soil Science Plant Analysis 25(1&2):129-135.

Chapter 4. Land Productivity

Aitken, M. N. 1995. Long-term effects of sewage sludge on grassland, in Soil use and management (1995) 11:145-154.

Cornell Waste Management Institute. 1999. The case for caution: recommendations for land application of sewage sludges and an appraisal of the U.S. EPA's Part 503 sludge rules. Working Paper August 1997; revised February 1999. Prepared by E.Z. Harrison, M.B. McBride, and D.R. Bouldin. Center for the Environment, Cornell University, Ithaca, NY.

Darmody, R. G., J. E. Foss, M. McIntosh, and D. C. Wolf. 1983. Municipal sewage sludge compost-amended soils: some spatiotemporal treatment effects, in J. Environ. Qual. (1983) 12:231-236.

Emmerlich, W.E., L.J. Lund, A.L. Page, and A.C. Chang. 1982. Movement of heavy metals in sewage sludge treated soils: solid phase forms of heavy metals in sewage sludge-treated soils - predicted solution phase forms of heavy metals in sewage sludge-treated soils. J. Environmental Quality 11:174-186.

Harrison, R., D. Xue, C. Henry, and D. W. Cole. 1994. Long-term effects of heavy applications of biosolids on organic matter and nutrient content of a coarse-textured forest soil, in Forest Ecology and Management (1994) 66:165-177.

National Academy of Sciences. 1996. Use of reclaimed water and sludge in food crop production. Committee on the Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption, Water Science and Technology Board, Commission on Geosciences, Environment and Resources, National Research Council. National Academy Press, Alexandria, VA

U.S. Environmental Protection Agency. 1992. Technical support document for land application of sewage sludge. Volume 1. Prepared for Office of Water by Eastern Research Group, Lexington, MA. November 1992. Washington, D.C.

Water Environment Federation. 1994. Beneficial use programs for biosolids management. Alexandria, VA.

Chapter 5. Public Health

Printed References

ABT Associates, Inc. 1993. Human health risk assessment for the use and disposal of sewage sludge: benefits of regulation. Government Reports Announcements & Index (GRA&I) 24.

al-Ghazali, M. R., and S. K. al-Azawi. 1988. Storage effects of sewage sludge cake on the survival of *Listeria monocytogenes*. J. Appl. Bacteriol. 65(3):209-213.

Ampel, N. M. 1996. Emerging disease issues and fungal pathogens associated with HIV infection. Emerging Infectious Diseases 2(2):109-116.

Ankley, G. T. et al. 1997. Development of a research strategy for assessing the ecological of endocrine disruptors. Rev. Toxicol. Ser. B: Environ. Toxicol. (From U. S. EPA Web site on endocrine disruptors.)

Bigness, J. 1999. Dust may be cause of meat contamination. Chicago Tribune reprinted in the Monterey County Herald, February 2, 1999 (page A3).

Brenner, K. P., P. V. Scarpino, and C. S. Clark. 1988. Animal viruses, coliphages, and bacteria in aerosols and wastewater at a spray irrigation site. Appl. Environ. Microbiol. 54:409-415.

California Association of Sanitation Agencies. 1999. January 17, 1998 - file transfer of Microsoft Access database containing California Association of Sanitation Agencies sewage sludge survey information.

California Water Environment Association. 1998. Manual of good practice - agricultural land application of biosolids. Prepared by the CWEA Steering Committee on Manual of Good Practice for Agricultural Land Application of Biosolids.

Carducci, A., S. Arrighi, and A. Ruschi. 1995. Detection of coliphages and enteroviruses in sewage and aerosol from an activated sludge wastewater treatment plant. Letters Appl. Microbiol. 21(3):207-209.

Centers for Disease Control. 1999. Internet home page containing Emerging Diseases Information and Morbidity and Mortality Weekly Reports. U.S. Department of Health and Human Services, Centers for Disease Control. www.cdc.gov/cdctext.htm. February 8-12, 1999.

Chaney, R.L. 1980. Health risks associated with toxic metals in municipal sludge. Pages 59-83 in G. Bitton, B. L. Damron, G. T. Edds, and J. M. Davidson (eds.), Sludge—health risks of land application. Ann Arbor Science Publ. Ann Arbor, MI.

Clark, C. S., et al. 1980. Health effects of occupational exposure to wastewater. Pages 239-264 in Pahren and Jakubowski (eds.), Wastewater aerosols and disease: proceedings of a symposium. September 91-21, 1979. Sponsored by Health Effects Research Laboratory, Office of Research and Development, U. S. Environmental Protection Agency.

__________. 1981. Evaluation of the health risks associated with the treatment and disposal of municipal wastewater and sludge. U.S. Environmental Protection Agency Research and Development Report. Health Effects Research Laboratory. Cincinnati, OH. (EPA-600/S1-81-030.) May (project summary).

Clark, C. S., R. Rylander, and L. Larson. 1983. Levels of gram-negative bacteria, *Aspergillus fumigatus*, dust and endotoxin at compost plants. Applied and Environmental Microbiology 45:1501-1505.

Colborn, T., and C. Clement. 1992. Chemically induced alterations in sexual and functional development: the wildlife/human connection. Princeton Scientific Publishing. Princeton, NJ.

Colborn, T., F. S. vom Saal, and A. M. Soto. 1993. Developmental effects of endocrine-disrupting chemicals in wildlife and humans. Environmental Health Perspectives 101(5):378-384.

Cooper, R. C. 1991. Disease risk among sewage plant operators: a review. Sanitary Engineering and Environmental Health Research Laboratory Report 91-1. University of California, Berkeley. Berkeley, CA.

Dawson, J. F., K. E. Hain, B. McClure, R. E. Sheridan, and J. G. Yeager. 1982. Sewage sludge pathogen transport model project. BDM Corp. Albuquerque, NM. Government Reports Announcements & Index (GRA&I), 02, NTIS/PB82-109000.

De Leon, R., C. Shieh, R. S. Baric, and M. D. Sobsey. 1990. Detection of enteroviruses and hepatitis A virus in environmental samples by gene probes and polymerase chain reaction. Pages 833-853 in Proceedings 1990 Water Quality Technology Conference. American Water Works Association. Denver, CO.

De Leon, R., S. M. Matsui, R. S. Baric, J. E. Herrmann, N. R. Blacklow, H. B. Greenberg, and M. D. Sobsey. 1992. Detection of Norwalk virus in stool specimens by reverse transcriptase-polymerase chain reaction and non-radioactive oligoprobes (RT-PCR-OP). J. Clin. Microbiol. 30:3151-3157.

De Leon, R., and C. P. Gerba. 1990. Detection of rotaviruses in water by gene probes. Wat. Sci. Tech. 24(2):281-284.

Dorn C. R., C. S. Reddy, D. N. Lamphere, J. V. Gaeuman, and R. Lanese. 1985. Municipal sewage sludge application on Ohio farms: health effects. Environ. Res. 38(2):332-59.

Droffner, M.L., and W. F. Brinton. 1995. Survival of *E. coli* and *Salmonella* populations in aerobic thermophilic composts as measured with DNA gene probes. Zentralbl. Hyg. Umweltmed. 197(5):387-97.

Eastern Research Group. 1992. Technical support document for reduction of pathogens vector attraction in sewage sludge. Lexington, MA. Prepared for U. S. EPA and available through National Technical Information Service (Document PB93110609), U. S. Department of Commerce. (Subsequently published as U.S. Environmental Protection Agency 1992).

EOA, Inc. 1995. Microbial risk assessment for reclaimed water. Final report. May 10, 1995. Prepared for Irvine Ranch Water District. Prepared in association with the University of California School of Public Health.

Fannin, K. F., S. C. Vanna, and W. Jakubowski. 1985. Effect of an activated sludge wastewater treatment plant on ambient air densities of aerosols containing bacteria and viruses. Appl. Environ. Microbiol. 49:1191-1196.

Feachem, R.G., D. J. Bradley, H. Garelick, and D. D. Mara. 1978. Health aspects of excreta and sullage management. The World Bank. Washington, D.C. [cf.: R.G. Feachem, D. J. Bradley, H. Garelick, and D. D. Mara. 1983. Sanitation and disease: health aspects of excreta and wastewater management. World Bank Studies in Water Supply and Sanitation, No. 3. John Wiley & Sons, New York.]

Feachem, R. G., et al. 1980. Appropriate technology for water supply and sanitation. World Bank. December.

Felsot, A. 1994. Pesticides, estrogen activity and breast cancer: new cause for regulatory concern? Agrichem. Environ. News 97:8-10.

Fitzgerald, P. R. 1979. Potential impact on the public health due to parasites in soil/sludge systems. Proceedings of the 8th National Conference on Municipal Sludge Management, 214. Information Transfer, Inc. Silver Springs, MD.

Gerba, C. P., D. K. Powelson, M. T. Yahya, L. G. Wilson, and G. L. Amy. 1991. Fate of viruses in treated sewage effluent during soil aquifer treatment designed for wastewater reclamation and reuse. Wat. Sci. Tech. 24(9):95-102.

Gerba, C. P., J. B. Rose, and C. N. Haas. 1996. Sensitive populations: who is at the greatest risk? International Journal of Food Microbiology 30:113-123.

Haas, C. N., J. B. Rose, C. Gerba, and S. Regli. 1993. Risk assessment of virus in drinking water. Risk Analysis 13(5):545-552.

Hammerberg, B., G. A. MacInnis, and T. Hyler. 1978. *Taenia saginata cysticerci* in grazing steers in Virginia. J. Am. Vet. Med. Assoc. 173:1462-1464.

Harris, B. L. 1996. Air quality/wind erosion dynamics of the Sierra Blanca biosolid application area. Pages 5.1-5.10 in Proceeding of the effect of land application of biosolids in the arid and semi-arid west. U. S. Environmental Protection Agency. Fort Collins, CO.

Harrison, E. Z., M. B. McBride, and D. R. Bouldin. 1999. The case for caution - recommendations for land application of sewage sludges and an appraisal of the U. S. EPA's Part 502 Sludge Rules. Working paper. Cornell Waste Management Institute, Center for the Environment, Cornell University. Ithaca, NY.

Henry, C. L. (ed). 1997. Microbial activity, survival and transport in soils amended with biosolids. Prepared for the Northwest Biosolids Management Association by the University of Washington, College of Forest Resources. (Part 5 of C. L. Henry, and R. B. Harrison, Environmental Effects of Biosolids Management.)

Jakubowski W. 1985. Epidemiological approach for determining the significance of pathogens in sewage sludge. U. S. Environmental Protection Agency, Health Effects Research Lab. Cincinnati, OH. Government Reports Announcements & Index (GRA&I) 23. NTIS/PB85-235141.

Kinde, H., D. H. Read, R. P. Chin, A. A. Bickeford, R. L. Walker, A. Ardans, H. E. Little, D. Willoughy, D. Berchold, R. Breitmeyer, D. Kerr, and I. A. Gardner. 1996. *Salmonella enteritidis*, Phase Type 4 infection in a commercial laying flock in

Southern California: bacteriologica nd epidemiologic findings. Avian Diseases 40(4):665-671.

Kowal, N. E. 1982. Health effects of land treatment: microbiological. (EPA-600/1-82-007.) U.S. Environmental Protection Agency. Cincinnati, OH.

__________. 1985. Health effects of land treatment: toxicological. (EPA-600/1-84-030.) U.S. Environmental Protection Agency. Cincinnati, OH.

Kramer, M. N. 1992. Testimony before the Committee on Merchant Marine and Fisheries, U. S. House of Reprsentatives regarding ocean dumping and enforcement and the current status of research efforts.

Lawson, H. W., M. M. Braun, R. I. Glass, S. E. Stine, S. S. Monroe, H. K. Atrash, L. E. Lee, and S. J. Englender. 1991. Waterborne outbreak of Norwalk virus gastroenteritis at a southwest US resort: role of geological formations in contamination of well water. Lancet 337(8751):1200-1204.

Little, M. D. 1980. Agents of health significance: parasites. Pages 47-58 in G. Bitton, B. L. Damron, G. T. Edds, and J. M. Davidson (eds.), Sludge--health risks of land application. Ann Arbor Science Publishers. Ann Arbor, MI.

MacMahon, B. 1994. Pesticide residues and breast cancer? (Editorial). J. National Cancer Institute 86(8):572-573.

McKay, L. D., and J. A. Cherry. 1993. A field example of bacteriophage as tracers of fractured flow. Environmental Science and Technology 27:1075-1079.

Millner, P. D., D. A. Bassatt, and P. B. Marsh. 1980. Dispersal of *Aspergillus fumigatus* from sewage sludge compost piles subjected to mechanical agitation in open air. Applied and Environmental Microbiology 39:1000-1009.

Munger, S. 1983. Health effects of municipal wastewater sludge - a risk assessment. Appendix B to the sludge management plan. Publication 334, Municipalityof Metropolitan Seattle. Seattle, WA (Abstract in Henry, C. L. 1997.)

National Academy of Sciences. 1996. Use of reclaimed water and sludge in food crop production. Committee on the Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption, Water Science and Technology Board, Commission on Geosciences, Environment and Resources, National Research Council. National Academy Press, Alexandria, VA

__________. 1978. Nitrates: an environmental assessment. National Academy of Sciences/National Research Council. Washington, DC.

National Research Council. 1977. Drinking water and health. National Academy of Sciences. Washington, DC.

Nethercott, J. R. 1981. Airborne irritant contact dermatitis due to sewage sludge. J. Occup. Med. 23(11):771-4. TOXBIB/82/100418.

Pahren, H., and W. Jakubowski (eds.). 1980. Wastewater aerosols and disease; proceedings of a symposium. September 91-21, 1979. Sponsored by Health Effects Research Laboratory, Office of Research and Development, U. S. Environmental Protection Agency.

Patel, S., S. Pedraza-Diaz, J. McLauchlin, and D. P. Casemore. 1998. Molecular characterisation of *Cryptosporidium parvum* from two large suspected waterborne outbreaks. Outbreak Control Team South and West Devon 1995, Incident Management Team and Further Epidemiologicai and Microbiological Studies Subgroup North Thames. Commun. Dis. Public Health 1(4):231-233.

Pillai, S. D., K. W. Widmer, S. E. Dowd, and S. C. Ricke. 1996. Occurrence of airborne bacteria and pathogen indicators during land application of sewage sludge. Appl. Environ. Microbiol. 62(1):296-299.

Raper, K. B., and D. I. Fennel. 1965. The genus *Aspergillus*. Williams and Wilkins Co. Baltimore, MD.

Rosenberg, A. S., and G. Y. Minimato. 1996. Aspergillosis in AIDS. The AIDS Reader 6(5):173-178.

Rusin, P. A., J. B. Rose, C. N. Haas, and C. P. Gerba.. 1997. Risk assessment of opportunistic bacterial pathogens in drinking water. Rev. Environ. Contam. Toxicol. 152:57-83.

Scarpino, P. V., L. Fradkin, C. S. Clark, N. E. Kowal, E. Lomitz, M. Baseheart, J. M. Peterson, R. L. Ward, and M. Hesford. 1988. Microbiological risk assessment for land application of municipal sludge. Pages 480-488 in Lichtenber, J.J, J. A. Winter, C. I. Weber, and L. Fradkin (eds), Chemical and biological characterization of municipal sludges, sediments, dredge spoils, and drilling muds. American Society for Testing Materials. Washington, DC.

Sorber, C. A., and B. E. Moore. 1987. Survival and transport of pathogens in sludge-amended soil - a critical literature review. Department of Civil Engineering, University of Texas at Austin. Prepared for U. S. Envronmental Protection Agency. (EPA/600/2-97/028.)

Straub, T. M., I. L. Pepper, and C. P. Gerba. 1993. Hazards from pathogenic microorganisms in land-disposed sewage sludge. Reviews of Environmental Contamination and Toxicology 132:58-61.

Straub, T. M., C. E. Enriques, V. Enriquez, C. P. Gerba, I. L. Pepper, and J. B. Rose. 1994. Monitoring of protozoan parasites in sewage biosolids and reclaimed wastewater. Pages 66-74 in Conference proceedings of the Water Environment Federation biosolids conference.

Straub T.M., I. L. Pepper, and C. P. Gerba. 1995. Comparison of PCR and cell culture for detection of enteroviruses in sludge-amended field soils and determination of their transport. Appl. Environ. Microbiol. 61(5):P2066-8.

Szabo I., K. No, and I. Varnai. 1982. Epidemic pulmonary infection associated with *Mycobacterium xenopi* indigenous in sewage-sludge. Acta Microbiol. Acad. Sci. Hung 29(4):263-266.

Teunis, P. F. M., and A. H. Havelaar. 1996. Application of microbial risk models. (Paper provided by Dr. Charles Gerba, March 27, 1996 manuscript.)

U.S. Environmental Protection Agency. 1985a. Summary of environmental profiles and hazard indices for constituents of municipal sludge: methods and results. Office of Water Regulations and Standards. Washington, DC.

__________. 1985b. Health effects of land application of municipal sludge. (EPA 600/1-85015.)

__________. 1989a. Technical support document: pathogen/vector attraction reduction in sewage sludge. Office of Water Regulations and Standards.

__________. 1989b. Environmental regulation and technology - control of pathogens in municipal wastewater sludge. (EPA/625/10-89/100.) September.

__________. 1990. National sewage sludge survey; availability of information and data, and anticipated impacts on proposed regulations; proposed rule. 40 CFR Part 503. Part III. Friday, November 9, 1990.

__________. 1992a. Technical support document for reduction of pathogens and vector attraction in sewage sludge. Office of Water. (WH-586.) EPA 822/R-93-004. November.

__________. 1992b. Technical support document for land application of sewage sludge. Office of Water. NTIS PB93-110575.

__________. 1992c. Control of pathogens and vector attraction in sewage sludge. Office of Research and Development. (EPA/625/R-92/013.)

__________. 1993. Domestic septage regulatory guidance: a guide to the EPA Part 503 rule. Office of Water. (EPA 832-B-92-005.)

__________. 1994. A plain English guide to the EPA Part 503 biosolids rule. Office of Wastewater Management. (EPA/832/R-93/003.)

__________. 1995. A guide to the biosolids risk assessments for the EPA Part 503 rule. Office of Water Management. (EPA 832-B-93-005.)

Water Environment Federation. WEF Highlights 36(1).

Winneberger, J..H.T. 1982. Nitrogen, public health and the environment. Ann Arbor Science Publishers. Ann Arbor, MI.

Woessner, W.A., T. Thomas, P. Bell, and D. C. DeBorde. 1998. Virus transport in the capture zone of a well penetrating a high hydraulic conductivity aquifer containing a preferential flow zone: challenges to natural disinfection. Pages 167-174 in Conference proceedings - source water assessment and protection. Technical Conference, April 28-30, Dallas, Texas. Sponsored by the National Water Research Institute, U. S. Environmental Protection Agency, and U. S. Geological Survey.

Yanko, W. A. 1988. Occurrence of pathogens in distributionand marketing municipal sludges. Prepared for U. S. Environmental Protection Agency Health Effects Research Laboratory, Research Triangle Park, by Los Angeles County Sanitation Districts, San Jose Creek Water Quality Laboratory, Whittier, CA. (PB88-154273.) EPA/600/1-87/014.

Zuk, J. A., D. King, H. D. Zakhour, and J. C. Deleney. 1989. Locally invasive pulmonary aspergillosis occurring in a gardener: an occupational hazard? Thorax 44:678-679.

Personal Communications

Bastian, Robert K. Senior environmental scientist. U. S. Environmental Protection Agency, Office of Water, Washington, DC. February 19, 1999 - telephone communication.

Brisco, Jim. President. Brisco Enterprises, Modesto, CA. January 7, 1999 - meeting.

Chaney, Rufus. U.S. Department of Agriculture. February 10, 1999.

Cook, Raymond. Registered environmental health specialist. Kings County Health Department, Hanford, CA. February 1, 1999 - telephone conversation.

Fondahl, Lauren. California biosolids coordinator. U.S. Environmental Protection Agency, Region IX, San Francisco, CA. January 27, 1999 - memorandum to Mike Harrison on biosolids quantities.

Gerba, Charles, Ph.D. Professor. University of Arizona, Phoenix, Arizona. February 16, 1999 - telephone communication.

Isozaki, Keith. Environmental health supervisor. Merced County Environmental Health Department. February 3, 1999 - telephone conversation.

Moise, Steven A. R.E.H.S. Riverside County Department of Environmental Health. March 22, 1999 - telephone conversation.

Shaw, Guy. Environmental health specialist. Kern County Health Department, Bakersfield, CA. February 3, 1999 - telephone conversation and facsimile transmission.

Starr, Dr. Mark. California Department of Health Services Disease Investigations & Surveillance Branch, Surveillance & Statistics Section. February 2, 1999 - telephone conversation and electronic data transmittal.

Thurber, Jeff. Technical specialist. Bio Gro, Oakland, CA. January 13, 1999 - meeting.

Chapter 6. Land Use and Aesthetics

Printed References

California Department of Finance. 1998. California Demographic Research Unit Reports, California Counties Ranked by Total Population - January 1, 1998. Sacramento, CA (Internet)

Personal Communications

Jensen, Laura. Central Valley Region, California Regional Water Quality Control Board, Sacramento, CA February 19, 1999 - Telephone conversation.

Chapter 7. Biological Resources

Printed References

California Department of Fish and Game. 1997. RareFind 2, Version 2.1.0 (August 31, 1998). Natural Diversity Data Base, California Department of Fish and Game, Sacramento, CA.

__________. 1998a. State and federally listed endangered, threatened, and rare plants of California. January 1998. Natural Heritage Division, Plant Conservation Program, Sacramento, CA.

__________. 1998b. State and federally listed endangered and threatened animals of California. April 1998. Natural Heritage Division, Natural Diversity Data Base, Sacramento, CA.

California Native Plant Society. 1994-1997. Electronic inventory of rare and endangered vascular plants of California, Version 1.5.0 (August 4, 1997). Sacramento, CA.

Fitzgerald, P. R. 1980. Observations of the health of some animals exposed to anaerobically digested sludge originating in the metropolitan sanitary district of greater Chicago system. IN: Sludge-health Risks of Land Application. Bitton, G. et al. Eds. Pp-267-284.

Henry, C. L. and R. B. Harrison. 1991. Literature reviews on environmental effects of sludge management. University of Washington, College of Forest Resources. Seattle, WA. Prepared for Regional Sludge Management Committee. July.

Martin, S. G., D. A. Thiel, J. W. Duncan, and W. R. Lance. 1987. Effects of paper industry sludge containing dioxin on wildlife in red pine plantations. In: TAPPI Proceedings 1987 Environmental Conference, Portland, OR. TAPPI Press, Atlanta. Pp. 363-377.

Mayer, K. E., and W. F. Laudenslayer, Jr. (eds.). 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire Protection. Sacramento, CA.

Zeiner, D.C., W. F. Laudenslayer, Jr., K. E. Mayer, and M. White. 1990. California's wildlife. Volumes I, II, and III. April. California Statewide Wildlife Habitat Relationships System. California Department of Fish and Game, Sacramento, CA.

Chapter 8. Fish

Printed Reference

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley.

Chapter 9. Traffic

Printed References

California Association of Sanitation Agencies. 1991. 1991 update - sludge disposal practices in the State of California. Prepared by James M. Montgomery Consulting Engineers in association with East Bay Municipal Utility District. Sacramento, CA.

California Department of Finance. 1998a. California demographics. Winter 1998 Edition. Sacramento, CA.

__________. 1998b. Interim county population projections - estimated July 1, 1996 and projections for 2000, 2010, and 2020. April 1997. Internet data downloaded on September 25, 1998. URL: www.dof.ca.gov/html/demograp/p1netar.htm. Sacramento, CA.

California Department of Health Services. 1983. Manual of good practice for land spreading of sewage sludge. Sacramento, CA.

California Department of Toxic Substances Control. 1998. A risk based regulatory system - revision of California Non-resource Conservation and Recovery Act (RCRA) waste classification regulation. June 29, 1998. Internet data downloaded on 9/1/98. URL: www.calepa.ca.gov/dtsc/rsu.htm

California Department of Transportation. California Department of Transportation Maintenance Program. July 28, 1998. Available: http//: www.dot.ca.gov/hq/maint./roadway.htm February 24, 1999.

California Department of Transportation. 1998. California Transportation Plan. "Statewide Goods Movement Strategy" Issue Papers 3&4. August 4, 1997. Available: http//:www.dot.ca.gov. February 24, 1999.

California State Water Resources Control Board. 1998. General order (GO) for general waste discharge requirements for the discharge of biosolids to land for use in agricultural, silvicultural, horticultural, and land reclamation activities in California.

California Water Environment Association. 1996. Biosolids land application training course. December. Visalia, CA.

__________. 1998. Manual of good practice for agricultural land application of biosolids. Oakland, CA.

Carollo Engineers. 1997. City and County of San Francisco draft report - long-term biosolids management plan. Sacramento, CA.

Cornell Waste Management Institute. 1999. The case for caution—recommendations for land application of sewage sludge and an appraisal of the U.S. EPA's Part 503 sludge rules. Revised. CWMI Center for the Environment. Ithaca, NY.

U.S. Environmental Protection Agency. 1994. A plain English guide to the EPA Part 503 Biosolids Rule. EPA/832/R-93/003.

Personal Communications

Harrison, Mike. Engineer. Carollo Engineers. February 18, 1999 - telephone conversation.

Pope, Craig. Road Department Director. Kern County Resource Management Agency. February 19, 1999 and February 25, 1999 - telephone conversations.

Price, Ben. Vice President. The Merriwood Corporation. February 17, 1999 - telephone conversation.

Skinner, William. General Manager. McCarthy Farms. February 25, 1999 - telephone conversation.

Chapter 10. Air Quality

Printed References

California Air Resources Board. 1998. Proposed amendments to the area designations for state ambient air quality standards, and proposed maps of the area designations for the state and national ambient air quality standards. Sacramento, CA.

__________. 1999. Motor vehicle emission inventory software available on the California Air Resources Board's web site at: http://www.arb.ca.gov/msei/mvei/mvei.htm

Sacramento County Air Quality Management District. 1994. Air quality thresholds of significance. Sacramento, CA.

San Joaquin Valley Unified Air Pollution Control District. 1998. Guide for assessing air quality impacts. Fresno, CA.

South Coast Air Quality Management District. 1993. CEQA air quality handbook. Diamond Bar, CA.

Personal Communications

Reider, R. Air quality analyst. San Diego County Air Pollution Control District. November 13, 1998 - telephone conversation regarding significance thresholds.

Chapter 11. Noise

Printed References

Federal Transit Administration. 1995. Transit noise and vibration assessment. Washington, DC.

Hoover, R. M. Noise control for buildings, manufacturing plants, equipment, and products. Houston, TX.

State of California, Office of Planning and Research. 1990. General plan guidelines. Sacramento, CA.

Chapter 12. Cultural Resources

Printed References

Basgall, M. E., and D. L. True, 1985. Archaeological investigations in Crowder Canyon, 1973-1984: Excavations at Sites SBR-421B, SBR-421C, SBR-421D, and SBR-713. Report on file, Caltrans, Sacramento CA.

Bean, L. J., and H. W. Lawton, 1973. Some explanations for the rise of cultural complexity in native California with comments on proto-agriculture. Ramona: Ballena Press Anthropological Papers, Vol. 1, pp. I-xlvii.

Bean, W. and J. J. Rawls, 1983. California: An Interpretive History. Fourth Edition. McGraw-Hill Book Company, New York.

Beck, W. A. and Y. D. Haase, 1974. Historical atlas of California. University of Oklahoma Press, Norman.

Clark, W. B. 1970. Gold districts of California. Bulletin 193. California Division of Mines and Geology. Sacramento, California.

Cook, S. F., 1976. The population of the California Indians, 1769-1970: Berkeley, University of California Press.

_________, 1978. Historical Demography. Handbook of North American Indians, California Volume 8:91-98. R. F. Heizer, ed. Smithsonian Institution, Washington, DC.

Chapter 17. Report Preparation

This draft EIR has been prepared by Jones & Stokes Associates and its subconsultants in association with the California State Water Resources Control Board. Additionally, Benton Price (The Merriwood Corporation) and Dr. Charles Gerba (University of Arizona) provided consultation or peer review during the preparation of this draft EIR. The following organizations, firms, and individuals who contributed to this report are listed below.

Jones & Stokes Associates

Albert Herson - Principal-in-Charge
Michael Rushton - Project Manager
Christine Engel - Project Coordinator
Matt Zidar - Soils, Hydrology, and Water Quality
Jeff Lafer - Soils, Hydrology, and Water Quality
Joel Butterworth - Soils, Hydrology, and Water Quality
Doug Brewer - Soils, Hydrology, and Water Quality
Roger Trott - Agricultural Resources
Rob Preston - Biological Resources
Stephanie Myers - Biological Resources
Ted Beedy - Biological Resources
Beth Campbell - Fisheries
Warren Shaul - Fisheries
Ray Weiss - Traffic, Noise
Tim Rimpo - Air Quality
Kevin Lee - Air Quality
Dave Buehler - Noise
Dana McGowan - Cultural Resources
Bill Norton - Cultural Resources
Debra Lilly - Technical Editor/Writer
Roberta Childers - Technical Editor/Writer
Charla McCollum - Word Processing
Tony Rypich - Graphics
Tim Messick - Graphics
Bev Fish - Reproduction

Carollo Engineers

Bob Gillette - Soils, Hydrology, and Water Quality
Michael Harrison - Soils, Hydrology, and Water Quality

K.P. Lindstrom, Inc.

Kris Lindstrom - Public Health

The Merriwood Corporation

Ben Price - Current Biosolids Management Practices

Quad Knopf Consultants

Harry Tow - Land Use and Aesthetics
Eugene Smith - Land Use and Aesthetics

Questa Engineering Corporation

Jeff Peters - Agricultural Resources

Harris & Company

Chris Harris - Public Participation

Appendix A. Draft Text of the General Order

STATE WATER RESOURCES CONTROL BOARD
WATER QUALITY ORDER NO. XX-XXX-DWQ

GENERAL WASTE DISCHARGE REQUIREMENTS FOR THE DISCHARGE OF BIOSOLIDS TO LAND FOR USE AS A SOIL AMENDMENT IN AGRICULTURAL, SILVICULTURAL, HORTICULTURAL, AND LAND RECLAMATION ACTIVITIES (GENERAL ORDER)

The State Water Resources Control Board (hereinafter referred to as the SWRCB) finds that:

1. Applications for the use of treated municipal sewage sludge meeting the requirements specified in Part 503 in Title 40 of the Code of Federal Regulations (CFR) (hereinafter referred to as biosolids) as a soil amendment have been received and waste discharge requirements (WDRs) have been issued by several of the nine Regional Water Quality Control Boards (RWQCBs). Section 13274 of the California Water Code requires the SWRCB or RWQCBs to prescribe General WDRs for the discharge of biosolids used as a soil amendment. This General Order is intended to satisfy the requirements of Section 13274 of the California Water Code and is intended for discharges of biosolids for use as a soil amendment. This General Order assists in streamlining the regulatory process for such discharges. For the purposes of this General Order, biosolids do not include septage. Biosolids material applicable for coverage under this General Order is as described below:

   a. All Class A biosolids not meeting the requirements contained in Table 3 of 40 CFR Part 503.13 and Class B biosolids that are land applied for agricultural, silvicultural, and horticultural activities, and land reclamation activities;

   b. All Exceptional Quality (EQ) biosolids-derived mixtures consisting of more than or equal to 50 percent biosolids (dry weight) applied at more than 10 dry-tons per acre per year to continuous fields/plots greater than 20 acres for agricultural, silvicultural, and horticultural activities, and land reclamation activities and where the said fields/plots are owned or operated by the same person, company or partnership;

   c. All EQ biosolids-derived mixtures consisting of less-than 50 percent biosolids (dry weight) applied at more than 20 dry-tons per acre per year for use as a soil amendment to continuous fields/plots greater than 20 acres for agricultural, silvicultural, and horticultural activities, and land reclamation activities and where the said fields/plots are owned or operated by the same person, company, or partnership.

2. EQ biosolids may not necessitate regulation in the future. However, public acceptance to large scale uses has indicated the need for oversight at this time, regardless of the actual threat to water quality while done at agronomic rates and using best management practices. The perception of unregulated dumping necessitates that this regulatory tool regulate material that is land applied at a high loading rate to discourage poor management and reduce risk to the public and the environment.

3. Within this General Order, the following terms are described as follows:

   a. Agriculture: The practice, science, or art of using the soil for the production of crops or raising livestock for man's use.

   b. Agricultural Mineral: Any material containing nitrogen, available phosphoric acid, or soluble potash, singly or in combination, in amounts less than 5 percent, or any substance containing essential secondary nutrients or micronutrients that is distributed for use in agriculture, silviculture, horticulture, and land reclamation activities for the purpose of promoting plant growth.

   c. Agronomic Rate: The nitrogen requirements of a plant needed for optimal growth and production, as cited in professional publications for California, by the County Agricultural Commissioner or recommended by a Certified Agronomist.

   d. Applier: Person, group of persons, or company that applies biosolids for use as a soil amendment.

   e. Biosolids: Sewage sludge that has been treated and tested and shown to be capable of being beneficially and legally used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under 40 CFR Part 503.

   f. Buffer Zones: An area of land that provides a separation distance between the land application site and an area of concern.

   g. Class A Biosolids: Biosolids meeting the pathogen reduction standards specified in 40 CFR Part 503.32(a).

   h. Class B Biosolids: Biosolids meeting the pathogen reduction standards specified in 40 CFR Part 503.32(b).

   i. Depth to Ground Water: The distance from the land surface elevation to the seasonal high water table.

j. Domestic Water Supply Well: A well that provides water used for human consumption.

k. Exceptional Quality Biosolids: Biosolids which meet metals standards, Class A pathogen reduction standards, and vector attraction reduction standards contained in 40 CFR Part 503.13 (Table 3), 40 CFR 503.32, and 40 CFR Part 503.33, respectively.

l. Fertilizing Material: Biosolids with 5 percent or more of nitrogen, available phosphoric acid, or soluble potash, singly or in combination.

m. Generator: Municipal Wastewater Treatment Facility or Sewage Sludge Treatment Facility.

n. High Potential for Public Exposure Areas: Land located within one-half mile of a developed border of a populated area.

o. Horticulture: The practice, science, or art of cultivating the soil to produce fruit, vegetables, or ornamental plants for human use.

p. Key Operating Personnel: Those individuals responsible for the oversight of daily operations, management decisions, and planning of biosolids land application projects.

q. Low Potential for Public Exposure Areas: Land not located within one-half mile of a developed border of a populated area.

r. Label: The display of all written, printed, or graphic matter on the immediate container of, or a statement, including the guaranteed analysis, accompanying fertilizing material as required by the California Department of Food and Agriculture.

s. Land Reclamation: The practice of revitalizing or restoring lands that are damaged from past or present human land use practices.

t. Long-term Storage Facility: Site which holds biosolids for more than 7 days consecutively.

u. Micronutrients: Refers to boron, chloride, cobalt, copper, iron, manganese, molybdenum, sodium, or zinc.

v. Municipal Wastewater Treatment Facilities: Facilities designed to collect and treat wastewater generated from primarily domestic sources for environmentally safe reuse or disposal.

w. Notice of Applicability: Written notice that a biosolids land application site is required to comply with the provisions of this General Order and that applications according to the General Order may commence.

x. Notice of Intent (NOI): Application for coverage under this General Order, as attached. The NOI is also a notification form for the public and interested parties for this General Order.

y. Notice of Termination (NOT): Request form to discontinue coverage of this General Order.

z. Nuisance: Nuisance means anything which meets all of the following requirements:

1. Is injurious to health, or is indecent and offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life and property.

2. Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.

3. Occurs during, or as a result of, the treatment or disposal of wastes.

aa. Pathogens: A disease causing agent including: helminths, bacteria, viruses, and protozoa.

ab. Pathogen Reduction: Process used to destroy pathogenic material contained in biosolids.

ac. Pollution: Means an alteration of the quality of the waters of the state by waste to a degree which unreasonably affects either of the following:

1. The waters for beneficial uses.

2. Facilities which serve these beneficial uses.

ad. Secondary Nutrients: The elements of calcium, magnesium, and sulfur.

ae. Septage: Waste material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar wastewater handling device that has not passed through a municipal wastewater treatment facility.

af. Sewage Sludge: The solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a municipal wastewater treatment facility. Sewage sludge includes solids removed or used during primary, secondary or advanced wastewater treatment processes. Sewage sludge does not include grit or screening material generated during preliminary treatment of domestic sewage at a municipal wastewater treatment facility.

ag. Short-term Storage: Biosolids storage sites used as a temporary holding facility for less than 7 days.

ah. Silviculture: The practice, science, or art of managing, developing and harvesting forests and trees for human use.

ai. Soil Amendment: Applications of a fertilizing material or agricultural mineral for the purpose of promoting utilization by plants and other living organisms with the goal of a net gain in soil productivity.

aj. Staging Area: Area used to hold biosolids for less than 48 hours prior to use for the specified activity listed in the NOI.

ak. Tailwater: Excess water discharged to surface water bodies resulting from crop irrigation.

al. Vector Attraction: Characteristic of biosolids that attracts potential pathogen transmitters such as flies, rodents, and other animals or organisms capable of transmitting pathogens.

4. Municipal wastewater treatment facilities serve urban and suburban population areas by collecting and treating municipal wastewater and reusing or disposing wastewater effluent. While serving the public in this manner, significant amounts of sewage sludge are generated. This material is typically further treated (stabilized) and dewatered and can be managed using a variety of options including: (a) disposal in a sanitary landfill, (b) incineration, (c) being placed into a landfill dedicated for this purpose, or (d) use as daily landfill cover, and (e) use in land application operations, including land reclamation, horticulture, agriculture, and silviculture applications.

5. Particularly in urban areas, industrial sources discharge into wastewater collection systems. Many of these discharges are regulated by pretreatment programs implemented pursuant to 40 CFR 403. These programs restrict industries from discharging toxic pollutants in concentrations creating concerns for the municipal wastewater treatment facilities (treatment facilities).

6. As a result of domestic and industrial uses, pollutants enter the collection system of municipal wastewater treatment facilities (treatment facilities). The majority of the pollutant load treated at the municipal wastewater treatment plants is organic matter. This material is removed through flotation and/or settling or converted to biological solids and then removed through settling prior to discharge. The settled material is then further treated to stabilize organic matter which constitutes the majority of the domestic sewage sludge. Metals from domestic and industrial sources are also present in the waste stream at the treatment facility. These pollutants are removed from the waste stream and concentrated in the sewage sludge. Organic chemicals can also be present from domestic and industrial uses of water. The fate of these pollutants is variable. Some are removed and destroyed through physical and biological processes at the treatment facility. Others may concentrate in the sewage sludge. Some pass through the treatment facilities unchanged and are subsequently discharged from the treatment process. A portion of the organic chemicals concentrated in the sewage sludge are degraded during sludge stabilization processes. Some organic chemicals can remain in the sewage sludge unchanged. For these reasons, testing of sewage sludge is necessary prior to their being classified as biosolids.

7. Biosolids are a source of organic matter, nitrogen, phosphorus, and micronutrients. These materials are beneficial to agriculture, silviculture, horticulture, and land reclamation activities and improve agricultural productivity. More specifically, the benefits derived from biosolids used as a soil amendment are as follows:

   a. Nitrogen is a basic nutrient for plant growth. In biosolids, it is present in the forms of ammonia, nitrates, and organic nitrogen at concentrations from 2 to 10 percent by weight on a dry weight basis. The ammonia and nitrate forms of nitrogen are immediately available for plant usage. Organic nitrogen is released slowly (mineralized) over many months, providing a continuing supply of nitrogen for crops and minimizing the potential for movement of nitrogen to the ground water. The nitrogen available for plant usage at any given time is the sum of the ammonia, nitrate, and mineralized organic nitrogen.

   b. Phosphorus is a basic nutrient for plant growth and is present in all biosolids in varying concentrations.

   c. Micronutrients, including a variety of salts and metals, are necessary for plant growth and are present in biosolids in varying amounts.

d. The addition of biosolids to soils can also be beneficial by enhancing soil structure, increasing water retention capability, promoting soil aggregation and reducing the bulk density. Organic matter assists in maintaining soil pores which allow water and air to pass through the soil medium. Such pores can be lost at sites under continuous cultivation and are critical in maintaining an aerobic environment within the plant root zone.

e. Organic matter helps soils retain water. Additional water retention can reduce the need for frequent water applications and facilitate water conservation.

f. Liming agents are available when the biosolids have been chemically stabilized with lime. Liming agents increase soil pH and can improve the permeability of the soils. Higher pH soils have a greater propensity to bind most heavy metals, decreasing the chance of the metals migrating to the ground water.

8. Biosolids have the following characteristics which can create water quality and public health problems if improperly treated, managed, and regulated during use as a soil amendment:

a. Pathogens (disease causing organisms) can be present. Unless the biosolids are specially treated or disinfected to destroy pathogens, significant concentrations of bacteria, viruses, and parasites can remain. Public health problems can be prevented with appropriate control over public access to the application areas and restrictions on the type and use of crops grown on the application sites. Buffer zones around water supply wells, surface water drainage courses, and public areas are designated to prevent transmission of pathogens to the public.

b. Heavy metals will be present. If heavy metals are over-applied to a field, they can cause ground water pollution, toxicity to plants, cause toxicity/adverse effects to soil microorganisms, or buildup in the plant tissues. A buildup of metals in plant tissues may allow transmission of the metals into the food chain, that is the cause of toxicity/adverse effects to animals eating plants or animals containing elevated metals. Future cropping or other land uses could be restricted. Only some of the metals commonly found in biosolids are known to cause water quality or public health problems. Application rates for those metals have been established to avoid the problems.

c. Nitrogen can be over-applied, allowing a buildup of nitrogen in soils. Excess nitrogen will eventually be converted to the nitrate form and can migrate to ground water. Excess nitrate in the ground water can result in the exceedance of drinking water standards and a public health threat. Nitrogen over-application can be prevented by biosolids application at an agronomic rate, that is, by matching the application rate of the nitrogen to the nitrogen usage rate of the crops and to soil permeability and soil retention capability.

d. Odor and insect nuisances can be caused if the biosolids have not been adequately treated (stabilized) prior to application or if wet biosolids are allowed to remain on the ground surface for several days. Compliance with State and Federal standards for stabilization of the biosolids will minimize the potential for odors and insect nuisances. Proper management at the application site will prevent odor or insect nuisances. Properly stabilized biosolids will generate limited, transient odors in the immediate vicinity of the application operations. Adequate buffer zones around residences and public areas, therefore, should be provided.

e. Discharge of organic matter, metals, and pathogens to surface waters can affect water quality. These effects can be prevented by controlling field runoff. The water quality threat of organic matter of biosolids origin affecting surface water is no greater than for a similar quantity of other organic soil amendments.

9. The U. S. Environmental Protection Agency (U.S. EPA) has promulgated 40 CFR 503 for the use of biosolids as a soil amendment. These regulations establish ceiling concentrations for metals and pathogen and vector attraction reduction standards; management criteria for the protection of water quality and public health; and annual and cumulative discharge limitations of persistent pollutants, such as heavy metals, to land for the protection of livestock, crop, and human health and water quality protection. The requirements of 40 CFR 503 are based on a risk-based evaluation using 14 different pathways.

10. The National Research Council established a committee to review the methods and procedures used by the U.S. EPA while forming the basis of the 40 CFR 503. The National Research Council's members are drawn from the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. Committee members included university professors from the schools of law, science, and agriculture; a state health official; a food industry professional; a professional from a sanitation agency; and a professional consultant. After a three-year study (starting in 1993), the committee made some recommendations for improvement but also stated: "Established numerical limits on concentration levels of pollutants added to cropland by sludge are adequate to assure the safety of crops produced for human consumption." As a result of the peer review, monitoring for organic chemicals and using fecal coliform testing as a parameter for determining Class A level pathogen reductions is included in this General Order.

11. Due to the extensive work done by the U. S. EPA, this General Order is using the 40 CFR 503 requirements as baseline requirements for compliance. However, this General Order is applicable to sites where biosolids are applied to land and is not intended to regulate the generator (unless the generator is also the landowner or land applier). The 40 CFR 503 requirements are intended for and enforceable against the generator. Therefore, this General Order does not constitute compliance with 40 CFR 503. Since the SWRCB is not delegated with authority for the Biosolids Program, the U. S. EPA is the only authority to determine compliance with the 40 CFR 503.

12. Each discharger covered by this General Order shall submit an annual fee and an application fee equal to the annual fee, pursuant to Section 13260, California Water Code. The amount of the fee is currently determined by the type of order issued and the threat to water quality and complexity of the specific discharge, as detailed in Section 2200, Chapter 9, Division 3, Title 23, California Code of Regulations. Biosolids application projects greater than 40 acres are deemed as Non-Chapter 15 WDRs with a Category "II" threat to water quality rating and a Category "b" complexity rating. Biosolids projects consisting of less than 40 acres are deemed Category "III" threat to water quality rating and a Category "b" complexity rating.

13. This General Order may be periodically revised to reflect changes in Federal or State laws or regulations or policies of the SWRCB or RWQCB.

14. Under Section 13263 of the California Water Code, the SWRCB can prescribe General WDRs to categories of discharges which involve the same or similar waste type or are produced by the same or similar operations.

15. This General Order shall primarily apply to the landowner of sites using biosolids, but may also include, as determined by those involved in the operation, the individuals, companies, or municipalities generating, transporting and placing the biosolids (Class A or Class B) and the land lessee, in conjunction with the landowner. To obtain coverage under the General Order, a complete NOI and an appropriate fee must be submitted to the RWQCB. Once a completed application is submitted, RWQCB staff will evaluate the project to determine if it is suitable for regulation under this General Order and the corresponding California Environmental Quality Act (CEQA) document. Only after a determination of applicability is made will the discharger be issued a Notice of Applicability by the RWQCB Executive Officer. Only applicants (dischargers) who submit a complete NOI, appropriate fee, and are issued an Notice of Applicability are authorized to land apply biosolids at an agricultural, horticultural, silvicultural, or land reclamation site as a soil amendment onto the land specified in the NOI, in compliance with the terms and conditions of this General Order. If it is determined that a local agency already adequately regulates the activity subject to this permit, the RWQCB may choose not to issue this General Order in order to avoid any duplicative regulation.

16. A separate NOI and filing fee must be filed for each biosolids reuse project to be eligible for coverage under this General Order. A separate NOI and filing fee must be filed for each landowner involved in a reuse project. Attachment A to this General Order contains an NOI form which details the minimum contents of the NOI. A single reuse project will be limited to sites comprising not more than 2,000 net acres available for application. Net acreage is the land available for application, excluding roads, surface water drainage, and required buffer areas. The sites comprising a single reuse project shall be contained within a ten-mile radius of a given location. There is no restriction of the number of NOIs which may be filed for reuse within any geographic area. A single reuse project may be a one-time application or repetitive applications to the same parcel. Filing fees are annual fees. Projects will be billed for an annual fee equaling the filing fee until the project is completed and coverage under the General Order has been terminated.

17. This General Order sets minimum standards for the use of biosolids as agricultural, horticultural, silvicultural, or reclamation site soil amendments and does not preempt or supersede the authority of local agencies to prohibit, restrict, or control the use of biosolids subject to their control. It is the responsibility of the discharger to make inquiry and obtain any local governmental agency permits or authorizations prior to the application of biosolids at each site.

18. Some areas in California have been designated as unique and valuable public resources. Such areas have been defined in the State law and the California Code of Regulations as jurisdictional waters or preserves or are addressed through acts specifically intended to preserve and manage the resource. This General Order is not applicable to those areas as described below:

    a. The Lake Tahoe Basin.

    b. The Santa Monica Mountains Zone as defined by Section 33105 of the Government Code.

    c. The California Coastal Zone as defined in and mapped pursuant to Section 30103 of the Public Resources Code.

    d. An area within one quarter mile of a wild and scenic river, as defined by Section 5093.5 of the Public Resources Code.

    e. The Sacramento-San Joaquin Delta, as defined in Water Code Section 12220.

    f. The Suisun Marsh, as defined in Public Resources Code Section 29101.

    g. The jurisdiction of the San Francisco Bay Conservation and Development Commission, as defined in Government Code Section 66610.

h. The following prohibition areas contained in the Water Quality Control Plan of the Lahontan Basin Regional Water Quality Control Board:

(1) Glenshire and Devonshire Subdivisions, Town of Truckee.

(2) Areas southwest of Piute Creek and north of Susan River and included in Sections 21, 25, 26, 27, 28, 33, 34, 35, and 36, T30N, R11E, MDB&M.

(3) Eagle Lake Basin - Spaulding Tract, Stones-Bengard Subdivision, and Eagle's Nest Summer Home Tract.

(4) Mono-Owens Planning Area.

i. Rush Creek Watershed above the outlet of Grant Lake.

ii. Mammoth Creek Watershed, including the drainage area of the community of Mammoth Lake, and the Sherwin Creek Watershed upstream of the confluence of Sherwin and Mammoth Creeks.

iii. Inyo County Service Area No. 1.

(a) Assessment District No. 1.
(b) Assessment District No. 2
(c) Rocking K Subdivision
(d) City of Bishop

(5) Antelope Valley Planning Area

i. The Antelope Hydrologic Unit above an elevation of 3,500 feet.

(6) Mojave River Planning Area

i. The Silverwood Lake Watershed.

ii. The Deep Creek Watershed above an elevation of 3,200 feet.

iii. The Grass Valley Creek Watershed above an elevation of 3,200 feet.

iv. Area north of State Highway 18 within the area commonly known as Apple Valley and Desert Knolls.

(7) Hilton Creek/Crowley Lake communities.

19. The biosolids applied to land under this General Order are non-hazardous decomposable wastes applied as a soil amendment pursuant to best management practices and, as such, are exempt from the requirements of Title 23, California Code of Regulations (CCR), Section 2510, et seq., (Chapter 15), in accordance with Section 2511(f).

20. The construction and use of biosolids storage facilities allowed by this General Order are for short-term storage of biosolids in the event that biosolids cannot be immediately applied to the ground surface because of an unanticipated event, such as mechanical breakdown of equipment or an unseasonable rainstorm. Because of the short period of storage allowed by this General Order, the stockpiled biosolids are not a threat to the quality of underlying ground water; thus, the storage basins need not be regulated as either a waste pile or surface impoundment under Title 27 of the CCR. If longer term storage is proposed, the discharger will need to apply for separate WDR for the long-term biosolids storage facility. Biosolids' application to land associated with a project using a permitted long-term biosolids' storage basin may be conducted under this General Order, if appropriate.

21. Ground water and surface waters of California have been evaluated for their maximum potential beneficial uses. Those use categories are discussed below:

a. The designated beneficial uses of surface waters within the State are:

(1) Municipal Supply (MUN)
(2) Agricultural Supply (AGR)
(3) Aquaculture (AQUA)
(4) Fresh Water Replenishment of Salton Sea (FRSH)
(5) Industrial Service Supply (IND)
(6) Ground Water Recharge (GWR)
(7) Water Contact Recreation (REC I)
(8) Noncontact Water Recreation (REC II)
(9) Warm Water Habitat (WARM)
(10) Cold Freshwater Habitat (COLD)
(11) Wildlife Habitat (WILD)
(12) Hydropower Generation (POW)
(13) Preservation of Rare, Endangered or Threatened Species (RARE).

b. The designated beneficial uses of ground waters in California are:

(1) Municipal Supply (MUN)
(2) Industrial Service Supply (IND)
(3) Agricultural Supply (AGR)

Some ground water and surface waters have fewer beneficial uses. Beneficial uses for specific water bodies can be found in the applicable RWQCB's Water Quality Control Plan (Basin Plan).

22. On _____________, in accordance with the California Environmental Quality Act (Public Resources Code, Section 21000, et seq.), the SWRCB adopted a Mitigated Environmental Impact Report No._______for these General WDRs.

23. The SWRCB has notified all known interested agencies and persons of its intent to prescribe General WDRs for the reuse of biosolids as a soil amendment and has provided them with an opportunity for a public hearing and an opportunity to submit comments.

24. The SWRCB, in a public meeting on____________________ heard and considered all comments pertaining to the General Order.

IT IS HEREBY ORDERED that all dischargers that file an NOI indicating their intention to be regulated under provisions of this General Order, and all heirs, successors, or designees, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, shall comply with the following:

A. PROHIBITIONS

1. The discharge of biosolids is prohibited unless the discharger has submitted an NOI, filing fee, and a preapplication report; and in response to these submittals, the RWQCB has issued a Notice of Applicability, individual WDRs, or a waiver of WDRs for the discharge.

2. Applications of biosolids shall be confined to the designated use areas stated and shown in the NOI and pre-application report.

3. The discharge shall not cause or threaten to cause pollution, as defined in Section 13050 of the California Water Code.

4. The application of any material that results in a violation of the Safe Drinking Water and Toxic Enforcement Act (Health and Safety Code Section 25249.5) is prohibited.

5. The storage, transport, or application of biosolids shall not cause a nuisance, as defined in Section 13050 of the California Water Code.

6. There shall be no discharge of biosolids from the storage or application areas to adjacent land areas not regulated by this General Order, to surface waters, or to surface water drainage courses.

7. Surface water runoff the permitted site resulting from irrigation of sites to which biosolids has been applied is prohibited for 30 days after application of biosolids if vegetation in the application area and along the path of runoff does not provide 33 feet of unmowed grass or similar vegetation in the application area and along the path of runoff to prevent the movement of biosolids from the application site.

8. Application of biosolids at rates in excess of the nitrogen requirements of the vegetation or at rates that would degrade ground water is prohibited except as allowed by Prohibition A.9.

9. Application of biosolids at rates in excess of the nitrogen requirements of the vegetation may be allowed for soil reclamation projects as part of an overall plan for reclamation of sites (such as abandoned mine tailings and gravel quarries), provided the discharger can demonstrate that the application of excess nitrogen will not result in unacceptable degradation of underlying ground waters. A report prepared by a Certified Agronomist, Registered Agricultural Engineer or Registered Civil Engineer providing this demonstration shall be submitted to and approved by the RWQCB Executive Officer prior to the application of biosolids to reclamation sites at greater than agronomic rates.

10. The discharge of biosolids except as allowed for authorized storage, processing, and application sites is prohibited.

11. The application of "hazardous waste" as defined in Chapter 11, Division 4.5, Title 22 of the California Code of Regulations, is prohibited.

12. Discharge of biosolids with pollutant concentrations greater than those shown below is prohibited.

Constituent	Ceiling Concentration mg/kg dry weight
Arsenic	75
Cadmium	85
Chromium	3,000
Copper	2,500
Lead	350
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7,500

13. The application of biosolids to water-saturated or frozen ground or during periods of precipitation that induces run-off from the permitted site is prohibited.

14. Any visible airborne particulates leaving the application site during biosolids applications or during incorporation of biosolids at the permitted site is prohibited.

15. The application of biosolids in areas where biosolids are subject to erosion or washout offsite is prohibited.

B. DISCHARGE SPECIFICATIONS

1. All biosolids subject to this General Order shall comply with the applicable pathogen reduction standards listed in 40 CFR 503.32. In addition to those standards, all biosolids meeting Class A standards shall not have a maximum fecal coliform concentration greater than 1,000 MPN per gram of biosolids.

2. All biosolids subject to this order shall comply with one of the applicable vector attraction reduction requirements specified in 40 CFR 503.33.

3. Biosolids' application rates shall not exceed the agronomic rate for nitrogen for the crop being planted except as allowed by Prohibition No. 9 or for biosolids research projects.

4. Biosolids shall not be applied to land in amounts that cause the following cumulative loadings (including background soils metals and metals additions from biosolids) to be exceeded:

Cumulative Loadings:		
Constituent	Kilograms per hectare	pounds per acre
Arsenic	41	36
Cadmium	39	34
Copper	1,500	1,336
Lead	300	267
Mercury	17	15
Molybdenum	18	16
Nickel	420	374
Selenium	100	89
Zinc	2,800	2,494

5. If biosolids are incorporated into the ground, tillage practices shall be used which minimize the erosion of soils from the application site by wind, storm water, or irrigation water.

6. If biosolids are applied to ground surfaces having a slope greater than ten percent (10%), a report, including an erosion control plan, shall be prepared by a Certified Agronomist, Registered Agricultural Engineer, Registered Civil Engineer, or a Certified Professional Erosion and Sediment Control Specialist and submitted to the RWQCB for approval. This report shall describe the site conditions that justify application of biosolids to the steeper slopes and shall specify the application and management practices necessary (a) to assure containment of the biosolids on the application site and (b) to prevent soil erosion.

7. Biosolids distinguished as "Class B" in 40 CFR 503 must comply with the following:

    a. The discharge of tailwater or field runoff within 30 days after application of biosolids is prohibited for application areas where biosolids have not been incorporated into the soil, and there is not a minimum of 33 feet[1] of unmowed grass or similar vegetation bordering the application area and along the path of runoff to prevent movement of biosolids particles from the application site.

    b. After an application of biosolids in any field, the discharger shall ensure the following:

        (1) For at least 30 days:

            (a) Public access to the application sites is restricted for sites with a low potential for public exposure;
            (b) Food, feed, and fiber crops are not harvested; and
            (c) Animals are not grazed.

        (2) For at least 12 months:

            (a) Public access to the site is restricted for sites with a high potential for public exposure;
            (b) Turf is not to be harvested if the harvested turf is placed on land with a high potential for contact by the public as defined in 40 CFR 503.11; and

[1] For sites where the topography slopes greater than 10 percent, the minimum width of vegetative border shall be proposed in accordance to Discharge Specification No.6. above.

(c) Grazing of milking animals used for producing unpasteurized milk for human consumption is prevented if the field is used as pasture.

(3) For at least 14 months:

Food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface are not harvested.

(4) For at least 20 months:

Food crops with harvested parts below the land surface are not harvested, when the biosolids remain exposed on the surface for four months or longer prior to incorporation.

(5) For at least 38 months:

Food crops with harvest parts below the land surface are not harvested, when the biosolids remained exposed on the ground surface for less than four months prior to incorporation into the soil.

8. Staging and biosolids' applications areas shall be at least:

(a) 10 feet from property lines,
(b) 500[1] feet from domestic water supply wells,
(c) 100[2] feet from non-domestic water supply wells,
(d) 50 feet from public roads,
(e) 100 feet from surface waters[3], including wetlands, creeks, ponds, lakes, underground aqueducts, and marshes,
(f) 10 feet from agricultural buildings,
(g) 33 feet from primary agricultural drainage ways,
(h) 500 feet from occupied non-agricultural buildings, and off-site residences,
(i) 400 feet from a domestic water supply reservoir,
(j) 200 feet from a primary tributary to a domestic water supply,
(k) 2,500 feet from any domestic surface water supply intake.

---

1 A lesser setback distance from domestic supply wells (not to be less than 100 feet) may be used if the discharger can demonstrate to the Executive Officer that the ground water, geologic, topographic and well construction conditions at the specific site are adequate to protect the public health of individuals using the supply well.

2 A lesser setback distance (not to be less than 25 feet) may be used if the discharger can demonstrate to the Executive Officer that the ground water, geologic, topographic and well construction conditions at the specific site are adequate to protect the groundwater.

3 Not including agricultural drains.

C. BIOSOLIDS' STORAGE[1] AND TRANSPORTATION SPECIFICATIONS

Biosolids shall be considered to be "stored" if they are placed on the ground or in non-mobile containers (i.e., not in a truck or trailer) at the application site or an intermediate storage location away from the generator/processing for more than 48 hours. Biosolids shall be considered to be "staged"if placed on the ground for brief periods of time solely to facilitate transfer of the biosolids between transportation and application vehicles.

1. Biosolids shall not be stored for more than seven (7) consecutive days prior to application.

2. Biosolids containing free liquids shall not be placed on the ground prior to application on an approved site, excluding equipment cleaning operations.

3. Biosolids shall not be stored directly on the ground at any one location for more than seven (7) consecutive days.

4. Sites for the storage of Class B biosolids shall be located, designed, and maintained to restrict public access to the biosolids.

5. Biosolids' storage facilities that contain biosolids between October 1 and April 30 shall be designed and maintained to prevent washout or inundation from a storm or flood with a return frequency of 100 years.

6. Biosolids' storage facilities that contain biosolids between October 1 and April 30 shall be covered during periods of runoff inducing precipitation.

7. Biosolids' storage facilities shall be designed, maintained, and operated to minimize the generation of leachate and the effects of erosion.

8. If biosolids are to be stored at the site, a plan describing the storage program and means of complying with this General Order shall be submitted for RWQCB Executive Officer approval not less than 60 days prior to the storage of biosolids. The storage of biosolids shall not commence until after approval of the plan.

9. The discharger shall operate the biosolids' storage facilities in accordance with the approved biosolids' storage plan.

10. The discharger shall immediately remove and relocate any biosolids stored or applied on site in violation of this General Order.

---

[1] Applies to biosolids' storage facilities as the reuse site, not to biosolids' storage facilities which are part of a wastewater treatment plant or which are covered by separate WDRs.

11. All biosolids shall be transported in covered and leak proof vehicles.

12. Each biosolids' transport driver shall be trained as to the nature of their load and the proper response to accidents or spill events and carry a copy of an approved spill response plan.

D. PROVISIONS

1. To obtain coverage under this General Order and terminate coverage thereof, the following must take place:

a. Coverage:

A complete NOI form and filing fee must be filed by the discharger for each proposed application site covered by these General WDRs. The NOI form may be modified by the RWQCB Executive Officer as the need arises. An NOI form is attached (Attachment A) to this General Order. Coverage does not begin until a notice of applicability has been issued by the applicable RWQCB's Executive Officer.

b. Coverage Termination:

(1) A biosolids application project covered by these General WDRs may be terminated by submittal of the Final Monitoring and Reporting Program technical report and a Notice of Termination (NOT), as shown on Attachment B of these General WDRs. The discharger(s) will be responsible for paying all annual fees for coverage under these General WDRs until approval of the NOT is granted by the RWQCB Executive Officer. For sites using Class B biosolids, termination shall not take place until 38 months after the last Class B biosolids application. The NOT form may be modified by the RWQCB Executive Officer as the need arises.

(2) If an individual WDR Order is issued to the discharger for a project covered by this General Order, the applicability of this General Order to the discharger is automatically terminated on the effective date of the individual WDR Order.

2. Where ground water monitoring is required, as specified by the Executive Officer or contained in the Monitoring and Reporting Program, the ground water monitoring program must be in place prior to any application of biosolids.

3. The discharger shall submit copies of each NOI to the appropriate regional office(s) of the Department of Fish and Game, local water district, City Planning Department, County Health Department(s), County Planning Department(s), and County Agricultural Commissioner(s) with jurisdiction over the proposed application site(s). Also, the discharger shall notify adjacent property owners with parcels abutting the subject land application site and, where applicable, tennants. The Discharger shall submit proof to the Regional Board that all the above agencies and persons were notified. Other than compliance evaluations, the Regional Board is not responsible for the notification process.

4. The discharger shall comply with the Monitoring and Reporting Program No. XX-XXX which is part of this General Order and any revisions thereto.

5. The discharger must notify the RWQCB Executive Officer in writing at least 30 days in advance of any proposed transfer of this General Order's responsibility and coverage to a new discharger. The notice must include a new NOI for the proposed discharger, an NOT for the existing discharger, and a specific date for the transfer of this General Order's responsibility. This agreement shall include an acknowledgment that the existing discharger is liable for compliance with this General Order and for all violations up to the transfer date and that the new discharger is liable for compliance with this General Order and all violations after the transfer date.

6. Where the discharger becomes aware that it failed to submit any relevant facts in an NOI or submitted incorrect information in an NOI or in any report to the RWQCB, it shall promptly submit such facts or information.

7. The discharger shall be responsible for informing all biosolids transporters and growers using the site of the conditions contained in this General Order.

8. The discharger must comply with all conditions of this General Order, including timely submittal of technical and monitoring reports as directed by the RWQCB Executive Officer. Violations may result in enforcement action, including RWQCB or court orders requiring corrective action or imposing civil monetary liability or revision or rescission of the applicability of this General Order to a specific project.

9. Individuals and companies responsible for site operations retain primary responsibility for compliance with these requirements, including day-to-day operations and monitoring. Individual property owners and property managers retain primary responsibility for crop selection and any access or harvesting restrictions resulting from biosolids' application. Individual owners of the real property at which the discharge will occur are ultimately responsible for ensuring compliance with these requirements. Enforcement actions for violations of this General Order may be taken against all dischargers required to comply with this General Order.

10. A copy of this General Order shall be kept at the discharge facility for reference by operating personnel. Key operating personnel shall be familiar with its contents.

11. This General Order does not convey any property rights of any sort or any exclusive privileges. The requirements prescribed herein do not authorize the commission of any act causing injury to persons or property, do not protect the discharger from his liability under Federal, State or local laws, nor do they create a vested right for the discharger to continue the waste discharge.

12. Provisions of these WDRs are severable. If any provision of these requirements is found invalid, the remainder of these requirements shall not be affected.

13. The SWRCB will review this General Order periodically and will revise requirements when necessary.

14. The discharger, at all times, shall properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with conditions of this General Order. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of this General Order.

15. The discharger shall allow the RWQCB or an authorized representative upon the presentation of credentials, valid identification with photograph, and other documents as may be required by law to:

    a. Enter upon the discharger's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this General Order;

b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Order;
c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Order; and
d. Sample or monitor at reasonable times, any substances or parameters at any location for the purposes of assuring compliance with this General Order or as otherwise authorized by the California Water Code.

16. All monitoring instruments and devices used by the discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy. All measurement devices shall be calibrated at least once per year or more frequently to ensure continued accuracy of the devices.

Unless otherwise permitted by the RWQCB's Executive Officer, all analyses shall be conducted at a laboratory certified for such analyses by the California Department of Health Services. The RWQCB's Executive Officer may allow use of any uncertified laboratory under exceptional circumstances, such as when the closest laboratory to the monitoring location is outside the State boundaries and therefore not subject to certification. All analyses shall be required to be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants" (40 CFR Part 136) or "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (SW - 846) as established by the U. S. EPA.

17. The discharger shall report any noncompliance which may endanger human health or the environment. Any such information shall be provided orally to the RWQCB's Executive Officer within 24 hours from the time the discharger becomes aware of the circumstances. A written submission shall also be provided within five days of the time the discharger becomes aware of the circumstances. The written submission shall contain (a) a description of the noncompliance and its cause; (b) the period of noncompliance, including exact dates and times; and (c) if the noncompliance has not been corrected, the anticipated time the noncompliance is expected to continue and steps being taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance with a time schedule that includes milestone dates. The RWQCB Executive Officer or an authorized representative may waive the written report on a case-by-case basis if the oral report has been received within 24 hours. Also, the discharger shall notify the Office of Emergency Services (1-800-852-7550) and the local health department as soon as practical but within 24 hours after the incident.

18. The discharger shall retain records of all monitoring information including all calibration and maintenance records for on-site monitoring equipment (if applicable), copies of all reports required by this General Order, and records of all data used to complete the application for this General Order. Records shall be maintained for a minimum of three years from the date of the sample, measurement, report, or application. This period may be extended during the course of any unresolved litigation regarding this discharge or when requested by the RWQCB Executive Officer.

    Records of monitoring information shall include:

    a. The date, exact place, and time of sampling or measurements;
    b. The individual(s) who performed the sampling or measurements;
    c. The date(s) analyses were performed.
    d. The individual(s) who performed the analyses;
    e. The analytical techniques or method used; and
    f. The results of such analyses.

19. All application reports or information to be submitted to the RWQCB Executive Officer shall be signed and certified as follows:

    a. For a corporation--by a principal executive officer or at least the level of vice president.
    b. For a partnership or sole proprietorship--by a general partner or the proprietor, respectively.
    c. For a municipality, State, Federal, or other public agency--by either a principal executive officer or ranking elected official.

20. A duly authorized representative of a person designated in Provision No. 19 of this provision may sign documents if:

    a. The authorization is made in writing by a person described in Provision No. 19, above.
    b. The authorization specifies either an individual or position having responsibility for the overall operation of the regulated facility or activity; and
    c. The written authorization is submitted to the RWQCB Executive Officer.

    Any person signing a document under these Provisions shall make the following certification:

    > "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals

immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on ______________________.

AYE:

NO:

ABSENT:

ABSTAIN:

____

Maureen Marché
Administrative Assistant to the Board

STATE WATER RESOURCES CONTROL BOARD
MONITORING AND REPORTING PROGRAM NO.XX-XXX-DWQ
GENERAL WASTE DISCHARGE REQUIREMENTS (WDRs) FOR THE
DISCHARGE OF BIOSOLIDS TO LAND FOR USE IN AGRICULTURAL,
SILVICULTURAL, HORTICULTURAL, AND LAND RECLAMATION ACTIVITIES

PRE-APPLICATION REPORT

A pre-application report shall be submitted for each field or distinct application area prior to the initial application of biosolids in proposed application areas in accordance with the WDRs. Where biosolids are applied on a continuing basis to a single area, the pre-application report may cover ongoing operations and need not be submitted for each load applied. The Pre-Application Report shall be signed by the Owner/Operator of the biosolids' application operation and by the Property Owner. The Property Owner may submit written authorization to allow a representative of the Property Owner, such as a tenant or land management company, to sign the Pre-Application Report.

The following items shall be included in the Pre-Application Report and shall be submitted to the appropriate Regional Water Quality Control Board (RWQCB):

Waste Discharge Identification System No.___________________________

This number is established at the time the initial Notice of Intent (NOI) is submitted to the RWQCB and can be obtained at the RWQCB.

1. **Site Location/Applier**--A separate Pre-Application Report must be filled out for each different site.

Applier:	
Address:	
Contact:	Phone:
Site Location (including address, if any):	
Nearest Cross Street(s):	
County:	Total Size of Site
Section(s)/Township/Range/Meridian:	
Latitude (from field center):	Longitude (from field center):

Attach a USGS 7.5 Minute map or similar map (1:24000 or larger) showing the proposed application site and surrounding properties within 2,500 feet from site boundaries. The map should show:

a. Site topography
b. Run-on/runoff controls
c. Storage or staging areas
d. Nearby surface waters, wells, residences, and public roads
e. Application area(s) including buffer zones (setbacks)
f. Ground water monitoring wells (if required)
g. Site elevation

2. **Biosolids Source**--A separate Pre-Application Report must be filled out **for each different biosolids' source**.

Wastewater Treatment Plant				
Mailing Address				
City	County	Zip	State	Phone
Contact Person				

Level of pathogen treatment: Class A__________ Class B__________
Description of treatment and how vector attraction reduction was achieved:____

3. **Constituent Concentrations (Each Source)**

Constituent	Concentration in Biosolids, mg/kg, dry weight	Concentration in Soil, mg/kg, dry weight
Arsenic		
Cadmium		
Chromium		
Copper		
Lead		
Mercury		
Molybdenum		
Nickel		
Selenium		
Zinc		
pH		
Cation Exchange Capacity	N/A	meq/100g
Salinity		
Total Solids Content	%	N/A
Total Nitrogen		
Fecal Coliform	MPN/gram	N/A
Ammonia Nitrogen, as N		
Total Phosphorus, as P		
Total Potassium		
SW 846[1] Method 8080 for PCB Aroclors, Aldrin/Dieldrin		
EPA Method 8270 Semi-Volatile Organics		

Date samples collected ______________ ______________

---

1 The Discharger shall use the most recent version of SW 486 methods for detecting PCB constituents and list all Aroclor concentrations with the summation of total PCBs.

Date samples analyzed ________________ ________________
Attach copies of all lab reports.

4. **Application Area Information**

Subject	Value	Applicable Unit/ Type of Measure
Quantity of Biosolids to be Applied		dry tons per year
Total Biosolids Application Proposed		dry tons
Land Use Zone		
Adjacent Land Use Zones		
Application Area Size		acres
Proposed Nitrogen Loading		lb. Plant Available Nitrogen/acre
Estimated Permeability	N/A	cm/sec
Proposed Crop, use		crop type, human/animal/neither
Crop Nitrogen Usage		1b. Nitrogen/year
Nitrogen Usage Reference		
Depth of Root Zone for Crop Being Planted		inches
On-site Biosolids Storage?		Yes or No
Will Setback Limits be Met?		Yes or No
Distance to Nearest Inhabited Dwelling		feet/miles
Distance to Nearest Surface Waters, Name of Water Body, Ephemeral/Perennial		feet/miles Name ephemeral/perennial
Public Access Controls		Specify Type
Runoff Controls		Attach plans
Prevailing Wind Direction		
Minimum Depth to Ground Water		feet
How Minimum Depth to Ground Water Determined		
Site Zoning		
Anticipated Average Daily Application Rate		dry tons/day
Average Annual Precipitation		inches/year

Attach an anticipated annual time schedule for the field operations including anticipated biosolids applications windows, seeding operations, supplemental fertilization, and cultivation/harvest.

5. **Ground Water Monitoring**

For biosolids' application operations where minimum depth to useable ground water[3] is less than 25 feet, a ground water monitoring program, at a minimum, consists of three monitoring wells (one upgradient, two downgradient) for each application area is required and shall be in place prior to any application of biosolids if the discharger intends to or does apply biosolids more than twice within a five-year period at any particular location. A report specifying location, construction, and development details of ground water monitoring wells shall be submitted to the RWQCB for approval by the Executive Officer prior to the installation. In addition, a mean sea level (MSL) reference elevation shall be established for each well in order to determine water elevations. The Executive Officer, after reviewing the information submitted, may waive this requirement if it is determined that the benefit of such monitoring is not commensurate to the level of protection.

Results shall be submitted to the RWQCB 30 days prior to any biosolids' application at each site and annually thereafter. Samples shall be collected from each of the monitoring wells annually and shall be analyzed for the following parameter

Parameter	Units
Static Water Level	feet (MSL)
Total Dissolved Solids	mg/L
Sodium	mg/L
Chloride	mg/L
Nitrate	mg/L as N
Total Nitrogen	mg/L as N
pH	pH units

Initial testing shall also include the following parameters:

Arsenic	mg/L
Cadmium	mg/L
Chromium	mg/L
Copper	mg/L
Lead	mg/L
Mercury	mg/L
Molybdenum	mg/L
Nickel	mg/L
Selenium	mg/L
Zinc	mg/L

3 Useable ground water: Ground water is defined as having either an agricultural or domestic supply source as descibed in the Regional Water Quality Control Board Basin Plan

6. **Biosolids' Storage Plan**

A biosolids' storage plan must be attached (even if no *on-site* biosolids storage will be provided). The biosolids' storage plan should include at a minimum:

If on-site storage will be provided:

a. Size of biosolids storage (or staging) area
b. How frequently it will be used (emergency basis only or routine use)
c. Leachate controls
d. Erosion controls
e. Run-on/runoff controls

If no on-site storage will be provided:

a. Location of off-site storage facilities
b. Emergency storage plans

7. **Erosion Control Plan (if applicable)**

Biosolids applied to ground surfaces having a 10 percent or greater slope requires an Erosion Control Plan. The Plan should outline conditions that justify application of biosolids to the 10 percent or greater slopes and specify the application and management practices to be used to assure containment of the biosolids on the application site.

8. **Spill Response and Traffic Plan**

a. The Spill Response Plan should include at a minimum:

1 Emergency contacts and notification procedures
2. Require personal protective equipment require
3. Response instructions for spill during biosolids transport
4. Response instructions for storage facility failure
5. Response instructions if hazardous or other unauthorized material is found

b. The Traffic Plan should include at a minimum:

1. The proposed route for all vehicles handling biosolids
2. Describe the anticipated maximum vehicle weight
3. Identify all load restrictions for each traveled roadway

9. Adverse Weather and Alternative Plan:

Submit an Adverse Weather and Alternative Plan that details procedures to address times when biosolids cannot be applied to the site(s) due to adverse weather or other conditions (wind, precipitation, field preparation delays, access road limitations, etc.).

ANNUAL REPORTING

1. **Ground Water Monitoring** (if required in the pre-application report)

   Samples shall be collected from each of the monitoring wells annually and shall be analyzed for the following parameters:

Parameter	Units
Static Water Level	feet (MSL)
Total Dissolved Solids	mg/1
Sodium	mg/1
Chloride	mg/1
Nitrate	mg/1 as N
Total Nitrogen	mg/1 as N
pH	pH units

2. **Application Information**

Quantity of Biosolids Applied		dry tons
Application Area Size		acres
Total Nitrogen Concentration in Biosolids		mg/kg
Nitrogen Loading		1b. Plant Avail. Nitrogen/Acre
Crop		
Amount of Crop Produced		specify units

3. **Pollutant Loadings for Each Application Site**

Pollutant	Total Loadings from Previous Years, kg/ha	Loading This Year, kg/ha	Background Soils Conc. kg/ha	Cumulative Metal Load to Date, kg/ha	Percent Cumulative Limit to Date
Arsenic					
Cadmium					
Chromium					
Copper					
Lead					
Mercury					
Molybdenum					
Nickel					
Selenium					
Zinc					

4. **Constituent Concentrations (Each Source)**

Constituent	Concentration in Biosolids, mg/kg, dry weight
Arsenic	
Cadmium	
Chromium	
Copper	
Lead	
Mercury	
Molybdenum	
Nickel	
Selenium	
Zinc	
Total Solids Content	%
Total Nitrogen	
Fecal Coliform	MPN/gram
Ammonia Nitrogen, as N	
Total Phosphorus, as P	
Total Potassium	
SW 846[1] Method 8080 for PCB Aroclors, Aldrin/Dieldrin	
EPA Method 8270 Semi-Volatile Organics	

5. **Site Map**

Provide a site map identifying the area(s) of application clearly showing each field to which biosolids have been applied and crop planted.

GENERAL REPORTING

1. Pre-Application Reports shall be submitted for RWQCB staff review and approval at least 30 days prior to application of biosolids. Annual Reports shall be submitted by January 15 of every year.

2. The collection, preservation, and holding times of all samples shall be in accordance with U.S. Environmental Protection Agency approved procedures. All analyses shall be conducted by a laboratory certified by the California Department of Health Services to perform the required analyses. The RWQCB's Executive Officer may allow use of an uncertified laboratory in accordance with Provision No. 16.

---

1 The Discharger shall use the most recent version of SW 486 methods for detecting PCB constituents and list all Aroclor concentrations with the summation of total PCBs.

3. If there is no discharge during a required reporting period, the discharger shall submit a letter report to the RWQCB indicating that there has been no activity during the required reporting period.

4. Each report shall be signed and contain the following certification:

   "I declare under the penalty of law that I have personally examined and am familiar with the information submitted in this document; and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

5. A duly authorized representative of the discharger may sign the documents if:

   a. The authorization is made in writing by the person described above;

   b. The authorization specified an individual or person having responsibility for the overall operation of the regulated disposal system; and

   c. The written authorization is submitted to the RWQCB's Executive Officer.

6. The discharger shall arrange the data in tabular form so that the specified information is readily discernible. The data shall be summarized in such a manner as to clearly illustrate whether the facility is operating in compliance with waste discharge requirements.

7. Report immediately (within 24 hours) by telephone with follow-up letter any discharge which threatens the environment or human health to the RWQCB Executive Officer and Director of County Environmental Health. During non-business hours report by telephone the Office of Emergency Services at 1-800-852-7550.

8. The results of any monitoring done more frequently than required at the locations specified in the Monitoring and Reporting Program shall be reported to the RWQCB.

Appendix B. Notice of Preparation and Distribution List

Notice of Completion

Form A

See NOTE below

SCH # ____________

Mail to: State Clearinghouse, 1400 Tenth Street, Sacramento, CA 95814 916/445-0613

Project Title: NOP for a statewide program EIR on General Waste Discharge Requirements for Biosolids Land Application

Lead Agency: California State Water Resources Control Board | Contact Person: Todd Thompson

Street Address: 901 P Street | Phone: 916/657-0577

City: Sacramento, CA | Zip: 95814 | County: Sacramento

Project Location

County: entire state | City/Nearest Community: varies

Cross Streets: N/A | Total Acres: N/A

Assessor's Parcel No. N/A | Section: ____ | Twp. ____ | Range: ____ | Base: ____

Within 2 Miles: State Hwy #: ____ | Waterways: ____

Airports: ____ | Railways: ____ | Schools: ____

Document Type

CEQA:
- [x] NOP
- [ ] Early Cons
- [ ] Neg Dec
- [ ] Draft EIR
- [ ] Supplement/Subsequent
- [ ] EIR (Prior SCH No.) ____
- [ ] Other ____

NEPA:
- [ ] NOI
- [ ] EA
- [ ] Draft EIS
- [ ] FONSI

Other:
- [ ] Joint Document
- [ ] Final Document
- [ ] Other ____

Local Action Type

- [ ] General Plan Update
- [ ] General Plan Amendment
- [ ] General Plan Element
- [ ] Community Plan
- [ ] Specific Plan
- [ ] Master Plan
- [ ] Planned Unit Development
- [ ] Site Plan
- [ ] Rezone
- [ ] Prezone
- [ ] Use Permit
- [ ] Land Division (Subdivision, Parcel Map, Tract Map, etc.)
- [ ] Annexation
- [ ] Redevelopment
- [ ] Coastal Permit
- [ ] Other ____

Development Type

- [ ] Residential: *Units* ____ *Acres* ____
- [ ] Office: *Sq.ft.* ____ *Acres* ____ *Employees* ____
- [ ] Commercial: *Sq.ft.* ____ *Acres* ____ *Employees* ____
- [ ] Industrial: *Sq.ft.* ____ *Acres* ____ *Employees* ____
- [ ] Educational ____
- [ ] Recreational ____
- [ ] Water Facilities: *Type* ____ *MGD* ____
- [ ] Transportation: *Type* ____
- [ ] Mining: *Mineral* ____
- [ ] Power: *Type* ____ *Watts* ____
- [ ] Waste Treatment: *Type* ____
- [ ] Hazardous Waste: *Type* ____
- [x] Other: General Waste Discharge Requirements

Project Issues Discussed in Document

- [x] Aesthetic/Visual
- [x] Agricultural Land
- [x] Air Quality
- [x] Archeological/Historical
- [ ] Coastal Zone
- [x] Drainage/Absorption
- [ ] Economic/Jobs
- [ ] Fiscal
- [x] Flood Plain/Flooding
- [ ] Forest Land/Fire Hazard
- [x] Geologic/Seismic
- [ ] Minerals
- [x] Noise
- [ ] Population/Housing Balance
- [ ] Public Services/Facilities
- [ ] Recreation/Parks
- [ ] Schools/Universities
- [ ] Septic Systems
- [ ] Sewer Capacity
- [x] Soil Erosion/Compaction/Grading
- [x] Solid Waste
- [x] Toxic/Hazardous
- [x] Traffic/Circulation
- [x] Vegetation
- [x] Water Quality
- [x] Water Supply/Groundwater
- [x] Wetland/Riparian
- [x] Wildlife
- [ ] Growth Inducing
- [x] Land Use
- [x] Cumulative Effects
- [x] Other public health

Present Land Use/Zoning/General Plan Use

N/A

Project Description

The California State Water Resources Control Board (SWRCB) proposes to adopt a General Order for General Waste Discharge Requirements for the discharge of biosolids to land for use in agriculture, silviculture, horticulture, and land reclamation activities in California. Biosolids are defined as sewage sludge that has been treated tested, and shown to be capable of being beneficially used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under federal regulation.

NOTE: Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. from a Notice of Preparation or previous draft document) please fill it in.

Revised October 1989

Reviewing Agencies Checklist

Key
S = Document sent by lead agency
X = Document sent by SCH
✓ = Suggested distribution

	Resources Agency
	Boating & Waterways
✓	Coastal Commission
	Coastal Conservancy
	Colorado River Board
	Conservation
S	Fish & Game
✓	Forestry
✓	Office of Historic Preservation
✓	Parks & Recreation
	Reclamation
✓	S.F. Bay Conservation & Development Commission
S	Water Resources (DWR)
	Business, Transportation & Housing
	Aeronautics
	California Highway Patrol
✓	CALTRANS District # ______
	Department of Transportation Planning
	Housing & Community Development
S	**Food & Agriculture**
	Health & Welfare
S	Health
	State & Consumer Services
	General Services
	OLA (Schools)

	Environmental Affairs
S	Air Resources Board
✓	APCD/AQMD
S	California Waste Management Board
	SWRCB: Clean Water Grants
	SWRCB: Delta Unit
	SWRCB: Water Quality
	SWRCB: Water Rights
S	Regional WQCB # ______ (all regions)
	Youth & Adult Corrections
	Corrections
	Independent Commissions & Offices
✓	Energy Commission
✓	Native American Heritage Commission
	Public Utilities Commission
	Santa Monica Mountains Conservancy
✓	State Lands Commission
	Tahoe Regional Planning Agency
	Other ______

Public Review Period (to be filled in by lead agency)

Starting Date October 26, 1998 Ending Date December 1, 1998

Signature Maggie Townsley Date 10/26/98

Lead Agency (Complete if applicable)

Consulting Firm: Jones & Stokes Associates, Inc.
Address: 2600 V Street
City/State/Zip: Sacramento, CA 95818
Contact: Mike Rushton/Maggie Townsley
Phone: (916) 737-3000

Applicant: N/A
Address:
City/State/Zip:
Phone: ( )

For SCH Use Only:

Date Received at SCH
Date Review Starts
Date to Agencies
Date to SCH
Clearance Date
Notes:

Revised October 1989

Peter M. Rooney
Secretary for Environmental Protection

State Water Resources Control Board

John P. Caffrey, Chairman

Division of Water Quality
901 P Street • Sacramento, California 95814 • (916) 657-0756 FAX (916) 657-2388
Mailing Address: P.O. Box 944213 • Sacramento, California • 94244-2130
Internet Address: http://www.swrcb.ca.gov

Pete Wilson
Governor

OCT 26 1998

To: Interested Agencies and Individuals

NOTICE OF PREPARATION OF A STATEWIDE PROGRAM ENVIRONMENTAL IMPACT REPORT FOR GENERAL WASTE DISCHARGE REQUIREMENTS FOR BIOSOLIDS LAND APPLICATION

The State Water Resources Control Board (SWRCB) will be the lead agency for preparation of a statewide program EIR for the subject project as described in this Notice of Preparation (NOP). One of the principal goals of this NOP is to inform the public about issues related to the project and request information on additional issues that should be addressed in the Environmental Impact Report (EIR). The NOP also seeks public and agency input on the scope and content of the program EIR. The preliminary project description, description of alternatives, and preliminary list of environmental issues to be addressed in the draft EIR are contained in the enclosed materials. This NOP may also be viewed and downloaded in the SWRCB's home page at **http:\\www.swrcb.ca.gov.** We encourage recipients of this notice to inform others who may have an interest or responsibility regarding biosolids land application that this NOP is available for review.

The SWRCB staff has made a preliminary determination that the following issues are of concern and should be addressed in the program EIR:

- hydrology and water quality,
- agriculture and soils,
- public health,
- land use and aesthetics,
- biological resources,
- traffic,
- air quality,
- noise, and
- cultural resources.

OCT 2 5 1998

Because of time limits mandated by State law, agency responses should be submitted as soon as possible and must be received no later than December 1, 1998. Please send comments concerning the scope or content of the program EIR to Todd Thompson, Associate Water Resources Control Engineer, at the address listed above or call him at 916/657-0577. Please identify a contact person who would be available to answer any questions regarding your comments.

Public scoping meetings to solicit additional public input have been scheduled at the following locations and times:

Palmdale
Monday, November 9, 1998, 6:30-9:00 p.m.
City of Palmdale Cultural Center Auditorium
704 East Palmdale Boulevard
Palmdale, CA 93550

Bakersfield
Tuesday, November 10, 1998 6:30-9:00 p.m.
Kern County Fire Fighters #1301
3615 Mt. Vernon Avenue
Bakersfield, CA 93306

Davis
Monday, November 16, 1998, 6:30-9:00 p.m.
Veteran's Memorial Center, Multipurpose Room
203 East 14th Street
Davis, CA 95616

Those persons wishing to participate further in the CEQA process or learn more about the agenda for each of the proposed meetings can contact Mr. Thompson at the phone number listed above.

Sincerely,

Stan Martinson

Stan Martinson, Chief
Division of Water Quality

Enclosure

Appendix C. Existing Regulatory Programs for Biosolids Land Application

Summary of Federal, State and Regulatory Requirements

Numerous federal, state, and local agencies currently regulate biosolids land application. Agency jurisdiction may vary depending on the beneficial use/disposal methods employed and location. In general, the United States Environmental Protection Agency (EPA) provides federal regulations that are implemented by state and local governments. In California, many state and local agencies have developed additional rules, guidelines, and criteria for biosolids regulation.

Table 1 Federal Regulations Governing Biosolids

	Federal Regulation	Land Appli-cation	Distribution and Marketing	Monofills and Surface Disposal	Codisposal Landfill and Landfill Cover
40 CFR 122-124	Requires biosolids disposal to be included in NPDES	X	X	X	X
40 CFR 257	Regulates use and disposal of biosolids not regulated by 40 CFR 503	X	X	X	X
40 CFR 261-268, 271, and 301	Defines whether biosolids are hazardous	X	X	X	X
40 CFR 501	Requires states to implement federal regulations for biosolids	X	X	X	X
40 CFR 503	Regulates land application, surface disposal, and incineration	X	X	X	X
40 CFR 761	Defines biosolids containing more than 50 mg/kg of PCBs as toxic	X	X	X	X

Federal Requirements

The EPA is the primary federal agency having jurisdiction over biosolids management. It is the responsibility of each state to develop programs to implement the rules and guidelines established by EPA. In general, state compliance with EPA guidelines is verified by EPA's regional offices.

Congress has been aware of biosolids use and disposal problems since passing the Clean Water Act (CWA) in 1972. However, regulations governing biosolids management practices did not appear until 1977, when amendments to the CWA led to the promulgation of 40 CFR Part 257 (under the joint authority of the CWA and the Resource Conservation and Recovery Act [RCRA]). Passage of Part 257 established standards for cadmium, PCBs, and pathogens in biosolids applied to land and established general management standards for solid waste landfills. In addition to the CWA, several other federal laws provide authority to regulating various aspects of biosolids disposal. These include the Clean Air Act; Subtitles C and D of RCRA; the Marine Protection, Research, and Sanctuaries Act (MPRSA); the Toxic Substances Control Act; and the recently promulgated 40 CFR Part 503 Standards for the Use and Disposal of Sewage Sludge. Table 5.1 lists current federal regulations that directly apply to the land application of biosolids.

Recent Federal Activity

In 1987, Congress called upon the EPA to comprehensively regulate the use and disposal of biosolids with the passage of the Water Quality Act of 1987 (P.L. 100-4)(WQA). This act required the promulgation of technical standards and placed new emphasis on identifying and limiting those toxic pollutants in biosolids that may adversely affect public health or the environment. Congress further required that EPA implement the technical standard through NPDES permits issued to POTWs unless current permit conditions issued under other federal programs or state programs ensured compliance with Section 405.

In order to implement the long-term biosolids permitting program required by the WQA, EPA has initiated two rulemakings. The first rulemaking includes 40 CFR Parts 122, 123, and 124 and 40 CFR Part 501. Parts 122, 123, and 124 set requirements and procedures for including biosolids conditions in NPDES permits. Part 501 sets requirements and procedures for approving state biosolids management programs to operate in lieu of federal programs, or for federal programs to implement biosolids permits if a state so chooses. The second rulemaking, 40 CFR Part 503 (503), adopted February 19, 1993 sets the technical standards for biosolids use and disposal.

As stated previously, biosolids land application is regulated at the federal level by the EPA through the 40 CFR Part 503 (503) regulations. These regulations establish standards for pollutant limits, operational standards, management practices, and monitoring, recordkeeping, and reporting requirements. The regulation is self-implementing and imposes requirements on persons who prepare sewage biosolids or material derived from sewage biosolids and land appliers of sewage biosolids. Compliance with the 40 CFR Part 503 standards became effective February 19, 1994. To land apply biosolids, the biosolids must satisfy the requirements for pollutant limitations, pathogen reduction, and vector attraction reduction as described in the following sections.

Pollutants Limits

Tables 2 and 3 present standards for the metals regulated by 503 for land application of biosolids. The 503 pollutant concentrations and ceiling concentrations are presented in Table 5.2. Biosolids with pollutant levels greater than the 503.13 Table 1 ceiling concentrations cannot be applied to land. Biosolids with pollutant levels below the 503.13 Table 1 ceiling concentrations, but above pollutant concentrations in 503.13 Table 3 can be applied to land, but are subject to the annual and cumulative pollutant loadings shown in Table 3. Biosolids with pollutant levels below 503.13 Table 3 limits can be applied to land without regard to annual or cumulative loading restrictions.

Pathogen Reduction

In addition to pollutant concentrations, biosolids must not pose a public health risk. 40 CFR Part 503, therefore, stipulates that biosolids applied to land must also be treated for pathogen and vector attraction reduction. 503 gives both performance-based standards and technology based standards for methods to reduce pathogens.

The 40 CFR Part 503 identifies two levels of pathogen reduction requirements, Class A and Class B, which may be satisfied by certain treatment methods and/or by meeting pathogen limitation standards. The goal of Class A requirements is to reduce pathogens to below detectable limits. The goal of Class B biosolids is to meet adequate pathogen reduction requirements and to rely upon

Table 2 CFR Part 503 Land Application - Pollutant Concentration Limits

Pollutant	503.13 Table 1 Ceiling Concentrations (mg/kg)(1)	503.13 Table 3 Pollutant Concentrations (mg/kg)(1)
Arsenic	75	41
Cadmium	85	39
Copper	4,300	1,500
Lead	840	300
Mercury	57	17
Molybdenum	75	NA(2)
Nickel	420	420
Selenium	100	100
Zinc	7,500	2,800

Notes:
(1) Dry weight basis.
(2) Temporarily suspended by EPA pending further consideration. Value was 18 mg/kg.

environmental factors at the beneficial site to further reduce pathogens. Therefore, sites which use Class B biosolids must follow additional site restrictions concerning public access, animal grazing, and crop harvesting.
The 40 CFR Part 503 provides various alternatives for meeting Class A and Class B pathogen requirements. Class A biosolids must meet the following two criteria:

1. One of the Class A pathogen reduction alternatives listed on Table 4 must be met before or at the same time as vector attraction, except when vector attraction reduction is met by Options 6, 7, or 8 (see Table 5.12), and

Table 3 40 CFR Part 503 Annual and Cumulative Land Application Rates

Pollutant	503.13 Table 2 Cumulative Pollutant Loading Rate (kg/hectare)	503.13 Table 4 Annual Pollutant Loading Rate (kg/hectare/year)
Arsenic	41	2.0
Cadmium	39	1.9
Copper	1,500	75
Lead	300	15
Mercury	17	0.85
Molybdenum	NA(1)	NA(2)
Nickel	420	21
Selenium	100	5.0
Zinc	2,800	140

Notes:
(1) Temporarily suspended by EPA pending further review. Value was 18 kg/hectare.
(2) Temporarily suspended by EPA pending further review. Value was 0.90 kg/hectare/yr.

Table 4 40 CFR Part 503 Class A Pathogen Reduction Alternatives	
Alternative	**Description**
A1: Thermally Treated Biosolids	Maintain biosolids at certain elevated temperature for prescribed period of time (see 503 Regulations for details).
A2: Biosolids Treated in a High pH-High Temperature Process	Maintain biosolids at certain elevated temperature and pH for prescribed period of time (see 503 Regulations for details).
A3: Biosolids Treated in Other Process	• The density of enteric viruses in the biosolids after pathogen treatment must be less than 1 PFU per 4 grams of total solids. • The density of viable helminth ova in the biosolids after pathogen treatment must be less than 1 per 4 grams of total solids. • Report operating parameters to indicate consistent pathogen reduction treatment.
A4: Biosolids Treated in Unknown Processes	• The density of enteric viruses in the biosolids after pathogen treatment must be less than 1 PFU per 4 grams of total solids. • The density of viable helminth ova in the biosolids after pathogen treatment must be less than 1 per 4 grams of total solids.
A5: Processes to Further Reduce Pathogens (PFRP)	
Composting	Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the biosolids is maintained at 55 degrees Celsius or higher for three days. Using the windrow composting method, the temperature of the biosolids is maintained at 55 degrees or higher for 15 days or longer. During the period when the compost is maintained at 55 degrees or higher, there shall be a minimum of five turnings of the windrow.
Heat Drying	Biosolids is dried by direct or indirect contact with hot gases to reduce the moisture content of the biosolids to 10 percent or lower. Either the temperature of the biosolids particles exceeds 80 degrees Celsius or the wet bulk temperature of the gas in contact with the biosolids as the biosolids leaves the dryer exceed 80 degrees Celsius.
Heat Treatment	Liquid biosolids is heated to a temperature of 180 degrees Celsius or higher for 30 minutes.
Thermophilic Aerobic Digestion	Liquid biosolids is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time of the biosolids is 10 days at 55 to 60 degrees Celsius.
Beta Ray Irradiation	Biosolids is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20 degrees Celsius).
Gamma Ray Irradiation	Biosolids is irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature (ca. 20 degrees Celsius).
Pasteurization	The temperature of the biosolids is maintained at 70 degrees Celsius or higher for 30 minutes or longer.
A6: Use of Processes Equivalent to PFRP	Demonstrate operating parameters and/or pathogen levels to be PFRP equivalent subject to permitting authority approval.

2. Class A biosolids must be monitored for bacteria regrowth at the time of usage or disposal. Fecal coliform density must be less than 1,000 Most Probable Number (MPN) per gram of total dry solids (1,000 MPN/g TS) or Salmonella sp. density less than 3 MPN per 4 grams of total dry solids (3 MPN/4g TS).

Biosolids that are to be land applied must, at a minimum, meet Class B pathogen reduction re quirements and provide for site restrictions. Alternatives for Class B are shown on Table 5.

Table 5 40 CFR Part 503 Class B Pathogen Reduction Alternatives

Alternative		Description
B1:	Monitoring of Fecal Coliform	The geometric mean of seven samples of treated biosolids, collected at time of use or disposal shall meet a fecal coliform density of less than 2 million colony forming units or most probable number per gram of biosolids solids (dry weight basis).
B2:	Processes to Significantly Reduce Pathogens (PSRP)	
	Aerobic Digestion	Biosolids is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20 degrees Celsius and 60 days at 15 degrees Celsius.
	Air Drying	Biosolids is dried on sand beds or on paved or unpaved basins. The biosolids dries for a minimum of three months. During two of the three months, the ambient average daily temperature is above zero degrees Celsius.
	Anaerobic Digestion	Biosolids is treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35 to 55 degrees Celsius and 60 days at 20 degrees Celsius.
	Composting	Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the biosolids is raised to 40 degrees Celsius or higher and remains at 40 degrees Celsius or higher for five days. For four hours during the five days, the temperature in the compost pile exceeds 55 degrees Celsius.
	Lime Stabilization	Sufficient lime is added to the biosolids to raise the pH of the biosolids to 12 after two hours of contact.
B3:	Use of Processes Equivalent to PSRP	Demonstrate operating parameters and/or pathogen levels to be PSRP equivalent subject to permitting authority approval.

Site Restrictions

Biosolids meeting Class B pathogen reduction requirements must also comply with the following site restrictions.

1. Food crops with harvested parts that touch the biosolids/soil mixture (such as melons, cucumbers, squash, etc.) shall not be harvested for 14 months after application of biosolids.
2. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 20 months after application of biosolids if the biosolids had been stored on land surface for at least 4 months prior to incorporation into the soil.
3. Food crops with harvested parts below the soil surface (root crops such as potatoes, carrots, radishes) shall not be harvested for 38 months after application if the biosolids had been stored on land surface for less than 4 months prior to incorporation into the soil.
4. Food crops, feed crops, and fiber crops shall not be harvested for 30 days after biosolids application.
5. Animals shall not graze on a site for 30 days after biosolids application.
6. Turf shall not be harvested for one year after biosolids application if the turf is placed on land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.
7. Public access to land with high potential for public exposure shall be restricted for 1 year after biosolids application.
8. Public access to land with a low potential for public exposure shall be restricted for 30 days after biosolids application.

Vector Attraction Reduction

Vector attraction is any characteristic which attracts disease vectors. Disease vectors are insects or animals which are capable of transporting and transmitting infectious agents. Some common vectors include flies, mosquitos, and rodents. Their interaction with humans provides a pathway for transmission of disease. Vectors themselves are not pathogenic. The 40 CFR Part 503 specifies ten alternatives for meeting the vector attraction reduction requirement as shown on Table 6.

Exceptional Quality Biosolids

Biosolids that meet the High Quality Pollutant Concentrations listed in Table 5.8, one of the Class A pathogen reduction requirements, and one of the vector attraction reduction alternatives (Options 1 through 8) may be identified as "exceptional quality biosolids." Exceptional quality biosolids may be used and distributed in bulk or bag form and are not subject to general requirements and management practices other than monitoring, recordkeeping, and reporting to substantiate that the quality criteria have been met.

Table 6 40 CFR Part 503 Vector Attraction Reduction Requirements

Option	Process
(1)	The mass of volatile solids in the biosolids shall be reduced by a minimum of 38 percent during biosolids treatment.

Table 6	40 CFR Part 503 Vector Attraction Reduction Requirements
Option	**Process**
(2)	When the 38 percent volatile solids reduction requirement cannot be met for an anaerobically digested biosolids, vector attraction reduction can be demonstrated by digesting a portion of the previously digested biosolids anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. When, at the end of the 40 days, the volatile solids in the biosolids at the beginning of that period is reduced by less than 17 percent, vector attraction reduction is achieved.
(3)	When the 38 percent volatile solids reduction requirement in cannot be met for an anaerobically digested biosolids, vector attraction reduction can be demonstrated by digesting a portion of the previously digested biosolids that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for 30 additional days at 20 degrees Celsius. When, at the end of the 30 days, the volatile solids in the biosolids at the beginning of that period is reduced by less than 15 percent, vector attraction reduction is achieved.
(4)	The specific oxygen uptake rate (SOUR) for biosolids treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius.
(5)	Biosolids shall be treated in an aerobic process for 14 days or longer. During that time, the temperature of the biosolids shall be higher than 40 degrees Celsius and the average temperature of the biosolids shall be higher than 45 degrees Celsius.
(6)	The pH of biosolids shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours at 25 degrees Celsius.
(7)	The percent solids of biosolids that does not contain unstabilized solids shall be equal to or greater than 75 percent based on the moisture content and total solids prior to mixing with other materials.
(8)	The percent solids of biosolids that contains unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials.
(9)	Biosolids shall be injected below the surface of the land. No significant amount of the biosolids shall be present on the land surface within one hour after the biosolids is injected. When the biosolids that is injected below the surface of the land is Class A with respect to pathogens, the biosolids shall be injected below the land surface within eight hours after being discharged from the pathogen reduction process.
(10)	Biosolids applied to the land surface or placed on a surface disposal site shall be incorporated into the soil within six hours after application to or placement on the land. When biosolids that is incorporated into the soil is Class A with respect to pathogens, the biosolids shall be applied to or placed on the land within eight hours after being discharged from the pathogen treatment process.
(11)	Biosolids placed on a surface disposal site shall be covered with soil or other material at the end of each operating day.
(12)	The pH of domestic septage shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes at 25 degrees Celsius.

Management Practices

The following are a few general management practice guidelines for the land application of biosolids.

1. Bulk biosolids shall not be applied to the land if it is likely to adversely affect a threatened or endangered species listed under Section 4 of the Endangered Species Act or its designated critical habitat.

2. Bulk biosolids shall not be applied to agricultural land, forest, a public contact site, or a reclamation site that is flooded, frozen, or snow-covered so that the bulk biosolids enters a wetland or other waters of the United States, as defined in 40 CFR Part 122.2, except as provided in a permit issues pursuant to Section 402 or 404 of the Clean Water Act.

3. Bulk biosolids shall not be applied to agricultural land, forest, or a reclamation site that is 10 meters (33 feet) or less from waters of the United States, as defined in 40 CFR 122.2, unless otherwise specified by the permitting authority.

Distribution and Marketing of Biosolids Products

The distribution and marketing of biosolids-derived fertilizers and soil conditioners are regulated under 40 CFR Part 503. Biosolids applied to farmland, forest, and reclamation sites must at a minimum meet the pollutant Ceiling Concentration Limits from Table 2, Class B pathogen requirements, and vector attraction reduction requirements. The biosolids can be applied using the Cumulative Pollutant Loading Rates under Table 3 if the biosolids do not meet the pollutant Ceiling Concentrations. Biosolids that are applied on lawns and home gardens must meet Class A pathogen requirements, a vector attraction reduction requirement, and the High Quality Pollutant Concentration listed in Table 2. The exception is that biosolids which meet the pollutant Ceiling Concentration, but not the High Quality Pollutant Concentration can be sold for use at product application rates prescribed on a label that are based on meeting Annual Pollutant Loading Rates.

Overall, a label shall be affixed to the bag or other container in which biosolids are sold or given away for application to land, or an information sheet shall be provided to the person who receives biosolids sold or given away in a container for application to the land. The label or information sheet shall contain the following information:

1. The name and address of the person who prepared the biosolids that is sold or given away in a bag or other container for application to the land;

2. A statement that application of the biosolids to the land is prohibited except in accordance with the instructions on the label or information sheet; and

3. The annual whole sludge application rate for the biosolids that does not cause any of the annual pollutant loading rates in Table 3 to be exceeded.

Monitoring Frequency

Monitoring frequency for pollutants, pathogen densities, and vector attraction reductions is based on the amount of biosolids used or disposed as shown on Table 7. More frequent monitoring is encourage to check quality abnormalities. Alternatives which use operating parameters to satisfy pathogen and vector attraction reduction requirements should monitor operations continuously.

Table 7 40 CFR Part 503 Monitoring Frequency

Amount of Biosolids Used or Disposed (metric tons per 365 day period - dry weight)(1)	Monitoring Frequency per Year
0 > amount > 290	Once
290 ≥ amount > 1,500	Quarterly (4 times)
1,500 ≥ amount > 15,000	Bimonthly (6 times)
amount ≥ 15,000	Monthly (12 times)

(1) 1 metric ton = 1.1 English tons.

Recordkeeping
Generally, the preparer(s) of the biosolids is required to maintain records of the biosolids to meet pollutants, pathogens, and vector attraction reduction requirements. The applier(s) are required to maintain records of application rates, management practices, and site restrictions. Records must be kept for five years.

Reporting
Annual reports are due to the permitting authority February 19 every year from all POTWs with a design flow of 1 million gallons per day (mgd) or greater or which service a population of 10,000 people or greater.

These 503 standards, which are known as the Round 1 regulations, set limits for nine heavy metals in biosolids that are land applied. Meanwhile, the EPA continued to evaluate 31 candidate pollutants for Round 2 of the regulation. Based on the results of risk assessment screening, EPA concluded that 2 of the 31 pollutants warrant further consideration for regulations:

1. Dioxins/dibenzofurans.
2. Polychorinated biphenyls (co-planes) (PCB).

Currently, the EPA has not established any preliminary range of concentration limits for these constituents. Per discussions with Lauren Fondahl of EPA Region IX, possible limits may be derived from other current regulations. The dioxin limitation may reference the pulp and paper mill discharge limitation which ranges from an average concentration of 10 parts per trillion (ppt) to a maximum of 50 ppt. The PCB concentration limit may derive from 40 CFR Part 761 which states that biosolids exceeding 50 parts per million is considered a hazardous waste.

However, EPA can still add or delete other pollutants when the Round 2 regulation is proposed. The Round 2 regulation must be proposed by December 1999 and promulgated by December 2001.

The EPA also published revisions to 40 CFR Part 261 on March 29, 1990, defining the new toxicity characteristic leaching procedure (TCLP) to be used as of September 25, 1990, in determining whether a waste is "hazardous." The revised rule also adds 25 new organic constituents to the list of toxic constituents of concern. Other changes are also made in calculations or regulatory levels of organic chemicals. The new TCLP replaces the Extraction Procedure (EP) leach test that was previously used by EPA in defining toxicity.

State Requirements

On the State level, biosolids beneficial use/disposal is regulated by the following agencies under Cal/EPA: State Water Resources Control Board (SWRCB), Office of Environmental Health Hazard Assessment (OEHHA), Department of Toxic Substances Control (DTSC), California Integrated Waste Management Board (CIWMB), and California Air Resources Board (CARB). In general, the SWRCB, through its nine regional boards, is primarily concerned with protecting present and probable future beneficial uses of water, as required by the Porter-Cologne Water Quality Control Act (contained in Division 7 of the California Water Code).

The discharge of wastes to land in California is also regulated by the SWRCB according to the California Code of Regulations (CCR), Title 23 Waters, Chapter 15, Article 2. Chapter 15 regulations apply to the disposal of biosolids on dedicated land. Other regulations include Title 22, Chapter 11; Department of Health Services Manual of Good Practice; the California Environmental Quality Act, etc. Table 8 lists current California regulations that directly apply to biosolids use and disposal methods.

Table 8	California Regulations Governing Biosolids				
	Federal Regulation	**Land Appli-cation**	**Distributio n and Marketing**	**Monofills and Surface Disposal**	**Codisposal Landfill and Landfill Cover**
CCR Title 23 §2908	Regulates discharge of municipal solid waste to land including biosolids.	X	X	X	X
CCR Title 23 §2510 et. seq.	Regulates discharge of waste to land including biosolids.	X	X	X	X
CCR Title 23 §3680 et. seq.	Regulates operator certification for wastewater treatment operators.			X	
CCR Title 22 §66261.24	Defines whether biosolids are hazardous.	X	X	X	X
PRC §40191	Includes biosolids in the definition of solid waste.	X	X	X	X
PRC §42246	Requires procuring agencies to document use of fertilizing material, including biosolids, as not harmful to public health and safety.	X	X		
PRC §50002(b)	Establishes requirements for exemption of land application of biosolids that poses no threat to public health or the environment.	X	X	X	X
FAC §14505	Regulates municipal biosolids as a fertilizer.	X	X		
FAC §14560	Defines biosolids with respect to its use as a fertilizer.	X	X		
FAC §14682	Prohibits distribution of adulterated fertilizing materials including biosolids.	X	X		

Note: CCR = California Code of Regulations
PRC = Public Resource Code
FAC = Food and Agriculture Code
IN = Incineration
LA = Land Application
LC = Landfill Cover
SD = Surface Disposal

Presently, under the California Code of Regulations (CCR), Title 22, it is the waste discharger's responsibility to determine if the waste is classified as a hazardous waste pursuant to criteria established in CCR, Title 22, Division 4.5, Chapter 11, Article 3. If a waste were marginal, the DTSC would need to classify the waste.

In addition, the office of Environmental Health Hazard Assessment (OEHHA) has both a general and specific authority under the Health and Safety Code to protect public health. This includes the responsibility of regulating the utilization and disposal of biosolids via land application. While the OEHHA's advisory guidelines and recommendations are not regulations, they often are used in an enforcement manner through incorporation into the RWQCB's Orders (Waste Discharge Requirements).

In response to concerns over the lack of State standards or guidelines regarding the land application of biosolids, the OEHHA's Sanitary Engineering Branch published a manual in April 1983 entitled "Manual of Good Practice for Landspreading of Sewage Sludge." The purpose of the manual was to set forth "those practices in the treatment and use of sewage biosolids which have been found effective in assuring the safe and beneficial use of the material."

State Regulations

On the State level, the SWRCB through its RWQCBs, regulates the landspreading of biosolids. The RWQCB currently follows EPA and DHS guidelines on land application of biosolids. Application of biosolids to land must not violate the water quality standards established for the respective Water Quality Control Basin Plans developed pursuant to Section 303(e) of the Clean Water Act. Therefore, each RWQCB may act independently in establishing permitting requirements for the land application of biosolids. Serano Regional Water Quality Control Boards have issued Waste Discharge Requirements (WDRS).

In June 1995, The Central Valley Regional Water Quality Control (CVRWQCB) Board adopted "General Order No. 95-140, Reuse of Biosolids and Septage on Agricultural, Forest, and Reclamation Sites", and "Resolution No. 95-144, "Waiving Waste Discharge Requirements for the Reuse of Exceptional Quality Wastewater Treatment Plant Biosolids as Fertilizer and Soil Amendment" (Appendix A and B, respectively). These new actions provided dischargers two additional permitting options beyond the standard individual Waste Discharge Requirements (WDRs).

In April 1996, General Order No. 95-140 and Resolution 95-144 were invalidated by the State Water Resources Control Board, by the adoption of Order 96-08. Projects previously permitted through the General Order were still allowed to operate; however, in 1997, Order 96-08 was amended with Order 97-07, which allows only those sites operating under waivers submitted before April 1, 1996 to continue to operate until the General Order complies with CEQA.

The discussion below provides the general intent and major technical parts of the General Order and the Waiver, including how they differ from the 503 regulations.

General Order. The General Order is intended to apply to the broadest number of situations in which biosolids would be land applied. No site-specific review is required by the Board under the General Order; therefore, several limitations are included that are more stringent than the 503 regulations. The General Order would streamline the regulatory process and make it quicker for discharges to obtain a land application permit. The General Order would not override any local prohibition against land application of biosolids. A summary of the major technical components of the General Order are:

<u>Biosolids Material Covered</u>:

1. Class A biosolids not meeting table 3 of 40 CFR503.13
2. Class B biosolids
3. Exception Quality (EQ) biosolids
    a. Mixture contain >50% biosolids applied at 10 dry ton per acre per year or greater on at least 20 acres.
    b. Mixture contain <50% biosolids applied at 20 dry ton per acre per year or greater on at least 20 acres.

Metals Standards:

1. The 503 ceiling limitations, high quality limitations, and cumulative loadings are the same except molybdenum has limits set. However, the General Order requires the lifetime tracking of cumulative loadings for metals in the biosolids, even when the "high quality" metals concentrations are met ("high quality" metals are exempt from tracking in 40 CFR Part 503).

2. Calculation methods are provided to allow the applicant to compare the metals concentrations with both EPA's "dry-weight" limits and Title 22's "wet-weight" limits.

Pathogens:

1. Both the Class A and Class B definitions are incorporated with no changes.

2. The "waiting periods" for public access, grazing, and crop harvest are the same; animals used in the production of unpasteurized milk are not allowed to graze on the land for 12 months after application of biosolids.

3. There must be at least a 24 inch depth to groundwater at the time of application (additional requirement beyond 503).

Vector Attraction Reduction Standards:

1. The 503 standards are incorporated with no changes.

Management Practices:

1. The Department of Fish and Game must be notified if biosolids will be placed on land which has not been disturbed for two or more years. A survey of listed plants and animals must be conducted, and written approval received from DF&G for avoidance, mitigation, or incidental take of the species.

2. Discharge of tailwater or field runoff within 30 days after application of Class A and B biosolids, septage is prohibited for application areas where biosolids have not been incorporated into the soil, or where there is not sufficient vegetation to prevent movement of biosolids particles from the site.

3. Land application at rates which exceed the agronomic rate of nitrogen uptake are prohibited. For reclamation sites, however, the rates can be exceeded with approval from the appropriate Regional Board administrator.

4. Setback distances for staging areas and application sites are as follows:

property lines	10 feet
domestic water supply wells *	500 feet
non-domestic water supply	100 feet
public roads	50 feet
surface waters	100 feet
agricultural buildings	10 feet
residential buildings	500 feet
domestic water supply reservoir	400 feet
primary tributary to a domestic water supply	200 feet
domestic surface water supply intake	2,000 feet

* A lesser setback distance from domestic supply wells (100 feet minimum) may be used if the Discharger can demonstrate that the groundwater, geologic, topographic and well construction conditions are adequate to protect the public health of users of the well water.

5. Discharge of Class A biosolids shall not cause or threaten to cause pollution as defined in the California Water Code.

6. Storage, transport, or application of biosolids shall not cause a nuisance as defined in the California Water Code.

7. Surface water runoff off the permitted site resulting from irrigation of sites to which biosolids has been applied is prohibited for 30 days after application of biosolids if vegetation in the application area and along the path of runoff does not provide 33 feet of unmowed grass or similar vegetation in the application area and along the path of runoff to prevent the movement of biosolids from the application site.

8. Any visible air-borne particulates leaving the application site during biosolids applications or during incorporation of biosolids at the permitted site is prohibited.

Storage Requirements:

1. Storage of biosolids on the ground is allowed for up to seven days at any one location within a 60 day period. The biosolids must not contain free liquids and runoff protection must be provided.
2. Flood and runoff controls are required in winter including covered storage between October 1 and April 30.
3. Storage facilities must be designed, maintained and operated to minimize leachate generation.
4. Public access must be controlled if the biosolids are Class B.
5. A storage plan must be approved by RWGCB officer if biosolids are to be stored at the site b beyond the time limits of the General Order.
6. Each biosolids' transport driver shall be trained as to the nature of their load and the proper response to accidents or spills events and carry a copy of an approved spill response plan.

Monitoring and Reporting:

1. There are three aspects to monitoring and reporting: pre-application reporting, semi-annual monitoring, and post-application reporting. Forms are provided with the General Order for the "Pre-Application Report" and the "Post-Application Report". Semi-annual monitoring of the biosolids is required for projects which continue for long periods of time.

Application Process:

Under the General Order, the individuals responsible for site operations retain primary responsibility for compliance with the requirements, including day-to-day operations and monitoring. Individual property owners and managers retain primary responsibility for crop selection, site restrictions, etc. The property owners have the ultimate responsibility for ensuring compliance. Under the General Order, the term "Discharger" refers to the owner/operator of the landspreading operation or facility.

1. The Discharger submits a "Notice of Intent" (NOI) and fee. The NOI describes who will be conducting the project and where the project is located. If correctly completed, submittal of the NOI grants coverage under the General Order without staff review or approval. The Regional Board has no discretion in accepting an NOI, other than to review it for completeness. The discharger must submit copies of the NOI to the Regional Board, Department of Fish and Game, and the County Health Department. A single NOI is limited to 2000 acres of land, within a 10 mile radius, and a single landowner.

2. The Discharger then submits a "Pre-Application Report" which describes how compliance with the General Order will be met (i.e. metals concentrations, loading rates, etc). The Regional Board must review and approve the "Pre-Application Report" prior to application of the biosolids.

3. Coverage under the General Order will cease upon submittal of a "Notice of Termination" and all required post-application reports.

Waiver Resolution

Waiver Resolution No. 95-144: The RWQCB adopted Resolution 95-144, waiving the waste discharge requirements for the beneficial reuse of biosolids that meet the 503 definition of "exceptional quality." The use of the biosolids must fully comply with all aspects of the 503 regulations, for bulk distribution or distribution in bags or containers. The biosolids must meet the 503.13 Table 3 criteria, Class A, and vector reduction requirements. Biosolids loading rates must not exceed the agronomic rates for the crop. The waiver places no restrictions on the acreage on which the biosolids are land applied, and no annual reports required.

The waiver can be issued to any qualifying dischargers and/or distributors of biosolids located within the Central Valley Region. The applicant must submit a one-page application form ("Request for Waiver of Waste Discharge Requirements for Beneficial Use of Exceptional Quality Biosolids") and pay the filing fee.

Local Requirements

Local enforcement agencies (LEA) may require use permits which regulate the implementation and operation of biosolids processing, handling, and beneficial use/disposal projects. Requirements vary from one jurisdiction to the next. Locally elected officials such as a board of supervisors may adopt ordinances which regulate biosolids projects. In other cases, local agencies such as the environmental health, planning, public works, or even sheriff's department may accept discretionary authority to regulate a project.

One issue that greatly impacts biosolids beneficial use/disposal sites in northern California is the passage of the Delta Protection Act in 1992. The Act declares the Sacramento-San Joaquin Delta as a natural resource of statewide, national and international significance, containing irreplaceable resources. As a result, the Delta Protection Commission adopted a ban which prohibits the location of new sewage treatment facilities and areas for disposal of sewage effluent and biosolids (including land application) within the Delta Primary Zone. The Delta Primary Zone includes portions of Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties as shown. The Act was approved by members of the Delta Protection Commission.

Local counties generally require a conditional use permit that needs to be approved by the Regional Water Quality Control Board. Waste Discharge Requirements (WDRs) are issues by the regional Board. WDRs are then reviewed and subsequently approved by County agencies that have local ordinances. Several counties have recently enacted local ordinances. County ordinances typically fall under three categories: absolute ban, effective ban, and regulated use. The regulated use ordinances are typically more restrictive than state or federal requirements. An effective ban ordinance is written in a way as to "effectively" ban the land application of biosolids. The following table lists the counties and what ordinance category that they fall under.

Table 9 - County Biosolids Ordinance Categories

Absolute Ban	Effective Ban	Regulated Use
Sutter San Joaquin Stanislaus	Monterey San Benito Yuba Glenn Imperial San Luis Obispo San Bernadino	Solano Merced Yolo Kern Riverside Tulare

Counties not listed above do not have any specific regulations and follow the RWQCB requirements.

County Ordinance Description

The following is a summary of county ordinances and how they differ from the proposed GO and 40CFR503 requirements.

Riverside county

A sludge management plan needs to be developed and approved by the County Environmental Health Officer. Biosolids transportation requirements include: vehicle maintenance and repair documentation, vehicle identification. Buffer zones include a minimum 50 feet distance between adjacent property lines and biosolids land application. Other requirements will be established by resolution adopted by the Board of Supervisors.

San Bernadino County

Minimum separation distances include a 1/2 mile between biosolids land application and 1. Operating dairy with lactating cattle, 2. Any public water supply well, 3. Any live stream, lake or surface impoundment.

Tulare County

Application of all class B biosolids is prohibited. Biosolids shall not be applied to land where surface to groundwater level. Wind speeds in excess of 20 miles per hour also prevent the land application of biosolids. Biosolids land application is prohibited where depth to groundwater is less than ten feet. A land spreading plan is also required. Annual monitoring includes testing for Dioxins, Furans, PCBs, and miscellaneous organic pollutants (Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics).

Yolo County

Biosolids shall not be applied to any land between November 15 to April 15, and in the delta primary zone at any time. Wind speeds in excess of 5 miles per hour also prevents the land application of biosolids. Biosolids shall not be applied on "highly erodible" land as classified by USDA Natural Resources Conservation Service (NRCS). Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biannual monitoring includes testing for Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics.

Kern County

The Kern County ordinance is currently being developed. The requirements have not yet been adopted by the County. Some of the interim requirements include: Depth to groundwater must be at least 20 feet unless shallow groundwater TDS levels exceed 3,000 mg/l and this groundwater cannot be reasonably expected to supply groundwater. Biosolids must be incorporated into the soil at least seven inches within 24 hours of application. Biosolids monitoring is required as frequently as once per month depending on the land application rate and area.

Merced County

For slopes greater than 2%, parallel disking to slope contours is required for biosolids incorporated into the soil. Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biosolids land application is limited to once per crop. Annual monitoring includes testing for Dioxins, Furans, PCBs, and miscellaneous organic pollutants (Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics).

Yolo County

Biosolids shall not be applied to any land between November 15 to April 15, and in the delta primary zone at any time. Wind speeds in excess of 5 miles per hour also prevents the land application of biosolids. Biosolids shall not be applied on "highly erodible" land as classified by USDA Natural Resources Conservation Service (NRCS). Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biannual monitoring includes testing for Chlorinated Pesticides, PCBs, and Base/Neutral Extractable Organics.

Solano County

Neighboring residents can file a protest which can effectively stop biosolids application. Biosolids shall not be applied to soils where depth to groundwater is less than five feet. Biosolids shall not be applied to any land between November 15 to April 15, and in the delta primary zone at any time.

Appendix D. Soils, Hydrology, and Water Quality Technical Appendix

Appendix D. Soils, Hydrology, and Water Quality Technical Appendix

This section describes the soil properties that are relevant to biosolids application; mobility, bioavailability, and potential toxicity of biosolids; and general soil characteristics in each of the nine Regional Water Quality Control Board (RWQCB) regions. In addition, this section describes hydrologic and water quality issues related to biosolids application. The fate and transport characteristics of pathogens and radioactive substances related to biosolids application are described in Chapter 5, “Public Health”.

Environmental Setting for Soils

Summary of Soil Properties Relevant to Biosolids Application

The soil properties described below affect the suitability of a site to be used for biosolids application. Some of these properties may change as a result of biosolids application. Additionally, most of the properties are closely related to the productivity of a site for food and fiber crop production and livestock forage.

Texture

Probably the most significant soil property relative to biosolids application is texture (i.e., the proportions of sand-, silt-, and clay-sized particles). With other factors held constant, fine-textured soils (e.g., silty clays and clays) tend to have relatively high capacity to retain nutrients and metals, have moderate water-holding capacity (i.e., the amount of water that can be taken up by plant roots [measured as inches of water per inch of soil] or that is available throughout the root zone), have slow infiltration capacity and permeability (to water and gas movement), and be relatively difficult to till. The pH (discussed below) of fine-textured soils ranges from near neutral to alkaline. Most clayey soils are fairly resistant to erosion when the vegetation cover is removed, except on steeper slopes.

Coarse-textured soils (e.g., loamy sands) tend to have relatively low nutrient- and water-holding capacities, have low native fertility, have rapid infiltration capacity and permeability, and be easily tillable. Many coarse-textured soils have low organic matter content. The pH of coarse-textured soils ranges from near neutral to acidic. Sandy soils are among the soils most subject to water erosion and high percolation rates.

Medium-textured soils (e.g., loams and silt loams) generally have fertility and hydrologic characteristics intermediate between fine- and coarse-textured soils, except that they have the highest available water-holding capacity. Medium-textured soils, particularly those with high organic matter content, are generally resistant to erosion on gentle to moderate slopes.

Cation Exchange Capacity

Cation exchange capacity (CEC) is a measure of a soil's net negative charge and a measure of a soil's capacity to retain and release cations (i.e., positively charged ions) for uptake by plant roots. Cations (e.g., calcium and ammonium) can be essential for plant growth in small concentrations but may be toxic in larger concentrations (e.g., molybdenum, zinc, and copper). Some trace elements, such as lead, are not required in any amount but may be toxic to plants and the animals that feed on them. The level of CEC is controlled primarily by the amount and type of clay mineral in the soil and the content of humus (highly decomposed organic matter) in the soil. In coarse-textured soils, humus may provide most of the soil's CEC. For a given quantity (i.e., weight) of soil, the CEC of humus is typically several times that of most pure clays. Clayey soil commonly has a CEC more than fives times that of sandy soil. A high CEC is desirable in soil because it lessens or prevents essential nutrient loss from the soil by leaching (Donahue et al. 1983). Soils with high CEC can also immobilize heavy metals such as copper and lead by binding the negatively charged metal anions to cation exchange sites associated with the clay minerals and organic matter.

Organic Matter

Organic matter, another important property of soil, enhances the physical condition of surface soil layers by binding together individual soil particles into larger aggregates, which give structure to the soil. Organic matter especially benefits the structure of sandy soils. Improved soil structure creates large pores through which gases and water can move and roots can penetrate. Accordingly, soils with good structure tend to have a lower bulk density and be more permeable than soils with poor structure. A well-aerated, permeable soil is usually more productive than a poorly aerated soil. High permeability tends to improve a soil's infiltration capacity and make the soil easier to till (Donahue et al. 1983). Further, soils with large, stable aggregates (i.e., well-structured soils) are more resistant to erosion than soils with poor structure (National Academy of Sciences 1996). Organic matter also improves tillability (particularly among coarse- and fine-textured soils) by promoting good structure of surface layers (Donahue et al. 1983).

Soil organic matter content also affects the capacity of the soil to retain water and many soluble nutrients and metals, particularly in coarse-textured soils. Organic matter is also the source of most of the nitrogen in an unfertilized soil and can be an appreciable source of phosphorus and sulfur. Soil microbes use organic matter as a food source (Donahue et al. 1983).

pH

Soil pH is a measure of the acidity or alkalinity of a soil. Nearly all California soils have a pH ranging from 5.0 to 8.5; a pH of 7.0 is considered neutral. A low pH (e.g., an acidic soil with a pH of 5.5) suggests that soil nutrient concentrations and microbial activity are low (Tucker et al. 1987). Bacteria that decompose organic matter and therefore release nitrogen and other nutrients for plant growth are less active in strongly acidic soils. In strongly acidic soils, most heavy metals and some nutrients are soluble and aluminum and manganese may be present in toxic concentrations. A high pH (e.g., an alkaline soil with a pH of 8.0) suggests that concentrations of some soil nutrients (particularly calcium and magnesium) are high; some soils with high pH have high concentrations of soluble salts, which can limit plant growth and affect the type of crops that can be grown on a site (Donahue et al. 1983). High pH levels can also bind soluble phosphorus, making it unavailable for plant growth. Iron (and, to a lesser degree, zinc) may be insufficient to allow sensitive crop species to grow in high-pH, calcareous soils (Tucker et al. 1987). Soil pH also greatly affects the solubility of minerals and many heavy metals, and therefore affects their availability for plant growth and uptake in biomass and their potential to be leached from the soil profile. A slightly acidic condition (e.g., pH 6.5) is best for many agricultural crops because overall, macronutrients and micronutrients are most available for plant uptake under slightly acidic conditions (Donahue et al. 1983). Maintaining neutral to slightly alkaline conditions is often recommended for soils if high levels of heavy metals are a concern because the metals tend to be less mobile at these pH conditions.

Salinity

Salinity refers to the salt content of soil. Salts are dissolved mineral substances, including sulfates, chlorides, carbonates, and bicarbonates of the elements sodium, calcium, magnesium, and potassium. Although a low level of salts in the soil is desirable, high salinity levels (commonly above an electrical conductivity of 4 decisiemens per meter for many crops) make it difficult for plant roots to extract water from the soil, which may reduce growth rates. High salt concentrations may delay seed germination or completely inhibit germination. The deleterious effects of high salt concentrations are most pronounced among young plants (Donahue et al. 1983).

Bulk Density

Bulk density refers to the mass of dry soil per unit of volume, usually measured in grams per cubic centimeter. Bulk density affects permeability and root penetration and is affected by texture, structure, organic matter content, and soil management practices. Because of differences in these factors, soils with different bulk densities may be effectively equal with respect to permeability and root penetration (Donahue et al. 1983).

Depth

Soil depth affects the capacity of a soil to retain nutrients and metals. References to soil depth pertain to the depth of a soil over rock or a restrictive layer that prevents significant root penetration, such as a hardpan or a very dense claypan. Soils less than 20 inches deep are considered shallow, and soils more than 60 inches deep are considered very deep (U.S. Department of Agriculture 1993).

Organisms

Soil microorganisms, including bacteria, actinomycetes, fungi, algae, and protozoa, play an important role in the decomposition of organic matter (including biosolids) (Phung et al. 1978) and the cycling of plant nutrients, such as nitrogen, phosphorus, and sulfur (National Academy of Sciences 1996). Some evidence suggests that the rate of decomposition of organic matter by microorganisms may be reduced in the presence of high heavy metal concentrations (Sommers et al. 1976). Soil organisms such as earthworms play an important role in breaking up organic materials and mixing them into the soil (Phung et al. 1978).

Drainage

A soil's drainage class is controlled primarily by permeability, seasonal depth of **[or "to"?]** the water table, and slope. At the dry end of the drainage spectrum, soils that are excessively drained tend to be coarse textured, not influenced by high groundwater, and located on steep slopes. Soils that are very poorly drained typically have groundwater at or near the surface for much of the growing season and are located in level or depressional areas (U.S. Department of Agriculture 1993). Sometimes shallow subsurface restrictive layers, such as claypans and hardpans, cause a perched water table (i.e., an area of groundwater that rests on an impermeable layer, preventing water from percolating downward) in the surface soil layers.

Decomposition of organic matter (including biosolids) is typically not restricted by soil moisture if the moisture content is maintained at approximately 30%–90% of the water-holding capacity of the soil. Conversely, saturated conditions (such as in a poorly drained soil) reduce the available oxygen, which can slow microbial decomposition rates. Soil microorganisms become essentially inactive when the soil moisture content drops below the level at which plants wilt (Phung et al. 1978).

Erodibility

Soils most susceptible to erosion (detached and entrained by water and wind) are those high in coarse silt- and fine sand-sized particles (Donahue et al. 1983), particularly when organic matter content is low and soil structure is weak or nonexistent. Erosion is usually of concern when the vegetative cover is removed or reduced, the soil is otherwise disturbed, or both of these conditions exist. Water erosion typically is a less pressing concern on shallow slopes (i.e., 10% or less), such as those generally used for biosolids application, because typically there is little runoff of rainfall. Erosion caused by water is also more easily controlled by maintaining a good vegetative cover. Significant wind erosion can occur in areas with a combination of high winds, removed or disturbed vegetation, fine sandy or silty textures, and low organic matter content.

The erosion rate of a particular soil in the absence of human activities is referred to as the natural or geologic erosion rate. Erosion in excess of the natural erosion rate is called accelerated erosion, which is usually caused by human activities such as cultivation, grazing, and grading.

Summary of Soil Properties by RWQCB Region

Soil conditions in California are extremely variable and reflect a diversity of geologic, topographic, climatic, and vegetative conditions that influence soil formation and composition. For the purposes of this document, broad generalizations can be made about the properties of soils in each RWQCB region that may influence or be influenced by biosolids application. Soil properties that are specific to either a particular region or the biosolids application process are provided, where this information is readily available.

Information Sources

Unless otherwise specified, the following summaries of soil properties in each region were based on Major Land Resource Areas defined by the U.S. Soil Conservation Service (1981) (now the U.S. Natural Resources Conservation Service). Major Land Resource Areas (MLRAs) consist of large areas that are broadly similar with respect to soils, geology, climate, water resources, and land use. Sixteen MLRAs have been designated in the state. MLRA information is appropriate for statewide resource description and planning. This information was supplemented by a general soil map of the state (Pacific Gas and Electric Company 1989) and other literature. Because biosolids are almost always applied on moderate to shallow slopes (i.e., up to approximately 15%), only the types of soil found in valleys, basins, terraces, and alluvial fans are described below.

Soils in the geographic areas excluded from the GO that otherwise would have been included in the discussion (i.e., the Sacramento-San Joaquin River Delta, Suisun Marsh, and the jurisdiction of the San Francisco Bay Conservation and Development Commission) are also not described.

The soils within each RWQCB region were identified by overlaying a map of the region's boundaries over the MLRA map. Table D-1 shows soil properties in California delineated by RWQCB basin areas.

Typical Soil Properties in Forested Areas

Soil properties in forested areas of the state that are suitable for biosolids application (i.e., have less than approximately 15% slope) differ from soils typically used for agricultural land application primarily in that they are underlain by bedrock and are relatively shallow. Forest soils in California tend to have neutral to acidic pH. The organic matter content ranges from relatively low to high (for mineral soils) but is usually concentrated in the upper soil layers. A layer of plant litter often rests on the soil surface. Forest soils are often more strongly leached of nutrients than agricultural soils. The texture typically ranges from clay loam to sandy loam and the soils often have rock fragments in the profile. Except in meadow areas (which typically would not be considered as suitable areas for biosolids application because they may qualify as jurisdictional wetlands) and in seep areas, groundwater tends to be deep (Colwell 1979, U.S. Soil Conservation Service 1981).

Typical Soil Properties at Mined Sites

Conditions at mined sites differ from those at agricultural land application sites in that the native soil material has typically been partially or entirely removed or mixed with less productive subsoil material. Although soil and site conditions may vary widely according to the type of mine, the soil materials at such sites often have low nutrient- and water-holding capacities, high rock-fragment content, low organic matter content, low pH, and high concentrations of trace metals. These conditions result in unfavorable conditions for seed germination and plant growth, making revegetation efforts difficult (Reed and Crites 1984). Slopes may be steep at some mined sites.

Typical Soil Requirements of Horticultural Operations

In California, biosolids are not widely used for horticultural plantings. It is expected that the most frequent uses would be in large parkland or golf course settings or in large-scale nursery operations. These settings could occur throughout the state but would likely be more common in valley or low foothill areas with relatively deep soils, moderate to shallow slopes (less than 15%), and a wide range of soil textures (coarse silts to clay loams and clays). Because horticultural areas are usually selected for their ability to support planted vegetation, they usually have low to medium organic content, are well drained, and have a pH ranging from slightly alkaline to slightly acidic. Soil conditions that would be unfavorable for seed germination and plant growth would be avoided. Where new parks or golf courses are being developed, biosolids may be applied to soil

Table D-1
Summary of Predominant Soil Characteristics in Each RWQCB Region

RWQCB Region	Depth	Texture	Drainage	Organic Matter Content	Acidity/ Alkalinity	Other Distinguishing Characteristics
1	shallow to deep (the former sometimes over a subsurface cemented hardpan)	sandy to clayey	well drained to poorly drained	low to high	moderately acid to neutral	Owing to the presence of serpentine rocks, upland soils in the region contain high amounts of nickel and copper (Holmgren et al. 1993); gently sloping alluvial soils below the serpentine watersheds may also contain high background concentrations of the two metals.
2	deep	loamy to clayey	well drained to poorly drained	moderate to high	slightly acid to slightly alkaline	
3	very deep	sandy to clayey	well drained to poorly drained	moderate to high	slightly acid to slightly alkaline	Some alluvial soils, lying below certain areas of Monterey shale, in the Salinas Valley have been reported to contain high background concentrations of cadmium (Holmgren et al. 1993).
4	shallow to deep (the former sometimes over a subsurface cemented hardpan)	loamy	well drained	moderate to high	slightly acid to slightly alkaline	
5	shallow to deep (the former sometimes over a subsurface cemented hardpan)	sandy (particularly along the eastern side of the San Joaquin Valley) to clayey	well drained to poorly drained	moderate	moderately acid to alkaline	Some areas along the western side of the San Joaquin Valley, have high selenium, boron, molybdenum, and arsenic (the latter in the extreme southern end) and salt concentrations (all of which occur naturally in the soils) in soils and groundwater, and high groundwater levels (San Joaquin Valley Drainage Program 1990). High concentrations of mercury have been identified in soils of the Panoche and Cantua Creeks alluvial fans (Tidball et al. 1986).

Table D-1. Continued

6	moderately deep	sandy to loamy	low rainfall causes the soils to be droughty	low	neutral to alkaline	Some soils have high calcium content
7	moderately deep to very deep	sandy to clayey	low rainfall causes the soils to be droughty	low	neutral to alkaline	Some areas have high salt (Letey et al. 1996) and calcium content. Wind erosion is a major issue in this region.
8	shallow to deep (the former sometimes over a subsurface cemented hardpan)	loamy	well drained	moderate to high	slightly acid to slightly alkaline	
9	shallow to deep (the former sometimes over a subsurface cemented hardpan)	sandy to loamy	well drained	low to moderate	slightly acid to slightly alkaline	

____

Notes:

1) The information provided in this table consists of generalizations about the predominant soils occurring in each RWQCB region; soils with characteristics different than those described above may also occur.

2) Because biosolids are nearly always applied on moderate to more shallow slopes (i.e., up to approximately 15%), only those soils occurring in valleys, basins, terraces, and alluvial fans are described. Additionally, soils occurring in the larger geographic areas excluded from the GO that otherwise would have been included in the table (i.e., the Sacramento-San Joaquin Delta, the Suisun Marsh, and the jurisdiction of the San Francisco Bay Conservation and Development Commission) are also not described.

Sources: U.S. Department of Agriculture Soil Conservation Service 1981, Pacific Gas and Electric Company 1989.

material imported from offsite. These soils may lack profile development and have little or no remaining soil structure.

Environmental Setting for Hydrology

Surface Water Hydrology

The surface waters of California can best be characterized by regions of similar hydrologic character. Six separate hydrologic regions have been designated in the state, based on divisions established by the California Department of Water Resources (DWR) (1994a). Each of these regions exhibits distinct precipitation, runoff, and geologic conditions. Because of vast differences in climate, vegetation, and geography between these regions, the state possesses wide-ranging variations in seasonal weather patterns, precipitation, and runoff potential. A variety of database resources are available, and new information is constantly being added that allows evaluation of site-specific hydrologic characteristics in California. With the advent and expansion of available Internet resources, computer databases now include extensive data from geographic information systems (GIS) databases such as those maintained by the California Teale Data Center for topography, watershed boundaries, surface water and groundwater resources, designated floodplains, geological features, soil characteristics, and vegetative cover (California Teale Data Center 1999). Databases are also available for specific streamflow information for gaged rivers in California on the U.S. Geological Survey Internet servers (U.S. Geological Survey 1999a). The DWR operates the California Irrigation Management Information System (CIMIS), a program of real-time atmospheric and precipitation data aimed at water management for agricultural operations (California Irrigation Management Information System 1999). DWR also maintains the California Data Exchange Center (CDEC) program of real-time data collection for river, reservoir, and snowpack information focused on water supply management (California Data Exchange Center 1999).

Characteristics of California Watersheds

High amounts of variation in climate, precipitation, and runoff characteristics dominate California watersheds. The North Coast region, for example, can receive up to 200 inches of rainfall per year, whereas some areas of the Colorado Desert region in the south part of the state receive less than 2 inches per year (Mount 1995). These patterns, combined with other regional factors, determine the amount and type of runoff emanating from the area, the rate of deep percolation and aquifer recharge, and the potential for flooding to occur. Table D-2 shows the seasonal patterns, precipitation and runoff characteristics of the six regions.

Water Supply Issues. The state is traversed by numerous facilities and infrastructure to ensure that water supplies are reliable. A water service system's reliability is based on that system's ability, through proper management, to meet demand regardless of fluctuations in supply, including shortages during periods of drought (California Department of Water Resources 1994a).

Of the 62.4 million acre-feet (maf) of total projected available supplies for the year 2000 (non-drought scenario), 55.1 maf is surface water for local and long-range deliveries and dedicated natural flow. A significant portion of the surface water originating in northern California is transferred through Central Valley Project (federal) and State Water Project operations to southern California from the Sacramento-San Joaquin River Delta, from the Mono-Owens Lake area in eastern California, and from the Colorado River (California Department of Water Resources 1994a). Table D-3 describes the major watersheds, surface water resources, and conveyance facilities in each Regional Water Quality Control Board (RWQCB) region.

Legislative and policy changes in federal and state deliveries and uses over the past 8–10 years have created a greater demand for optimal management of the state's water resources. More of the water is designated for environmental purposes, and mandates to reduce impaired water bodies have been reinforced. To meet these increased standards, long-term, comprehensive management programs are being developed and implemented throughout the state. Conserving water and maintaining the quality of existing water supplies are now the focuses for resource management and regulatory agencies, water supply purveyors, treatment plant operators, and users.

Groundwater Hydrology

Approximately 40% of the total land area of the state is underlain by groundwater basins. It is estimated that the storage capacity of these basins reaches totals of approximately 1.3 billion acre-feet of water, and many of them are estimated to be full or nearly full. The fraction of water that is usable from these basins, about 143 million acre-feet, is still more than three times the capacity totals of the state surface storage reservoirs.

Many of the California groundwater basins are located in arid valleys and are recharged by percolation of rainfall and surface water flows. Recharge occurs more readily in areas of coarse sediments, which are usually located near the alluvial fans associated with mountain ranges. Percolation in southern California occurs only during periods of intense precipitation, whereas northern California groundwater basins often receive direct recharge from annual precipitation (California Department of Water Resources 1975). The location and extent of impermeable confining layers in the alluvial deposits that contain the aquifers play a major role in the amount and rate of recharge of percolating water, and overall quality of the groundwater.

Table D-2.
Watershed Characteristics of California

Region	Seasonal Patterns	Runoff Characteristics	Precipitation
North Coast (Region 1)	Inland: Distinct rainy, cool winters and hot, dry summers. Coastal: Cool and wet year round with little temperature variation.	Highest peak discharges recorded in state, with highest total sediment yields.	Dominated by rainfall; average annual precipitation in region is 53 inches.
Sacramento, San Joaquin, and Tulare Lake (Region 5)	Valley: Hot, dry summers and cool, wet winters. Mountains: Mild summers with intermittent thundershowers, heavy winter snowfalls above 5,000 feet.	Prolonged spring runoff fed by Sierra Nevada snowpack; low sediment yields due to widespread vegetation and stable rock types/soils; locally high sediment yields due to land uses (e.g., logging, grazing, and urbanization).	Valleys receive winter rainfall, and mountains receive moderate to heavy snowfall; total average annual precipitation ranges from 36 inches in the Sacramento River region to 13-14 inches for the San Joaquin and Tulare Lake regions.
San Francisco Bay and Central Coast (Regions 2 and 3)	Coast: Cool and foggy year round with rain in the winter; small seasonal temperature variations Inland areas: Warm, dry summers with cool, rainy winters.	High peak runoff due to small, steep watersheds; local rivers susceptible to severe flooding during high-rainfall events; some watersheds produce high sediment yields due to unstable rock types/soils	Precipitation from rainfall, with insignificant snowfall; northern area - average annual precipitation is 31 inches, greater than 50 inches in some areas; southern area - average precipitation is 20 inches
North and South Lahontan (Region 6)	Valleys: Semi-arid, high-desert terrain; hot, dry summers with locally intense thunderstorms; mild, dry winters Mountains: Cool, mild summers; cold winters with regionally heavy snowfall	Valleys: High peak runoff in ephemeral drainages; watersheds except Owens River are short and steep ephemeral drainages; stable rock types/ soils result in low, coarse sediment yields Mountains: Extended spring runoff with locally high sediment yields in Sierra Nevada.	Valleys: Low to moderate precipitation totals due to rainshadow effects of Sierra Nevada and Cascade Mountains Mountains: Regionally heavy winter snowfall and intense summer thunderstorms; average annual precipitation ranges from 8 inches in the south to 32 inches in the north

Table D-2. Continued

Region	Seasonal Patterns	Runoff Characteristics	Precipitation
South Coast (Regions 4, 8, and 9)	Mediterranean climate with several dry years interrupted by infrequent high precipitation years; warm, dry summers and mild, wet winters; inland summer temperatures can exceed 90ºF; intense subtropical storms	Watersheds are largely ephemeral and fed by rainfall; rivers susceptible to frequent flooding due to peak discharge events; sediment yields are locally high due to intense urbanization, low vegetation, and unstable soils; debris flows and mudflows frequent in some smaller drainages	High rainfall with insignificant snowfall contribution; locally heavy storms have the highest 24-hour rainfall totals in the state; average annual precipitation is 18.5 inches
Colorado Desert (Region 7)	Arid desert region with hot, dry summers and mild winters; rainfall is limited to a few storms per year	Low runoff due to limited rainfall, but locally heavy during infrequent storm events; overall sediment yields are low but produce debris flows during storms	All precipitation falls in the form of rain; region has the lowest yearly precipitation totals in the state, with some areas receiving less than 2 inches; average regional rainfall is 5.5 inches.

Sources: Mount 1995; California Department of Water Resources 1994a; California Regional Water Quality Control Board 1994.

Table D-3.
Principal Surface Water Resources, Water Supply Facilities, and Beneficial Uses for Each RWQCB Region

Region	Primary Basins or Contributing Rivers	Major Storage Facilities (Reservoirs)	Major Conveyance Facilities	Sensitive Beneficial Uses	Central Valley Project (CVP) Supply Status	State Water Project (SWP) Supply Status	Notes
1- North Coast	Klamath River Basin, North Coast Basin	Clair Engle (Trinity), Upper Klamath (Oregon), Clear Lake, Lake Sonoma Warm Springs Dam	Canal from Clair Engle Reservoir to northern Sacramento Valley	Municipal, domestic and industrial supply, recreation, maintenance of resident and anadromous fisheries, national wildlife refuges	No CVP supplies to area	No SWP supplies to area	Area contains most of the state's wild and scenic rivers. 95% of supplies dedicated to environmental use.
2 - San Francisco Bay	Numerous local surface water drainages	Calaveras, Leroy Anderson, Del Valle, Briones, Crystal Springs	Putah South Canal, Sonoma-Petaluma Aqueducts, North Bay Aqueduct, Mokelumne Aqueduct, Contra Costa Canal, South Bay Aqueduct, Hetch Hetchy Aqueduct, San Felipe Unit	Municipal, domestic and industrial supply, groundwater recharge, water recreation , wildlife, cold and warm freshwater habitat, fish migration and spawning, estuarine habitat	CVP water delivered through the Contra Costa Canal to the Contra Costa Water District and through the San Felipe Project to the Santa Clara Water District. About 50% is used for recharge, the rest is used for direct supply	SWP water delivered through the South Bay Aqueduct to the Santa Clara Valley Water District for municipal and industrial supply, agricultural deliveries, and groundwater recharge	76% of supplies are for dedicated natural flow
3 - Central Coast	Numerous local surface water drainages	San Antonio, Nacimiento, Cuyama River, Santa Ynez. Over approximately 60 reservoirs. Most are privately owned	San Felipe Unit, Coastal Branch Aqueduct	Wildlife, municipal, domestic, and industrial supply, recreation, rare, threatened or endangered species	CVP water delivered through the San Felipe Unit	SWP water delivered through the Coastal Branch Aqueduct	82% of water supplies from groundwater, remainder of non-CVP/SWP supplies from local surface water and storage facilities.

Region	Primary Basins or Contributing Rivers	Major Storage Facilities (Reservoirs)	Major Conveyance Facilities	Sensitive Beneficial Uses	Central Valley Project (CVP) Supply Status	State Water Project (SWP) Supply Status	Notes
4 - Los Angeles	Santa Clara River, Los Angeles River, San Gabriel River	Castaic Lake, Lake Piru, Pyramid Lake, Lake Casitas	Los Angeles Aqueduct, California Aqueduct	Municipal, domestic, and industrial, agricultural, recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species	No CVP deliveries in region	SWP water delivered through the California Aqueduct. Supplies nearly one-half of the surface water deliveries in the region.	Water also delivered through the Colorado River Aqueduct (supplies comparable amount as the California aqueduct). About 26% of all water supplies come from groundwater resources.
5 - Central Valley	Sacramento River Basin and, San Joaquin River Basin (both contain numerous important watersheds)	Numerous large reservoirs in the Sierra range (capacities of 200 thousand acre-feet or more); several smaller reservoirs along east side of coast range	California Aqueduct (i.e., SWP), Delta-Mendota Canal (i.e., CVP), Friant-Kern Canal, numerous canals and ditches on valley floor	Agriculture, wildlife habitat, fish migration and spawning, preservation of rare and endangered species, warm and cold freshwater habitat, municipal, domestic, and industrial,	Projected water supplies from CVP operations are projected to be about 7.4 million acre-feet in the year 2000 (average year)	SWP supplies insignificant in northern and central valleys. Tulare Lake region is projected to receive just over 1 million acre-feet of water in the year 2000 (average year)	Other local surface water and groundwater supplies are projected to be 13.7 million acre-feet in the year 2000 (average year). Region supplies over 2/3 of the state's drinking water needs.

Region	Primary Basins or Contributing Rivers	Major Storage Facilities (Reservoirs)	Major Conveyance Facilities	Sensitive Beneficial Uses	Central Valley Project (CVP) Supply Status	State Water Project (SWP) Supply Status	Notes
6 - Lahontan Region	Truckee River, Carson River, Walker River, Owens River, Amargosa River, Mojave River	Stampede, Lake Tahoe, Lake Crowley	California Aqueduct (east and west branches), Los Angeles Aqueduct	Agriculture, wildlife habitat, warm and cold freshwater habitat, municipal, domestic, and industrial	No CVP deliveries in region	Supplies from SWP facilities are projected to total about 24% of all developed water supplies in South Lahontan. No SWP facilities in North Lahontan.	North Lahontan receives 74% of all water supplies from local surface water, and 23% from groundwater. South Lahontan receives 10% of supplies from local surface water, 52% from groundwater, and 23% is dedicated natural flow
7 - Colorado River Basin	Colorado River, White Water River	Salton Sea - saline	Colorado River Aqueduct, California Aqueduct, Coachella Canal, East Highline Canal, Westside Canal	Agriculture, municipal and industrial, recreation	No CVP deliveries in region	Small amount (2% of all supplies) provided through SWP deliveries	96% of all water supplies delivered to the region are conveyed from the Colorado River Aqueduct (year 2000 projection, non-drought scenario)

Region	Primary Basins or Contributing Rivers	Major Storage Facilities (Reservoirs)	Major Conveyance Facilities	Sensitive Beneficial Uses	Central Valley Project (CVP) Supply Status	State Water Project (SWP) Supply Status	Notes
8 - Santa Ana	Santa Ana River	Lake Perris, Lake Mathews, Lake Elsinore, Seven Oaks, Prado	Colorado River Aqueduct	Municipal, domestic, and industrial, agricultural, recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species	No CVP deliveries in region	SWP water delivered through the California Aqueduct. Supplies nearly one-half of the surface water deliveries in the region.	Water also delivered through the Colorado River Aqueduct (supplies comparable amount as the California aqueduct). About 26% of all water supplies come from groundwater resources.
9 - San Diego	San Luis Rey River, San Diego River	San Vicente Reservoir, Lower Otay Lake, El Capitan,	Colorado River Aqueduct, San Diego Aqueducts	Municipal, domestic, and industrial, agricultural, recreation, warm and cold freshwater habitat, wildlife habitat, rare, threatened or endangered species	No CVP deliveries in region	SWP water delivered through the California Aqueduct. Supplies nearly one-half of the surface water deliveries in the region.	Water also delivered through the Colorado River Aqueduct (supplies comparable amount as the California aqueduct). About 26% of all water supplies come from groundwater resources.

Groundwater Basins

There are about 250 important groundwater basins statewide, supplying about 40% of the state's applied water needs. Statewide, more than 15 million acre-feet (maf) of groundwater are extracted for use in agricultural, municipal, and industrial applications. Table D-4 identifies California's major groundwater basins by region. For types of sensitive beneficial uses of water by region, refer to Table D-2.

Water Quality Setting

Surface Water and Groundwater

State and federal water quality standards are established to achieve a level of quality that provides the highest benefit for all users. Therefore, water resources need to be protected from impairments that result from waste discharges. By assessing and identifying beneficial uses in a given area, water quality standards and treatment levels can be established to best meet the needs of that area. The primary beneficial uses that are evaluated for regulatory compliance (refer to "Regulatory Framework" below) include aquatic life support, fish consumption, primary-contact recreational activities such as swimming, secondary-contact recreational activities such as wading, drinking water supply, and agricultural/industrial supply. The costs of remedial cleanup actions and potential adverse environmental effects of poor water quality can be considerable and can affect the amount of water available for beneficial uses. Increased storage, treatment, and handling costs; reduced crop yields; and harmful effects on fish and wildlife are examples of the adverse effects of impaired waters.

Water quality is monitored through a variety of federal, state, and local programs. The state evaluates current water quality conditions and prioritizes funding efforts for protection, cleanup, and monitoring programs through individual water quality assessments, which are compiled into the state's Section 305(b) reporting process mandated under the federal Clean Water Act (California State Water Resources Control Board 1996). The Section 305(b) report includes the Section 303(d) lists, which are named in reference to the Clean Water Act section that mandates their preparation. The Section 303(d) lists identify water bodies that do not meet applicable water quality standards for designated beneficial uses with technology-based controls for waste discharges. Several other major ongoing water quality monitoring programs include the State Toxics Substance Control Monitoring Program (California State Water Resources Control Board 1999) and monitoring that is required to be conducted in the San Joaquin-Sacramento River Delta to manage SWP and CVP operations in the Central Valley (California Department of Water Resources 1994b, California Department of Water Resources 1999). Databases are also available for specific water quality information for many rivers, lakes, and groundwater wells in California on the U.S. Environmental Protection Agency's (EPA's) STORET data retrieval system (EarthInfo Inc. 1994, U.S.

Environmental Protection Agency 1999) and U.S. Geological Survey Internet servers (U.S. Geological Survey 1999b).

Water quality issues differ depending on the location and type of water resource, size and extent of the watershed and water resources, location with respect to potential pollutant sources, and season and climatic factors, as well as many other interacting physical, chemical, and biological processes. Medium to large surface water bodies typically have a large capacity to assimilate waste loads of pollutants because various physical and chemical processes are effective in diluting and transforming pollutants to less harmful components. Biological processes are especially important because many chemical constituents can be absorbed by plants or animals and removed from the water or metabolized in biological tissues to less harmful substances. Consequently, water quality impairment at a large scale usually occurs in watersheds with extensive development for human activities that receive pollutants from a variety of point- and nonpoint-source pollutant discharges. Point-source pollution refers to discharges from a single location, such as a wastewater treatment plants, landfill, or industrial site. Nonpoint-source discharges are generated over a large area and result from dispersed activities such as urban stormwater runoff; mining, agricultural and forestry activities, residential septic tanks, or accidental spills.

Surface water quality is primarily dependent on seasonal flow and hydrologic patterns in combination with the mineral composition of the watershed soils and associated parent materials, topography, and sources of contaminants. During summer low-flow conditions, the water quality characteristics of most importance to aquatic life are temperature, dissolved oxygen, turbidity, biostimulatory nutrients (e.g., nitrogen and phosphorus) and nuisance algae growth, and toxic constituents such as un-ionized ammonia or residual chlorine. During higher winter streamflow conditions, water quality is influenced more by stormwater runoff and associated pollutants, such as eroded soil, oil and grease from automobiles and paved areas, nutrients from agricultural fields and livestock boarding areas, and organic litter (e.g., leaves and grass clippings).

The most recent state Section 305(b) report indicates that most of the state's surface lakes and reservoirs, rivers and streams, freshwater wetlands, and estuaries only partially support all of their designated beneficial uses. Of the water bodies not supporting all of their uses, a small fraction fail to support the designated beneficial uses all the time. For example, 10,838 miles of the rivers and streams only partially support all beneficial uses; however, only 2,142 miles fail to support one or more beneficial uses all of the time. For lakes and reservoirs, approximately 569,000 acres only partially support beneficial uses, but only 9,670 acres fail to support one or more uses all of the time. For freshwater wetlands, approximately 107,000 acres partially support beneficial uses but there are no wetlands that do not support a beneficial use all the time. The Section 305(b) report also provides a listing of the physical or chemical constituents that cause impairment of beneficial uses. Lake and reservoir beneficial uses tend to be impaired predominantly by the presence of noxious weeds, trace metals, pesticides, and taste and odor problems, with each constituent affecting at least 100,000 acres. Approximately 30,000 acres are impaired by organic enrichment and dissolved oxygen effects, 12,000 acres are affected by nutrients and general eutrophication problems, and 12,000 acres are affected by

Table D-4. Major Groundwater Basins of California

Region	Major Groundwater Basins	Extraction (ac-ft/yr)
1 - North Coast	Tule Lake, Siskiyou Butte Valley, Shasta Valley, Scott River Valley, Hoopa Valley, Smith River Plain, Mad River Valley, Eureka Plain, Eel River Basin, Covelo Round Valley, Mendocino County	242,338
2 - San Francisco Bay	Petaluma Valley, Napa-Sonoma Valley, Suisun-Fairfield Valley, Santa Clara Valley, Livermore Valley, Marin County, San Mateo County	190,128
3 - Central Coast	Soquel Aptos, Pajaro Basin, Salinas Basin, S. Santa Clara - Hollister, Carmel Valley-Seaside, Arroyo Grande/Nipomo Mesa, Cuyama Valley, San Antonio, Santa Ynez Valley, South Central Coast, Upper Salinas, San Luis Obispo	1,075,800
4 - Los Angeles	Central Basin, West Coast Basin, San Fernando Valley, Raymond Basin, San Gabriel, Upper Ojai Valley, Fox Canyon	808,000
5 - Central Valley	Butte County, Colusa County, Tehama County, Glenn County, Sacramento County, Western Placer County, Yuba County, Sutter County, Eastern Solano County, Yolo County, Sierra Valley, Goose Lake Basin, Big Valley, Fall River Valley, Redding Basin, Almanor Lake Basin, Upper Lake Basin, Lake County/Scotts Valley, Kelseyville, Valley Basin, Coyote Valley, Middletown-Colalyomi Valley, San Joaquin County, Modesto Basin, Turlock Basin, Merced Basin, Chowchilla Basin, Madera Basin, Delta Mendota, Kings Basin, Tulare Lake Basin, Kaweah Basin, Tule Basin, Westside Basin, Pleasant Valley Basin, Kern County Basin	8,302,100
6 - Lahontan	Surprise Valley, Honey Lake Valley, Long Valley Basin, Thermo-Madeline Plains, Willow Creek Valley, Secret Valley, Owens Valley, Death Valley, Mojave River Valley, Antelope Valley	397,200
7 - Colorado River	Warren Valley, Coachella Valley, Cuckwalla	114,740
8 - Santa Ana	Orange County (also in Region 9), San Bernardino Basin Area, Riverside Basin Areas 1 and 2, Colton Basin	98,180
9 - San Diego	Temecula Valley, San Juan Valley, El Cajon Valley, Sweetwater Valley, Otay Valley, Warner Valley, San Luis Ray	34,000*

____

*Total does not include Warner Valley or San Luis Ray - extraction rates unknown.
Sources: California Department of Water Resources (1994a), and California Department of Water Resources (1975).

siltation. Smaller acreages are affected by unknown toxicity, flow alterations, un-ionized ammonia, pH, or unknown causes. Rivers and streams tend to be affected by a much larger variety of constituents. Siltation, pathogens, pesticides, and trace metals dominate the list of problem constituents, with each affecting more than 3,000 miles of channels. Debris, organic enrichment, habitat alterations, salinity, suspended solids, and other trace elements each affect more than 1,000 miles of channel. Freshwater wetlands tend to be impaired primarily by trace metals, salinity, and other trace elements, with each affecting more than 8,000 acres. Flow and habitat alterations, nutrients, pesticides, and siltation contribute to the problems less sizeably. Table D-5 summarizes the major water quality issues for surface water and groundwater resources affecting each of the nine RWQCB regions.

Groundwater quality has typically been less of a concern than surface water quality because many of the useable aquifers for domestic consumption were protected by the overlying soils and geological structures. Groundwater quality, when impaired, was typically associated with percolation from landfills, leaking underground tanks, or other readily identified source of pollution. However, the public attention and regulatory focus of managing and protecting groundwater quality are increasing because nonpoint sources are known to cause widespread impairment of groundwater quality through the introduction of inorganic contaminants such as nitrates from septic tanks and agricultural fertilizer use, large scale use of pesticides and herbicides, and major concerns still exist over the potential infiltration of hazardous wastes from historical land uses. The most recent state 305(b) report indicates that approximately 20,000 acres of groundwater basins only partially support all beneficial uses, however, only 1,150 acres fail to support one or more beneficial uses all of the time. Approximately 24,800 acres of groundwater have elevated levels of toxic constituents. A more detailed analysis of existing groundwater contamination issues associated with nitrates is presented below.

Nitrate in Groundwater and Nitrate-Sensitive Areas

Nitrogen may be a factor in limiting the quantity of land available for biosolids application in any specific area. Nitrate contamination of groundwater has been documented throughout California (California State Water Resources Control Board 1988, California Department of Food and Agriculture 1989). Nitrogen is present in groundwater primarily in the nitrate form, although minor amounts of ammonium or nitrite may be present. The California drinking water standard or maximum contaminant level (MCL) is 45 milligrams per liter (mg/l) of nitrate (NO_3). This is approximately equivalent to the state and federal drinking water standard of 10 mg/l nitrate as expressed as nitrogen (NO_3-N).

Increased nitrate levels can be attributed to increases in population and food production. Potential sources of nitrate contamination include human and animal waste and nitrogen fertilizers used for production agriculture and in municipal areas. Nitrate is a nonpoint-source contaminant. The largest nonpoint source of nitrate contamination to groundwater is fertilizers applied in commercial farming (California State Water Resources Control Board 1988). Potential groundwater contamination from nitrates is related to many complex factors that influence biological conversions and the physical processes by which nitrates are transported through the subsurface environment. These factors include soil characteristics, crop, irrigation practices, timing and application of nitrogen, geology, climate, and hydrologic conditions. It is difficult to determine whether an observed level of nitrates in groundwater results from current or past operations. It is also difficult to quantify the level of nitrate contribution from the potential sources (agricultural, animal waste, septic, or wastewater sources).

The most recent statewide compilation of nitrate conditions in groundwater by geographic area in California was produced in 1988 (California State Water Resources Control Board 1988). The data were compiled through contact with each of the nine RWQCBs, contact with county health directors, the California Department of Health Services (DHS), the California Department of Food and Agriculture (DFA), the U.S. Geological Survey (USGS), and EPA. State and federal databases and a literature search were conducted. The SWRCB found that a large body of data exists and that special investigations were being conducted at the local level, but determined that information was not readily available for use in a statewide assessment. Large data gaps were found to exist because of the different types of monitoring programs being conducted, and there was no readily accessible centralized source for making assessments of nitrates in groundwater. For any thorough investigation of nitrate loading at the scale of an individual groundwater basin, it would be imperative to have close contact with local agencies and with the studies being conducted at this level. In general, the data and research available suggest that the highest potential for subsurface transfer of surface-applied nitrogen to groundwater would be in highly permeable, sandy soils with low organic matter content under heavy irrigation, and that shallow wells were the water resource most susceptible to impairment. Areas that do not receive a large amount of freshwater recharge also may act as “sinks” that are more susceptible to cumulative loading of nitrates.

Figure D-1 shows well locations in areas throughout the state that have recorded nitrate levels of 45 mg/l or more during 1975–1987. Figure D-2 shows well locations where nitrate levels have been recorded in the range of 20–44 mg/l during the same period (California State Water Resources Control Board 1988). There is no statewide compilation more current than the 1988 SWRCB report, although water quality assessments prepared by each RWQCB also evaluate the level of impairment from nitrates to the designated beneficial uses for specific surface water bodies and groundwater basins.

DFA has developed criteria for evaluating nitrate-sensitive areas to prioritize funding and research on nitrates (California Department of Food and Agriculture 1998). Two conditions indicate an urgent problem: a high level of nitrate contamination in groundwater and a population that depends on that water for drinking. Those two conditions depend on various factors. Soil scientists with the University of California and DFA’s Fertilizer Research and Education Program (FREP) identified seven criteria for assessing the nitrate sensitivity of an area:

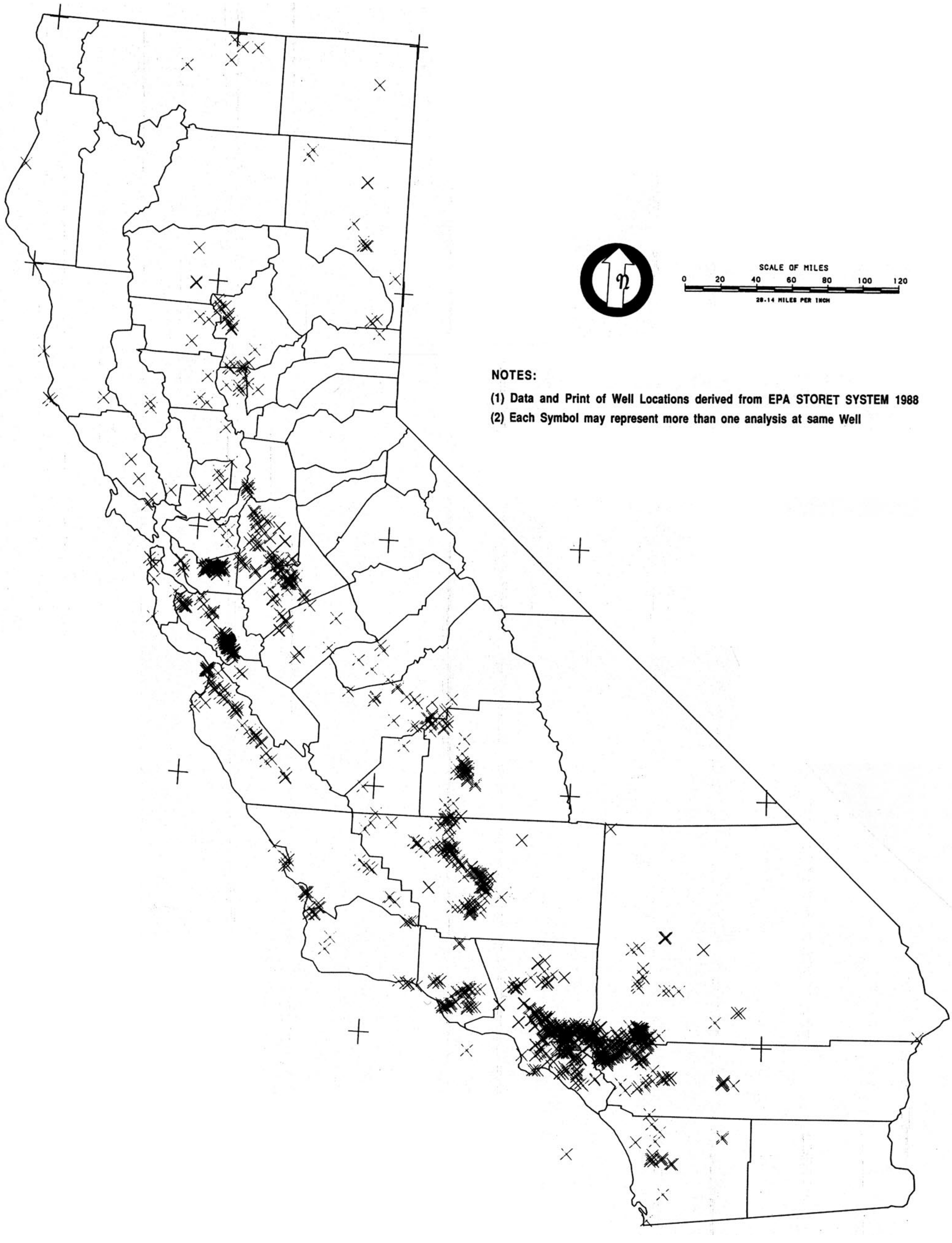
Table D-5. Major Water Quality Issues Affecting Beneficial Uses

Region	Surface Water Issues	Sources	Groundwater Issues	Sources
1 - North Coast	Sedimentation	Logging, Grazing	n/d	n/d
2 - San Francisco Bay	Sedimentation, eutrophication, elevated fish tissue levels, dissolved solids, trace metals, habitat degradation, toxic pollutants	Irrigated farm runoff, stormwater runoff, sewage discharges, industrial manufacturing	Threat of drinking water impairment, saline intrusion, synthetic organics	Irrigated farm runoff and other nonpoint sources, overdraft, tank leaks and industrial discharges
3 - Central Coast	Sedimentation, wildlife and fisheries impairments, trace metals	Irrigated farm runoff, nonpoint urban runoff	Drinking water impairment, saline intrusion, nitrates, toxic pollutants	Nonpoint source runoff, groundwater overdraft
4 - Los Angeles	Elevated tissue levels, nutrients, sedimentation, high coliform count, trace metals, salinity ammonia	Industrial and urban discharges and runoff, diversions, sewage discharges, illegal dumping	Nitrates, synthetic organics, salinity, VOCs, saline intrusion	Industrial manufacturing, nonpoint source runoff, overdraft
5 - Central Valley	Sedimentation, elevated fish tissue levels, eutrophication, aquatic habitat degradation, drinking water impairment, potential THM precursors	Irrigated agriculture, diversions, municipal and industrial discharges, mineral exploration and extraction	Drinking water impairment, pesticides and herbicides, agricultural impairment, VOCs	Irrigated agriculture, dairy nonpoint source pollution, agricultural wastewater, fuel tank leaks, overdraft

Table D-5. Continued

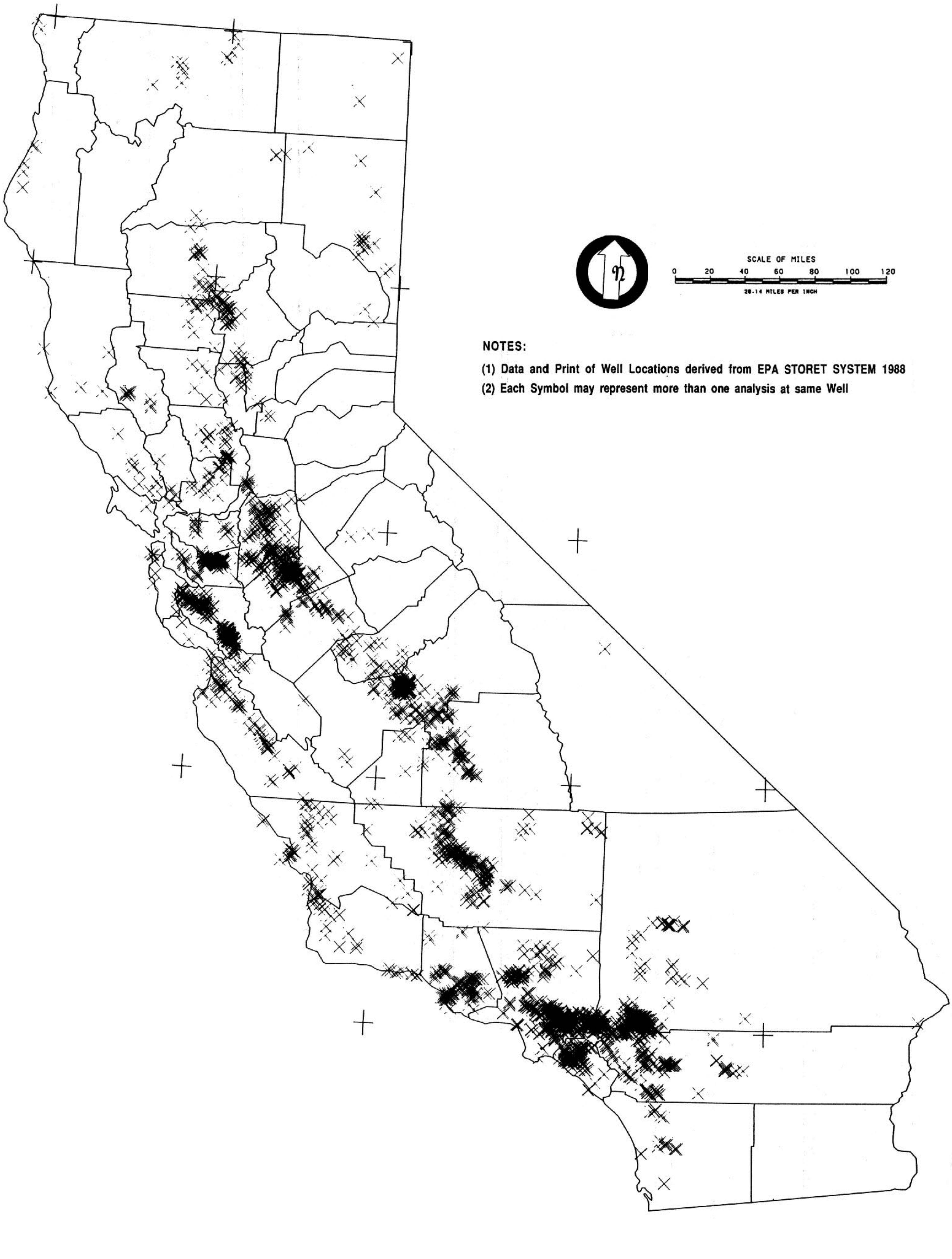
Region	Surface Water Issues	Sources	Groundwater Issues	Sources
6 - Lahontan	Recreational impacts, threats to rare and endangered species, eutrophication, sedimentation, fish kills, metals	Hydrologic modifications, grazing, mining drainage, agricultural runoff and wastewater	Drinking water impairment, salinity, VOCs	Mining drainage, overdraft, fuel tank leaks
7 - Colorado River	Sedimentation, salinity, threat of drinking water impairment, bacteria, pesticides and herbicides	Agricultural runoff and wastewater, erosion, diversions	VOCs, threat of drinking water impairment	Overdraft, fuel tank leaks,
8 - Santa Ana	Elevated shellfish tissue levels, threat of toxic pollutants, eutrophication, sedimentation, potential THM precursors, trace metals, ammonia	Agricultural wastewater, industrial discharges, urban stormwater runoff	Drinking water impairment	Agricultural nonpoint source runoff
9 - San Diego	Sedimentation, eutrophication, high coliform counts, metals	Municipal and industrial discharges and runoff, agricultural irrigation returns, mining operations	Salinity, nitrates, organics, metals	Overdraft, underground storage tank leaks

Sources: Regional Water Quality Control Board Basin Plans (California Regional Water Quality Control Boards 1995); California Water Quality Assessment Report (1996), California Department of Water Resources (1994a).
Notes: n/d = no data available;



Jones & Stokes Associates, Inc.

Figure D-1
Well Locations where Nitrate Levels have been Recorded at 45 mg/l or Greater during the Period 1975 through 1987



Jones & Stokes Associates, Inc.

Figure D-2
Well Locations where Nitrate Levels have been Recorded within the Range of 20 through 44 mg/l during the Period 1975 through 1987

- **Groundwater use:** Nitrate concentration is critical if groundwater is used for domestic or animal drinking supplies.

- **Soil properties:** Sandy or other coarse-textured soils transmit water containing dissolved nitrates downward more rapidly. Also, these soils are less likely to create conditions in which nitrate turns to a gas and escapes from the soil (denitrification).

- **Irrigation practices:** Inefficient irrigation systems that lead to large volumes of subsurface drainage increase the leaching of nitrates. Typically, these are surface flow systems with long irrigation runs. Well-managed sprinkler or drip systems and surface flow systems with short runs reduce the threat of nitrate leaching to groundwater.

- **Type of crop:** Crops most likely to increase nitrate leaching are those that (1) need heavy nitrogen fertilization and frequent irrigation; (2) have high economic value, so that the cost of fertilizer is relatively small compared to the revenue produced; (3) are not harmed by excess nitrogen; and (4) tend to take up a small fraction of the nitrogen applied. Many vegetable, fruit, nut, and nursery crops fit these criteria and, therefore, have elevated potential for nitrate leaching. Those with less potential include field crops such as alfalfa, wheat, and sugar beets.

- **Climate:** High total rainfall, concentrated heavy rains, and mild temperatures lead to more leaching of nitrates.

- **Distance from the root zone to groundwater:** Less distance means a more immediate problem if nitrate levels begin to increase.

- **Potential impact:** The severity of nitrate leaching also differs based on such factors as population density and availability of an alternate water supply.

The DFA's FREP initial field activities have been directed at areas based on groundwater use, soil characteristics, crop type, irrigation practices, climate, distance to groundwater, and potential impact indicate the nitrate sensitivity of an area. In general, two regions of the state, the Central Coast valleys and parts of the east side of the Central Valley, fit the above criteria.

Mobility, Bioavailability, and Potential Toxicity of Plant Nutrients and Trace Elements in Biosolids

Several closely related issues are associated with the occurrence of nutrients, trace metals, and synthetic organic compounds in biosolids. These issues are analyzed in a fate and transport analysis, which evaluates what happens to these compounds in the soil; how their presence may affect agricultural productivity and sustainability; how they change and move through soil (to be taken up by plants and grazing animals and ultimately to enter the human food chain); and how they are removed from the immediate land application site as soil dust or eroded particles, or become dissolved and leave with surface runoff and groundwater flow.

Because all of the fate and transport mechanisms ultimately derive from the behavior of applied biosolids in the soil, this section of the EIR provides background information and an outline of some of the important chemical processes that occur in soils and influence plant uptake and the movement of compounds released from biosolids. A separate discussion is provided in Appendix E, “Public Health Technical Appendix”, on uptake of biosolids-derived compounds, entry through the food chain, and related exposure mechanisms. Potential effects on soil productivity are discussed in the Chapter 4, “Land Productivity”.

Most elements present in soil and taken up by plants (including nutrients and toxic metals) must be in a soluble form in the soil water (called solution phase) for recovery by plant roots and incorporation into the root mass or aboveground plant biomass. Once taken up, elements may be preferentially concentrated in various parts of the plant (e.g., leaf, petiole, flower, seed, fruit). If preferential concentrations greatly exceed background soil levels, the compounds are said to bioaccumulate. Elements contained in biosolids are released into the solution phase by microbial decomposition of organic matter containing the elements and/or by various physical and chemical processes. For discussion purposes, elements (with the exception of pathogens, which are discussed in Chapter 5, “Public Health”, and Appendix E) contained in and released following biosolids application and subsequent decomposition can be placed in three broad groups:

- Major elements and plant nutrients, which include nitrogen, phosphorus, and potassium: These and other elements, such as calcium and magnesium, are generally more soluble, occur naturally in soils in relatively large amounts, and are required in moderate to large amounts for plant growth.

- Trace elements and heavy metals, which primarily occur in biosolids in small quantities and, when released, often form sparingly soluble reaction products: Some trace elements are required for plant growth, whereas other heavy metals may be toxic to plants.

- Potentially harmful synthetic organic compounds (SOCs), which typically are found in biosolids in very small amounts and are generally not taken up by plants: The principal concern with SOCs is ingestion of plants coated with dust from biosolids sources unusually high in SOCs, as well as direct biosoids ingestion by grazing animals.

Surface Water Runoff and Groundwater Leaching

Two of the key pathways identified in the Part 503 risk assessments were related to surface water runoff (Pathway #12) and the leaching of pollutants to groundwater (Pathway #14) from biosolids application sites. Surface water runoff from application sites can occur when rainfall exceeds the infiltration rate of the soil. Infiltration is influenced primarily by the permeability of the soil and the amount of water already stored in the soil. Runoff from application sites may cause erosion of sediments and transport of either dissolved or suspended contaminants to surface water bodies.

Leachate is water from either rainfall or irrigation that is transported through the soil. Some potential contaminants are soluble in water and may be transported in dissolved forms through the soils. Dissolved contaminants may then move through the soil and percolate to groundwater. Percolating groundwater may then move to surface water supplies or wells that provide drinking water. Complex biological, chemical, and physical processes govern how water moves through saturated and unsaturated porous materials.

Definitions

It is convenient to characterize the presence of trace metals and nutrients in a soil (or soil amendment) as being readily available (generally soluble and easily taken up by plants or moveable through the soil); slowly available (requiring some combination of microbial or physical/chemical breakdown for release to the soil-water system); or relatively unavailable (requiring significant physical, chemical, and biochemical changes to become available for movement in the soil water and plant uptake). Most often, an element is present in the soil in all three relative states, transforming between the three states as soil chemistry and environmental conditions change over time. These processes are complex and quite variable in the soil environment and differ element by element. General terms used to describe these processes include transformation (change from one chemical form to another, often with different mobility, bioavailability, and toxicity), mobility (movement in the soil, generally with pore-water flow), and bioavailability (chemical form with respect to ability to be taken up by plant roots or soil macroorganisms or microorganisms). Soil mechanisms and processes that slow down or retard mobility and bioavailability are termed attenuation mechanisms. Phytotoxicity refers to compounds such as trace elements that are toxic to growing plants

Major Elements and Plant Nutrients (Nitrogen and Phosphorus) in the Soil Environment

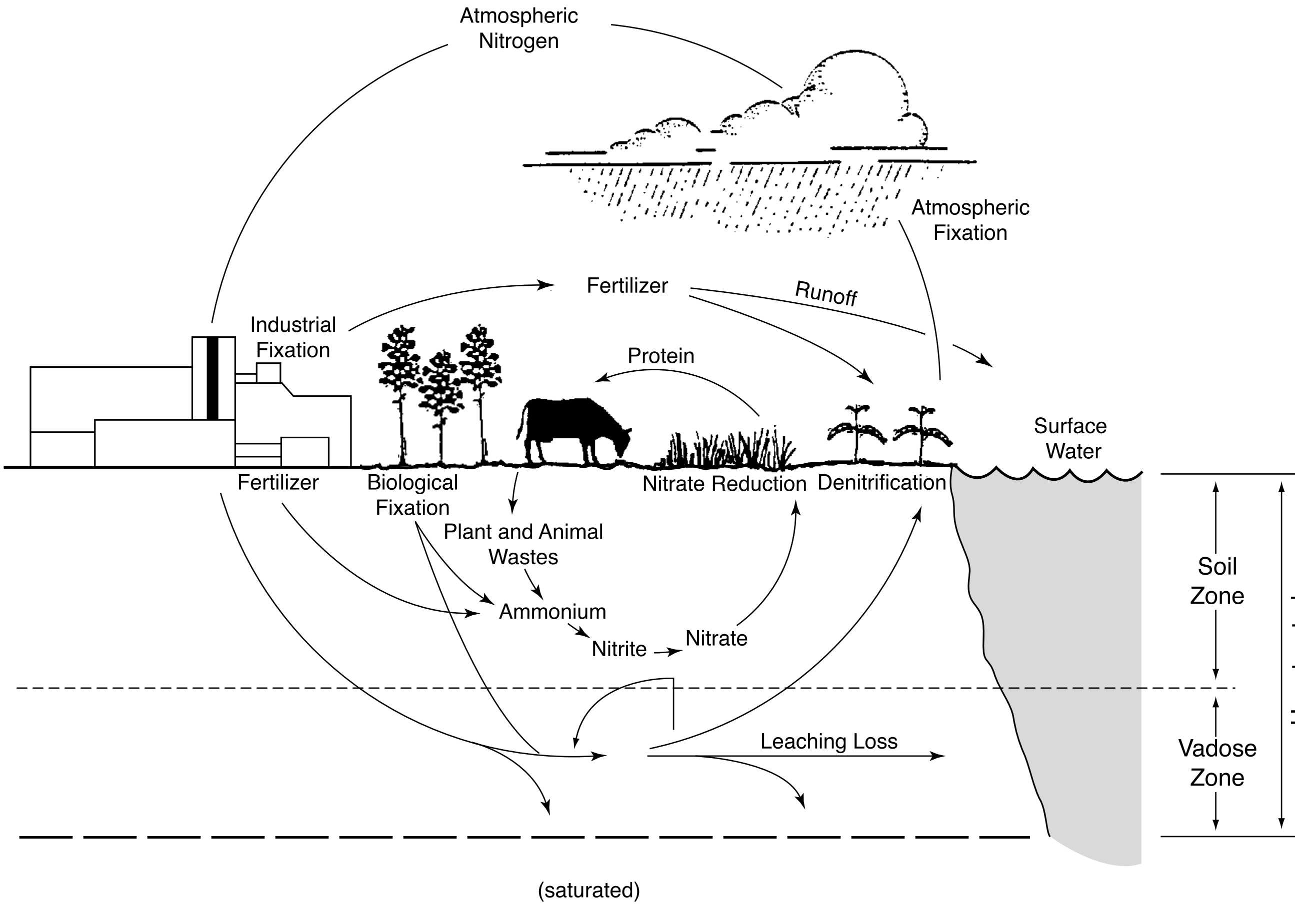
Major plant nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium are typically present in moderate amounts in biosolids; however, their total content, mobility in the soil environment, and bioavailability can vary widely. In addition, biosolids can contain low to moderate levels of soluble salts. Some generalizations can be made with respect to their fertilizer value and other issues with respect to plant nutrient management, mobility, and bioavailability.

Biosolids applied to soils provide nitrogen and phosphorus in several forms. Nitrogen may be present as organic nitrogen, ammonium, nitrate and nitrite ions. Figure D-3 presents the nitrogen cycle and shows how nitrogen moves through the environment. The transformation processes of nitrogen are biologically and chemically controlled and include biological fixation, mineralization, nitrification, and denitrification. With respect to nitrogen content, biosolids are comparable to barnyard manure, providing a source of low-grade but slow- to moderate-release nitrogen. Biosolids contain 1%-6% total nitrogen on a dry-weight basis (National Academy of Sciences 1996). Commercial fertilizers contain 11%-82% total nitrogen. Organic forms of nitrogen generally predominate in biosolids and must be converted to inorganic forms to be utilized by plants, in a process called mineralization. Organic forms of nitrogen are not available to plants. A smaller percentage of the total nitrogen is in the form of gaseous ammonia or dissolved ammonium. Biosolids also typically contain a moderate amount of total and dissolved (i.e., plant-available) phosphorus. As with other trace elements, the transformations between gaseous, soluble inorganic, and less soluble residual or organic forms, and associated mobility in the environment, are complex.

The amount of organic and ammonia nitrogen in biosolids depends on the way biosolids are processed. Depending on site conditions, ammonium forms of nitrogen may be converted to ammonia gas and lost to the atmosphere, utilized by soil microorganisms, or converted to nitrates. Nitrate forms of nitrogen are the most biologically available but also the most mobile and present the greatest risk of groundwater contamination if released from biosolids at rates greater than the crops can uptake and utilize. Nitrates in biosolids are highly mobile in soil and have the potential to contaminate groundwater (Ocrtel 1995, Artiola and Pepper 1992) and are discussed in detail below.

Mineralization of Organic Nitrogen. Through mineralization, soil microorganisms convert organic forms of nitrogen to inorganic (mineral) forms—ammonium (NH_4) and nitrate (NO_3)—which are readily soluble in water and available for plant uptake. Nitrogen mineralization rates vary as a function of the organic nitrogen content of the biosolids, soil, and climatic conditions. Mineralization rates may also vary greatly for different sites, and mineralization rates need to be properly accounted for to determine agronomic rates of biosolids application. Nitrate is the dominant form in well-drained agricultural soils, whereas ammonium dominates where available nitrogen is at a premium and nitrification is low (University of Washington 1991). Mineralization of nitrogen can take from 1–5 years, depending on application rates and site conditions.

Immobilization and Soil Nitrogen Storage. Immobilization is the conversion of mineral forms of nitrogen to organic forms. Nitrogen can be stored in soil through binding to cation exchange sites, immobilization by soil micro-organisms, or as accumulated biomass. The ability to store nitrogen as ammonium on cation exchange sites is dependent upon the CEC level. Soil pH can also affect the CEC level: typically there are less exchange sites in more acidic soils. Biologic immobilization results in



Source: California State Water Resources Control Board 1994.

Jones & Stokes Associates, Inc.

Figure D-3
The Nitrogen Cycle

relatively long-term storage of nitrogen and generally occurs when the carbon to nitrogen ratio is greater than 30:1.

Volatilization of Ammonia. Ammonia and ammonium ions are added to the soil with biosolids or are produced during mineralization. Ammonia is a gas at normal temperatures and pressures, and the loss to the atmosphere can be great under certain conditions. Wind and temperature are major factors. Ammonia loss from biosolids or soils is also affected by pH. Under acidic conditions, nearly all of the ammonia is converted to the mineral form ammonium and the potential for gaseous loss is decreased. Above pH 7, more ammonia is present, increasing the potential for gaseous loss (University of Washington 1991). In acidic and neutral soils, NH_3 is converted to ammonium ions, which can then be sorbed by organic matter or clay particles, effectively taking it out of solution. The CEC level has been identified as one of the most important factors affecting ammonia volatilization (University of Washington 1991).

Nitrification and Nitrogen-Phosphorus Relationships. Nitrification is the microbiological transformation of ammonium ions to nitrate through a two-step, biologically catalyzed transformation process involving the formation from nitrite, and then conversion to nitrate.

Phosphorus is typically present in biosolids in low to moderate amounts and also requires mineralization of organic forms to biologically available forms. The relative proportions of nitrogen and phosphorus are as important in plant nutrition management as total amounts. If nitrogen is limiting in the soil to plant growth (relative to phosphorus), then the relative excess of phosphorus may accumulate in the soil and be subject to erosion and leaching, potentially affecting surface water and groundwater. This usually is not a significant concern in most native California agricultural soils, which are generally deficient in both phosphorus and nitrogen. In most California soils, phosphorus is tied up in various chemical forms and is not lost from the soil, except the phosphorus that is attached to soil particles entrained by runoff.

More often the case with biosolids in California, application rates are dictated by the nitrogen content of the biosolids relative to crop needs, thereby raising concern that overapplication of nitrogen could result in excess leaching to groundwater and potential degradation of water quality. In some cases, particularly with lime-stabilized biosolids, the phosphorus present in the biosolids and available phosphorus present in the soil can be chemically bound to the lime (functionally making the phosphorus unavailable for plant uptake), or additional microbial growth in soils may assimilate the phosphorus to accomplish organic matter decomposition. Consequently, induced phosphorus deficiency in plants can result, causing reduced plant growth or affecting quality and yield. Similarly, biosolids high in carbon but relatively low in nitrogen (i.e., a high carbon:nitrogen ratio) can induce nitrogen deficiency as soil microorganisms have insufficient available soil nitrogen to decompose the organic matter in the biosolids. The former (carbon:nitrogen-induced deficiency) is apparently a rare phenomenon in California, but deficiency induced by poor nitrogen:phosphorus balance can occur in lime-stabilized biosolids. For example, stalks of oat grass (grown for hay) can grow disproportionately long in response to high nitrogen while seed set is reduced or delayed.

This can cause bend-over ("lodging") of the grass stalks, making harvesting difficult and reducing yield and hay quality. If recognized early, such situations can be remedied by application of commercial fertilizers to bring the carbon:nitrogen or nitrogen: phosphorus ratio into balance with crop needs.

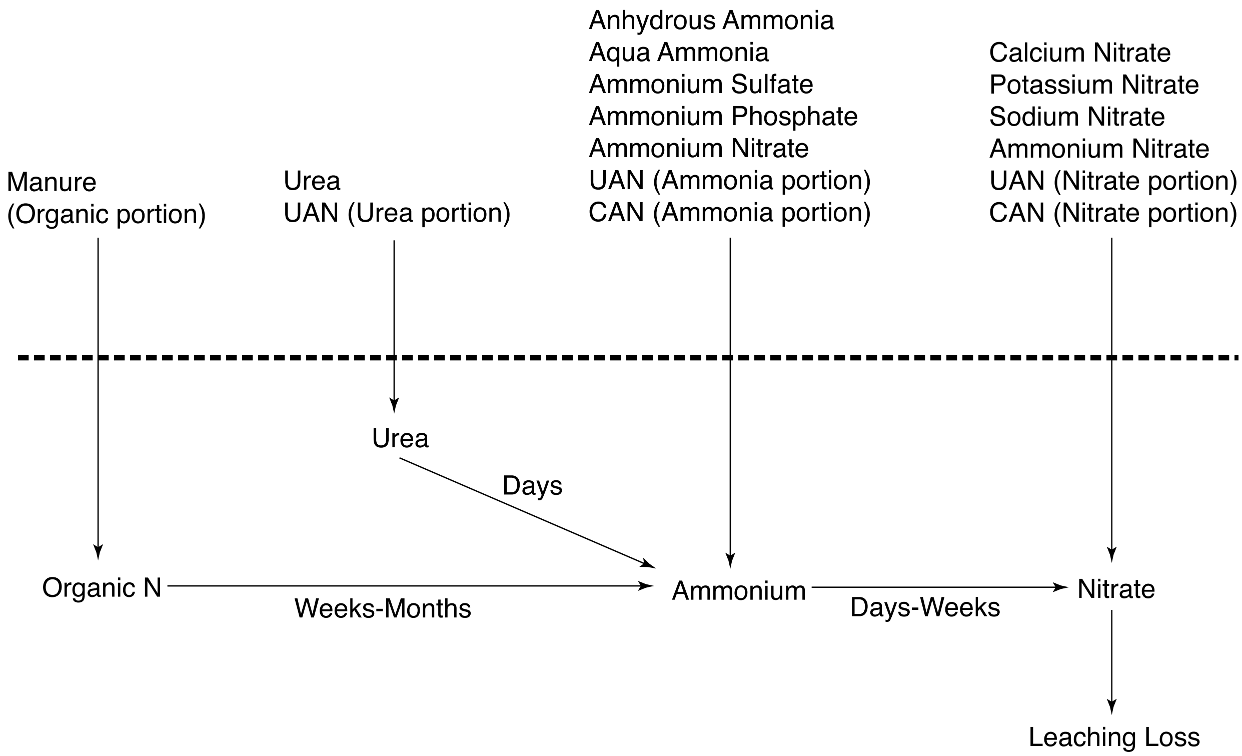
These problems usually can be easily avoided by testing the nitrogen, phosphorus, and potassium levels of the soil, measuring their concentrations in the biosolids, and adjusting biosolids additions and supplemental fertilizer applications to meet the agronomic needs of the crop. This involves setting application rates based on the nutrient most in abundance in the biosolids, not most limiting, and adding supplemental fertilizers when needed to make up for deficiencies.

The GO and Part 503 regulations currently require application at agronomic rates for nitrogen but do not provide guidance for phosphorus. As previously indicated, it is possible but rare in California to create phosphorus pollution problems from biosolids high in phosphorus-to-nitrogen crop demand. It is also possible to create a nitrogen:phosphorus-induced deficiency problem in certain unusual conditions.

For non-exceptional quality biosolids, particularly from large municipal sources with heavy industry, annual biosolids application rates and the total long-term amount that can be land applied may be dictated by their trace element content, not by their nutrient load. This issue is discussed in the next section.

Transport Mechanisms of Nitrates in Groundwater. Nitrates are the form of nitrogen that presents a groundwater contamination risk. The biological and physical mechanisms that govern groundwater susceptibility to nitrate contamination are complex and highly variable. The three key processes that influence groundwater impairment from nitrates are related to 1) how the various forms of nitrogen contained in the biosolids react with the environment and are transformed to nitrate, 2) hydrologic features that transport nitrates through the soil to groundwater, and 3) how nitrates behave in the saturated portion of the aquifer and may reach municipal or domestic wells. Figure D-4 shows major fertilizer nitrogen sources and fertilizer nitrogen transformations in the soil (adapted from California Department of Food and Agriculture 1989).

The movement of nitrates from biosolids that are applied to the soil, through the unsaturated soil, to the nearest groundwater-bearing aquifer is governed primarily by the hydrology of the site and water infiltration. Nitrates are highly soluble and stable in most aqueous environments, making the dissolved fraction hard to remove from potential sources of drinking water. Both water and fertility management are necessary to prevent leaching of nitrates. Intentional overapplication of irrigation water is necessary to leach accumulated salts from the soil and maintain soil productivity. The total amount of nitrate leaching depends on the amount of nitrate dissolved in the soil-water profile and the volume of water percolating per unit time. The amount of nitrate is partially a function of the volume of nitrogen applied from all sources (fertilizer, manure, biosolids), and is thus subject to farm management practices.



UAN - Urea Ammonium Nitrate
CAN - Calcium Ammonium Nitrate

Note: Time periods are for warm, moist soil.

Source: Adapted from California Department of Food and Agriculture 1989.

Jones & Stokes Associates, Inc.

Figure D-4
Major Fertilizer Nitrogen Sources and Fertilizer Nitrogen Transformations in the Soil

Once out of the root zone, leachate containing nitrates will move into the unsaturated area above the water table. This unsaturated area is called the vadose zone (Figure D-3). The vadose zone may serve as a reservoir in which nitrates can accumulate. Further movement through the vadose zone is governed by complex flow and transport mechanisms. Travel time through the vadose zone may be many years (University of California 1995). Once the nitrates reach the saturated portion of the aquifer, they move with the prevailing groundwater flow. It is difficult to determine whether an observed level of nitrates in groundwater is a result of current or past operations. It is also difficult to quantify the level of nitrate contribution from the potential sources (agricultural, animal waste, septic, or wastewater sources) (California State Water Resources Control Board 1988, California Regional Water Quality Control Board 1994). Groundwater flow rates may vary greatly, and contaminated groundwater may take many years to reach municipal supply wells. The nitrate concentration in groundwater is influenced by freshwater recharge and dispersion, both of which may reduce contaminant concentrations. Nitrates in groundwater do not impair agricultural beneficial uses of the water but may impair the suitability of the water for municipal and domestic uses. The assimilative capacity of a groundwater basin is a complex function of the recharge/discharge relationships and the mass loading of nitrogen from all sources.

Biostimulatory Nutrients Transport to Surface and Groundwater. Potential surface water quality impairment from biosolids applications are primarily related to potential runoff of biostimulatory substances that might impair the designated beneficial uses of water and result in violations of established water quality standards and objectives. Biostimulatory substances, primarily nitrogen and phosphorus, are typically found in low concentrations in aquatic systems. Eutrophication may result when additional nutrients are introduced into receiving waters. Eutrophication is the process by which nutrients increase biological productivity. Increased production can alter the biological system, potentially resulting in increased biomass production and resultant reductions in dissolved oxygen.

The effects of land application of liquid or dewatered biosolids on runoff water quality have received limited examination, in part because of the conservatism built into EPA's Part 503 guidelines, which require buffers and other management practices that restrict runoff and transport of potential contaminants (Northwest Biosolids Management Association 1998). Despite the limited amount of research specifically directed at liquid or dewatered biosolids applications, there are numerous studies evaluating nutrient runoff from agricultural lands, rangelands, and silvicultural areas where other biosolids or sources of nitrogen and phosphorus have been investigated. Nitrogen and phosphorus must be in mobile, dissolved forms for direct transport in surface water. Inorganic forms may be transported along with other sediments. There is a general consensus that application of biosolids or chemical fertilizer to no-till agricultural systems is a more effective means of limiting runoff of nutrients and sediment than application to conventional tillage (Breuggeman and Mostaghimi 1993, Mostaghimi et al. 1992, Northwest Biosolids Management Association 1998). Times of maximum seasonal precipitation have been strongly correlated to elevated nitrate levels in surface water and groundwater (Tindall 1994). Biosolids application techniques (surface application or incorporation into the soil, till or no till), total application rates, seasonal weather patterns, ambient soil moisture, and the duration and intensity of rainfall all influence the potential for runoff to mobilize nutrients in biosolids (Northwest Biosolids Management Association 1998).

Liquid biosolids have far greater concentrations of the mobile mineral forms of N and P than do the dewatered biosolids which are regulated by the GO. Studies related to the application of liquid biosolids to a watershed have demonstrated that there was little to no impact on stream water quality with respect to N and P levels. It is suggested that the application of dewatered biosolids will likely have no significant impact on the quality of water emanating from watersheds where dewatered biosolids are applied. This statement is qualified by the fact that there is a lack of peer-reviewed studies on the subject of water quality runoff covering an extensive range of conditions under which biosolids might be applied (Northwest Biosolids Management Association 1998).

Phosphorus is present in both organic and inorganic forms in biosolids, typically at concentrations of 0.8%–6.1%. Inorganic forms of phosphorus are quite insoluble and phosphorus tends to concentrate in the organic and inorganic solid phases. The amount of phosphorus applied is more than sufficient to meet the needs of the crop in areas where biosolids are applied to meet nitrogen requirements. At the appropriate application rate for nitrogen, available phosphorus may exceed the levels needed for crop production. High levels could increase the risk of surface water contamination if runoff is allowed. Based on long-term evaluations of treated biosolids over periods ranging from 9 to 23 years, the Water Environment Federation (1994) has recommended that soil phosphorus levels be monitored in areas where biosolids applications are used continuously over time, and that biosolids application rates may need to be determined by crop phosphorus levels rather than to meet the nitrogen needs of crops (National Academy of Sciences 1996).

Other essential plant nutrients and inorganic constituents are found in biosolids, including calcium, iron, magnesium, manganese, potassium, sodium, and zinc. Where biosolids are applied according to agronomic rates for nitrogen, most of these essential nutrients are usually present in amounts adequate to meet the needs of the crop (National Academy of Sciences 1996). No studies were found that indicated problems with excess runoff or leaching of other inorganic constituents found in biosolids. The concentration of other salts or minerals that could increase the total dissolved solids concentration in runoff or leachate has not been identified as a problem for contaminant runoff or leaching to groundwater. This is because most of the dissolved minerals are leached from the biosolids during wastewater treatment and sludge dewatering operations.

Trace Elements and Heavy Metals

Trace Elements and Heavy Metals in the Soil Environment. The terms *trace metal* and *trace element* refer to chemical elements normally present in the environment in very low concentrations. Typically, elements that are present in the soil in the dissolved phase at concentrations less than 0.01 microgram per milliliter are considered to be trace elements. Major elements or plant nutrients usually are present in the soil solution phase at concentrations orders of magnitude higher. Heavy metals are defined as trace elements that have densities greater than 5.0 milligrams per cubic centimeter.

In small quantities, many elements are essential to plant growth. These include fluoride, silicon, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, silicon, selenium, molybdenum, tin, and boron. At higher concentrations, some of these elements may become toxic to plants or accumulate in plants at levels that are toxic to animals that feed on them. In some cases, the range in concentrations between deficiency and toxicity is narrow, such as with boron. In several cases, there is no known biological necessity for a trace metal and its occurrence in small quantities in the soil solution may be harmful to plants. Lead, cadmium, and arsenic are examples of this effect. In other instances, such as with molybdenum, there is little or no plant toxicity at elevated soil levels, but grazing animals can be adversely affected by high levels in plant forage. Plants can vary widely in their sensitivity to trace element concentrations in the deficiency or toxicity range, in their capability to take up trace elements, and in their ability to avoid uptake even at high soil solution concentrations. Some, but not all, of the trace elements that can be present in biosolids in elevated concentrations are regulated in EPA's Part 503 regulations.

Trace metals may behave differently compared to more common soluble salts and plant nutrients in soils. Unlike soluble salts, most metallic compounds are not readily soluble in water or very mobile in the soil, except at low pH levels (as in strongly acidic soils). Because of their affinity to soil particles, including clay and organic colloids, carbonates, and iron complexes, trace metals are often retained in the soil and normally do not move readily with soil water. Therefore, most metals added to soils from irrigation water, reclaimed water, fertilizers, or organic additions such as biosolids may readily accumulate in surface layers and remain there, relatively biologically unavailable and immobile.

There are, however, important exceptions to this: arsenic, molybdenum, and cadmium in particular can be mobile in non-acidic soils and, under certain conditions, can accumulate in bioavailable forms and be potentially toxic in low soil-solution concentrations. Boron behaves differently in the soil than other trace elements, in that it is somewhat soluble and mobile. Plants vary widely in their boron phytotoxicity. Boron is naturally present in excessive concentrations in a small proportion of California soils. Although the total metal concentration is easy to measure in soils and biosolids, it is often a poor indicator of the mobility or bioavailable quantity of the metal in the soil when an understanding is lacking of the chemistry of the particular soil to which biosolids containing metals have been added.

The amount of accumulation of metals in soil (soil loading) is a function of the concentration of metals in the irrigation water, reclaimed water or biosolids, and the amount of material applied. The multiplication of concentration times annual application rate is termed the annual loading rate; cumulative loading refers to summation of loading over time. These are usually given in terms of pounds of trace metals added per acre or, in metric terms, kilograms per hectare. It is important to note that loading refers to the total amount added to the soil in all forms, and not the final soil concentration.

Total loading rates also do not distinguish between plant-available and mobile forms of metals in the soil solution. Aside from those originating from cities with extensive heavy industry, most biosolids contain low concentrations of trace metals, relative to levels that can accumulate and adversely affect soil productivity and agricultural sustainability under normal California soil conditions and loading rates. The low mobility of biosolids derived metals in typical soil environments has been demonstrated in research conducted by Camobreco et al. (1996) and Dowdy et al. (1991). However, some scientists remain cautious regarding the potential for adverse soil quality and health effects from poorly designed and poorly managed biosolids land application programs, particularly for non-exceptional quality biosolids or where unusual soil conditions and cropping patterns occur (Cornell Waste Management Institute 1999). The current GO and Part 503 regulations do not require specific consideration of bioavailable metals concentrations, irrigation and cropping practices that can affect bioavailability, or bioaccumulation factors and mobility when determining biosolids application rates.

Movement of water containing soluble trace elements and nutrients through the soil, and hence bioavailability, is influenced by a variety of physical processes and chemical reactions that determine the capacity of a natural soil body to immobilize metals, nutrients, and trace elements. The mechanisms of removal and movement are complex and depend on both the source and characteristics of the trace elements, the physical and chemical properties of the soil, and the rate of water movement through the soil.

Crops may also vary widely in their ability to uptake and bioaccumulate trace elements and in their sensitivity to concentrations in deficiency or phytotoxicity ranges. At any time, the concentrations of the major elements and trace metals in the solution phase of the soil-water-plant system are governed by various reactions, such as acid-base equilibria, complexation with organic and inorganic lignins and organic factions forming chelated compounds, precipitation and dissolution of solids of oxides and carbonates, and ion-exchange-adsorption on clay minerals. The issue is so complex that entire textbooks are written on the environmental chemistry of soils and the transformation and movement of organic and inorganic compounds in soils (for example, see McBride 1984, Dragun 1988, Davies 1980, Kabata-Pendias 1984).

The concentrations of major and minor elements in the soil-water solution are controlled by the progression in equilibrium in the solid and solution phases between unavailable and readily bioavailable forms, the rate at which these reactions occur, the rate of biological uptake by plants, and the loss from the system by groundwater flow. Soil clay content, CEC, organic matter content, oxidation/reduction state, and pH all influence the mobility and bioavailability of metals/nutrients in the soil to some degree.

The solubility (and hence mobility and bioavailability) of cadmium, copper, nickel, zinc, and chromium compounds is significantly pH dependent. The solubility of these metals typically increases as pH levels decline (i.e., become more acidic). These metals are associated with iron and manganese hydrous oxide compounds whose solubility increases with decreasing soil pH. The hydrous oxide or sulfide compounds are also more soluble under reducing conditions (i.e., when losing electrons caused by prolonged anaerobic conditions). As a result, poorly drained, acidic conditions that occur in some

California soils tend to favor mobilization of metals, whereas well drained, non-sandy, basic (alkaline) to slightly acidic soils tend to immobilize most cationic metals. Lead generally has limited mobility in the soil. In slightly acidic, non-calcareous soils, lead generally is not bioavailable and tends to precipitate as lead hydroxides or lead polymorphites; consequently, it does not readily reach groundwater. Maintaining suitable soil pH levels, drainage, and organic matter content thus becomes extremely important in managing lands to which biosolids have been applied. Because metal mobility varies with pH and the particular metal species, it is important to characterize and understand biosolids, soil chemistry, soil hydrology, and crop conditions to ensure sound biosolids application management.

The amount of finely divided, stable organic matter (humic and fulvic acids) in the soil can also greatly affect the mobility of metals in the soils by forming insoluble or slightly soluble complexes. Biosolids provide a rich source of these substances. Other reactions that immobilize metals include adsorption onto clay surfaces and ion exchange, particularly of divalent metallic cations. The organic matter- and clay-rich valley bottom land, basin, and low terrace soils in many areas of California should strongly immobilize metals contained in biosolids through organic complexing and cation exchange. Of greater concern is sandy, acidic soils with low organic matter content, in which metals are easily transformed to be readily bioavailable and in which water moves freely with little soil interaction. These soil conditions are somewhat rare in California, but they occur on recent sandy alluvial fan soils associated with the granitic foothills of the southern San Joaquin Valley, in some high mountain valleys, and in parts of San Diego and Monterey Counties. The soils of valley margin foothills, which are often acidic and have low organic matter content, can also be difficult to manage for biosolids application. Areas of shallow perched groundwater may also raise management concerns.

Because of the complexity of all the possible interactions of nutrients and trace elements in the soil-water-plant system, it is difficult to accurately predict element concentrations in plants from a biosolids source as it leaches through the root zone, is taken up by plants, and/or moves through the shallow groundwater system. This difficulty is compounded when water movement through the soil and subsequent deep percolation to groundwater or to streams must also be considered. Although scientists have developed several numerical models that can quantitatively estimate movement of major nutrients and some metals in the soil-water solution, plant uptake, and discharge to shallow groundwater, these are approximations at best. Quantitative analysis of particular metal types requires consideration of site-specific characteristics of soils, water movement, climate, and crop type. Given the wide range of these conditions in California, the use of numerical models is not practical for the purposes of this EIR. Broad assumptions of soil-crop factors were used in evaluating potential plant uptake of metals and in formulating the Part 503 sludge regulations, some of which have been questioned (Cornell Waste Management Institute 1999).

Table D-6 provides general information on the characteristics of major and trace elements, including factors influencing bioavailability and plant toxicity or phyto-toxicity. Table D-7 shows various physical and chemical processes in the soil that have important effects on the mobility and bioavailability of metals. Included in the table are mean K_d values (a measure of the mobility or adsorption propensity of the metal while moving with groundwater through porous media) determined for typical soils for various elements, and a comment on the general mobility of each element under acidic, neutral, or basic soil conditions. Common soil attenuation mechanisms are also presented.

Trace Metals in the Aquatic Environment. The known fate and transport mechanisms affecting toxic trace metal compounds in the aquatic environment and risk assessment procedures used for development of the Part 503 regulations are important factors for the environmental evaluation of the proposed GO regulation. The following trace metals are identified as priority pollutants by EPA under federal statutes: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc. Molybdenum is another trace metal that is of general concern in the regulation of biosolids disposal practices because of its mobility in the soil and water environment and its ability to cause phytotoxicity to plants if present in sufficient concentration. The priority pollutant trace metals and molybdenum are known to cause toxicity or otherwise have potential to degrade water resources if present under certain environmental conditions and in sufficient concentrations.

In general, trace metals are not substantially mobile in soil. They are usually physically and chemically bound to organic matter in the upper soil layer under normal environmental conditions. Depending on soil pH, a small fraction of metals will be water soluble and will be dissolved in water that is infiltrating down. Water infiltration occurs as a result of agricultural irrigation and rainfall. Ultimately, dissolved metals contact groundwater and are then carried with the groundwater flow. As the metals are transported to lower soil layers, small fractions of metals are partitioned between the soil and water. Several studies have shown that only small fractions of metals move to lower soil layers (Camobreco et al. 1996, Dowdy et al. 1991, Sidle and Kardos 1977, McGrath and Lane 1989).

The solubility of the metals in water is a major factor governing the transport from the soil zone to groundwater. Low pH conditions in the soil are required for trace metals to become soluble in water. One significant factor that may increase the leachability of metals is the decrease in pH resulting from mineralization of biosolids organic matter over time. No conclusive evidence has been presented that this process increases trace metal leachability. Other studies imply that low pH may be a precursor of high metal mobility, leading to groundwater contamination (Wallace and Wallace 1994, Emmerlich et al. 1982, McGrath and Lane 1989). One study evaluated the movement of metals in soil (cadmium, copper , and zinc) and showed that cadmium had the greatest movement but was only approximately 3.3% of the total metal below a depth of 120 cm. Because cadmium did not exhibit significant movement, it is reasonable to assume that copper and zinc would not move as a result of lowered pH.

Part 503 Risk Assessments of Trace Metals for Surface and Groundwater Pathways. The Part 503 regulations must be considered because they represent the most current understanding of the risks associated with land application of biosolids and are the basis for the proposed GO. Risk assessments were conducted for

Table D-6
Occurrence, Biological Function and Toxicity of Trace Metals in Soils

Trace Metal	Common Range in California Bio Solids[a] (*mg/kg*)	Common Range in Soils[b] (*Total mg/kg*)	A Typical Soil Concentration[c] (*Total mg/kg*)	Biological Function[d]	Mammalian Toxicity[d]	Phytotoxicity[d]	Impact on Crop[e] (*mg/kg*)	Cumulative Pollutant Loading Rate Limits (*kg/ha*)[f]	Title 22 Toxic Limits[g] (*mg/kg*)
Arsenic		0.1 - 40 3.6 - 8.8	6	None known in animals. Constituent of phospholipid in algae and fungi	High	Medium-High (5-20)	Not a required element for plant growth	41	500
Boron		2 - 55	10	Essential to plant. Phosphogluconate	Low	Medium-High (50-200)	Required, wide species differences	Not regulated	Not listed
Cadmium		0.01 - 1.1	0.06	None known	High Cumulative poison	Medium-High (5-30)	Not required, toxic to plants	39	100
Chromium		20 - 85	40	May be involved in sugar metabolism in mammals	High (Cr^{6+}) Medium (Cr^{3+})	Medium-High (20-100)	Not required, low plant toxicity	Not regulated	2,500
Copper		14 - 29	20	Essential to all organisms, cofactor in redox enzymes, 0_2 transport pigments	Medium	Medium (30-300)	Required 2-4 mg/kg; toxic>20 mg/kg in plant tissue	1,500	2,500
Lead		0.2 - 200	10	None Known	High Cumulative poison	High (1-3)	Low plant toxicity	300	500
Mercury		0.01 - 0.08	--	None Known	High (soluble or volatile forms). Cumulative poison	Medium (10-50)	High plant toxicity	17	20

Table D-6. Continued

Trace Metal	Common Range in California Bio Solids[a] (*mg/kg*)	Common Range in Soils[b] (*Total mg/kg*)	A Typical Soil Concentration[c] (*Total mg/kg*)	Biological Function[d]	Mammalian Toxicity[d]	Phytotoxicity[d]	Impact on Crop[e] (*mg/kg*)	Cumulative Pollutant Loading Rate Limits (*kg/ha*)[f]	Title 22 Toxic Limits[g] (*mg/kg*)
Molybdenum		0.35 - 5.8	2	Essential to all organisms, enzyme cofactor in N^2 fixation, NO_3 reduction	Medium	Medium-High (10-100) Bio-accumulative	Required; at <0.1 mg/kg in plant tissue	Not regulated	3,500
Nickel		10 - 1,000	40	None known in mammals. May be essential to plants. Found in urease enzyme	Medium	Medium-High (5-30) Bio-accumulative	Not required toxic >50 mg/kg in plant tissue	420	2,000
Selenium		0.19 - 1.05	0.5	Essential to mammals and some plants	High	High (5-10)	Toxic >50 mg/kg	100	100
Silver		0.1-5.0	--	None known	High	Low-Medium (100-400)	--	Not regulated	500
Zinc		10-300	50	Essential to all organisms. Cofactor in numerous enzymes	Low-Medium		Required: toxic >200 mg/kg in plant tissue	2,800	5,000

Sources:

a

b Compiled from McBride 1994, Drugan 1988, Pettygrove 1984.

C Pettygrove et al July 1984.

D Abstracted from McBride 1994

e Abstracted from McBride 1994.

f EPA 503 Rules.

g California Title 22 Limits.

Table D-7
Trace Element Mobility and Soil Transformation Mechanisms

Trace Element	Mean K_{ds}	Mobility at Various Soil pH Levels			Reacts to Less Bio-Available Form With			Primary Attenuation Mechanism
		Strongly Acid pH <5.5	Moderately Acid pH 5.5 to 7.0	Alkaline pH >7.0	Fe/Mn Oxides	Organic Matter	Other	
Arsenic	1.2	Medium-Low	Medium	Medium-High	Yes	--	sulfide, clays	precipitation (iron), specific adsorption
Boron	--	Medium-Low	High	Medium-High	--	--	calcium	caborate precipitation
Cadmium	1.9	Medium	Medium-High	Medium	No	--	reducing conditions	precipitation (hydroxides, carbonates, sulfides), specific adsorption
Chromium	7.7	Very Low	Very Low	Very Low	Yes	--	--	precipitation
Copper	3.1	High	Medium to Low	Very Low	Yes	Yes	sulfide, sulfate clay adsorption, carbonate, phosphate, reducing conditions	precipitation (hydroxides, carbonates, sulfides), specific adsorption
Lead	4.6	Low	Low	Low	--	--	reducing conditions	precipitation (hydroxides, carbonates, sulfides), specific adsorption
Mercury	--	Medium	Low	Low	Yes	--	sulfide, reduced conditions	adsorption at high pH
Molybdenum	--	Low	Medium-High	High	Yes	Yes	n____erystalime aluminosilicates	clays at low pH
Nickel	--	High	Medium to Low	Very Low	Yes	Yes	sulfide adsorption, silicate minerals	precipitation (hydroxides, carbonates, sulfides),

Table D-7. Continued

Trace Element	Mean K_{ds}	Mobility at Various Soil pH Levels			Reacts to Less Bio-Available Form With			Primary Attenuation Mechanism
		Strongly Acid pH <5.5	Moderately Acid pH 5.5 to 7.0	Alkaline pH >7.0	Fe/Mn Oxides	Organic Matter	Other	
Selenium	1.0	High	High	High to High	Yes	Yes	reducing conditions, absorption	precipitation (iron), specific adsorption
Silver	4.7	High	Medium to Low	Very Low	Yes	Yes	reducing conditions, sulfide	cation exchange
Zinc	2.8	High	High to Medium	Low to Very Low	Yes	Yes	sulfide, precipitation by carbonate	precipitation (hydroxides, carbonates, sulfides), specific adsorption

Sources: Dragun 1998, McBride 1994, Baes and Sharp 1983, Kabate-Pendias 1992, and Selim and Amacher 1997.

Note: K_{ds} is a coefficient or measure of the mobility or adsorption propensity of a metal while moving with water through porous media, such as a soil.

only those trace metals that were identified as having potential to be present in biosolids at sufficient concentrations to cause environmental toxicity or other impairment. Of the original list of approximately 200 pollutants evaluated for possible consideration in the Part 503 regulations, the risk assessments for surface water and groundwater pathways were conducted for seven trace metals (U.S. Environmental Protection Agency 1992). All other trace metals were either not detected in the sewage sludges tested during the 1990 National Sewage Sludge Survey (U.S. Environmental Protection Agency 1990) or were detected at sufficiently low concentrations to warrant no further consideration. Of the 14 pathways evaluated for the Part 503 regulations, neither the surface water or the groundwater pathway was found to be limiting to trace metal concentration limits or cumulative loading rates for land application of biosolids.

Some of the factors and assumptions used during the Part 503 development process for setting limits on trace metals are controversial. The risk assessments conducted for the groundwater pathway are a source of controversy among researchers and respondents to the scoping notice for this EIR. The primary arguments for considering inclusion of limits to organic compounds in the Part 503 regulations include the following: (1) elimination process was arbitrary, (2) lack of monitoring requirements results in not having information on which to base application decisions, (3) may not consider risks associated with specific compounds that lack supporting research data, and (4) groundwater dilution factors may have been too large (Cornell Waste Management Institute 1999).

Based on the recent 1998 California Association of Sanitary Agencies (CASA) survey of trace metal concentrations in sewage sludges from California (California Association of Sanitation Agencies 1999), average concentrations and variability are lower than the 1990 National Sewage Sludge Survey (NSSS) data (U.S. Environmental Protection Agency 1990). Average concentrations of cadmium, copper, lead, nickel, and zinc for the 1998 CASA data range from 25% to 50% of the 1990 national averages; 1998 CASA averages for arsenic, mercury, and molybdenum are generally similar to the national estimates. Selenium is the only trace metal that has higher average concentrations in the 1998 CASA data than in the 1990 NSSS results. Maximum reported concentrations of copper, mercury, and selenium are the only measurements in the 1998 CASA survey data that exceed the ceiling concentration limits under the discharge prohibitions of the proposed GO regulation.

Synthetic Organic Compounds

Synthetic Organic Compounds in the Soil Environment. Many SOCs used in industrial, commercial, and household applications can be conveyed to wastewater treatment plants through the municipal wastewater collection and treatment process, and therefore they can be present in biosolids. As with nutrients and trace elements, the character of the biosolids with respect to SOC content is a function of the type of business and industry within the wastewater treatment service area, any onsite pre-treatment conditions, and the effectiveness of the wastewater treatment process. Many organic compounds either are volatile (and are lost during the treatment process) or readily biodegrade in the treatment process, which is designed and managed to foster microbial decomposition. Other volatile compounds are quickly lost to the atmosphere following biosolids incorporation in the soil. Because of this, the possible presence of volatile organic compounds in biosolids has generally not been of great concern to regulators and the environmental community.

However, other non-volatile or semi-volatile organic compounds (SVOCs) generally occur in low amounts in municipal biosolids. These include plastic-like compounds (phthalates), pesticides, phenols, detergent additives, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyl compounds (PCBs), and the group of chlorinated dibenzo-para-dioxin and chlorinated dibenzo-furan compounds that are often cumulatively referred to as dioxins. Currently, the Part 503 regulations do not contain minimum standards or require testing of biosolids for SOCs; however, the proposed GO monitoring program would require testing of biosolids for PCBs and SVOCs. Upper limits are set by state and federal general hazardous materials rules and regulations, with control relying on local municipalities enforcing source inspection and pretreatment provisions associated with their wastewater discharge permits. Toxic chemicals such as DDT, chlordane, aldrin, dieldrin, benzo(e)pyrene, and lindane are known to cause cancer, and other compounds are known to be teratogenic (e.g., dioxin, 2,4,5-trichlorphenol, and pentachlorophenol). Consequently, many of the SOCs have been prohibited from use or manufacture in the United States.

Much less is known about SOCs with respect to soil accumulation, plant uptake, and concentration mechanisms in soils than is known about trace elements. The knowledge base is much greater with regard to the attenuation, degradation, and mobility of volatile compounds, pesticides, and PAHs in the soil. It is generally understood that the primary exposure pathways for organic compounds are through migration to drinking water sources or as residues and soil dust that accumulate on plant leaves, rather than as direct plant uptake. Direct ingestion of soil containing biosolids or ingestion by grazing animals as dust on plant parts is another area of concern. There are human health risk factors; however, as with phytotoxic trace elements, accumulation of SOCs in soils at levels that make the soils unusable for crop or livestock production can be considered a rather drastic agricultural soil productivity impact. This issue is reviewed in Chapter 4, “Land Productivity”.

Synthetic Organic Compounds in the Aquatic Environment. Biosolids can contain various organic compounds that are removed from the liquid waste stream during the wastewater treatment process. More than 100 EPA-designated priority pollutant organic compounds are regulated through various federal and state drinking water standards, ambient surface water quality criteria, and hazardous waste laws. Most of the priority pollutant organic compounds are generally not detected in biosolids or are present at very low levels (U.S. Environmental Protection Agency 1990).

It is generally recognized that transport of organic compounds from the solid to the liquid phase in the soil environment is limited for most constituents (U.S. Environmental Protection Agency 1992, Chaney 1990). Demirjian et al. (1987) evaluated the fate of organic compounds in soil from biosolids application and showed that organic compounds were degraded in the soil or adsorbed in the surface layer. At an application rate of 100 tons per acre, most compounds degraded considerably during one irrigation season. At less than 25 tons per acre, most compounds degraded to less than 50% of initial concentration. The authors concluded that their experiment represented severe conditions for land application because of the sandy soils and heavy irrigation requirement and, therefore, nutrients and heavy metals would be the limiting factors in determination of application rate under average soil conditions. Alexander (1995) showed that the binding effect that "locks" toxins in the soil becomes more pronounced the longer the pollutant remains in soil. The higher the organic matter, the greater the binding effect. The report indicates that disappearance of appreciable amounts of insecticides from the field was not a result of leaching because all are extensively sorbed and little vertical movement has been detected, even after many years. If a chemical persists and remains in contact with particulate matter for some time, it becomes increasingly resistant to extraction by many solvents. Rappe et al. (1997) reported that dioxins have extremely low solubility and are unlikely to leach from soil to groundwater.

Part 503 Risk Assessments of Synthetic Organic Compounds for Surface Water and Groundwater Pathways. Toxic organic compounds were included in the original pollutant screening and risk assessments conducted during development of the Part 503 regulations for land application of biosolids. Of the original list of approximately 200 pollutants evaluated for possible consideration in the Part 503 regulations, the risk assessments for surface water (Pathway #12) and groundwater (Pathway #14) were conducted for 10 priority pollutant organic compounds (U.S. Environmental Protection Agency 1992). All other organic compounds were not detected in the tested sewage sludges or were detected at sufficiently low concentrations to warrant no further consideration. Of the 14 pathways evaluated for the Part 503 regulations, the groundwater pathway was not found to be limiting for the concentration limits or cumulative loading rates of any organic compounds resulting from land application of biosolids. The surface water pathway of humans eating fish that accumulate pollutants in surface runoff was the limiting pathway for setting limits on DDT/DDE compounds.

Upon completion of the EPA risk assessments for organic compounds, EPA concluded that regulations for organic compounds were not required for the final Part 503 regulations because they met at least one of the following criteria: (1) the pollutant was banned from use, has restricted uses, or is not manufactured in the United States; (2) it was detected in less than 5% of the sludges tested for the 1990 National Sewage Sludge Survey; or (3) the 1-in-10,000 cancer risk limit was less than the 99% maximum probable concentration based on 1990 NSSS data. Limits were not set for DDT/DDE compounds because they are excluded from all of EPA's screening criteria. Several organic compounds were deferred for future consideration and evaluation for round two of the rule development, when more data would be available. The organic compounds of interest for future consideration included PCBs and dioxin. There is also research being conducted on various other aromatic surfactants (e.g., linear alkylbenzene sulphonates and ethoxylates) that may have hormone-mimicking properties; however, very little is known about their role in transport from biosolids application sites (Krogman 1997, Clapp et al. 1994).

Some of the factors and assumptions used during the Part 503 development process for setting limits on toxic organic compounds are controversial. The elimination and deferment of Part 503 limits for organic compounds is a source of controversy among researchers and respondents to the scoping notice for this EIR. The primary arguments for considering inclusion of limits to organic compounds in the Part 503 regulations were identified above (see "Part 503 Risk Assessments of Trace Metals for Surface and Groundwater Pathways"). Comments received during the scoping process indicated a concern that the Part 503 risk assessments may not accurately reflect environmental conditions specific to California or account for risks from new organic compounds such as pharmaceuticals. There is also general concern regarding the potential oversight of the Part 503 regulations in not accounting for synergistic or combined risks from exposure to multiple constituents that may be present in biosolids. EPA contends that the risk assessment process was based on conservative assumptions and no scientific data are present that would invalidate the results of the risk assessments (U.S. Environmental Protection Agency 1995).

Regulatory Setting

Key Policies, Laws, Programs

Water Quality Regulations and Permits.

Numerous laws, ordinances, and guidelines are administered by local, state, and federal agencies to limit the discharge of pollutants to the environment; maintain surface water and groundwater quality at existing levels; and protect beneficial uses such as municipal, industrial, and agricultural water supply, recreation, and fish and wildlife habitat. The California State Water Resources Control Board (SWRCB) establishes water quality control policies in California in accordance with the Porter-Cologne Water Quality Control Act and the federal Clean Water Act and implements those policies through nine individual RWQCB offices. Federal, state, and local water quality regulations are applicable to any chemical constituent contained in biosolids or any activities that would occur as a result of land application of biosolids. The nine regions were initially established according to regions with similar and unique hydrologic and water quality characteristics. Figure 1-1 shows the names and boundaries of the nine regional boards.

Each RWQCB has primary responsibility for designating the beneficial uses of water bodies within the regions, establishing water quality objectives for protection of those uses, and issuing permits and conducting enforcement activities. Beneficial uses are those uses of the water resource for which numerical and narrative water quality objectives are established to prevent water quality impairment. Water quality objectives and associated narrative and numerical water quality objectives are established in a Basin Plan for each region that is updated through a triennial review process. The principal permitting processes administered by the RWQCBs for water quality protection include issuance of waste discharge requirements (WDRs) for discharge of waste to land and water, and permits for the National Pollutant Discharge Elimination System (NPDES) in accordance with the federal Clean Water Act. WDRs and NPDES permits issued to waste dischargers impose discharge restrictions and pollutant limits, that take into consideration applicable state and federal water quality criteria for surface water, groundwater, and drinking water. The permit processes must also consider the state anti-degradation policy that is intended to maintain high quality waters by setting criteria that must be met before a discharge is allowed that would reduce water quality and yet still maintain beneficial uses.

Numerical Water Quality Criteria. Potential effects of waste discharges may be evaluated, undergo regulatory review by other resource agencies, or have permits issued that are based on a several categories of state and federal water quality criteria. Applicable water quality criteria include Basin Plan water quality objectives for surface water and groundwater, state and federal ambient surface water quality criteria, and state and federal drinking water standards. The RWQCBs are required to include effluent limitations on toxic priority pollutants in WDRs and NPDES permits issued for wastewater discharges to surface waters when the discharge may cause the surface water to exceed established priority pollutant standards. The regulated priority pollutants include approximately 130 trace metal and organic compounds that are known to be toxic to living organisms when present in water at sufficient concentrations.

Regulations pertaining to priority pollutants have been developed over the years in four main regulations, including narrative requirements in the Clean Water Act, the National Toxics Rule (NTR), the now-defunct Inland Surface Waters Plan/Enclosed Bays and Estuaries Plan (ISWP/EBEP), and the recently proposed California Toxics Rule (CTR). The proposed CTR was developed in accordance with Section 303(c)(2)(B) of the Clean Water Act (Federal Register Vol. 62, No. 150 - August 5, 1997) to fill the gap in regulation created by the legal overturn of the ISWP. The SWRCB subsequently issued a Draft Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California and Accompanying Functional Equivalent Document (California State Water Resources Control Board 1997) that identifies the proposed rules for implementation of the CTR criteria as a new ISWP. Following adoption of the CTR and/or another form of ISWP, wastewater discharges and NPDES-permitted facilities will be required to comply with the new standards for priority pollutants. The criteria were developed to protect against acute and chronic toxicity of aquatic organisms and humans from ingestion of water or organisms in contact with the water. By definition, the criteria represent "the highest concentration of a substance in water which does not present a significant risk to the aquatic organisms in the water and their uses". Under the criteria, toxicity in aquatic organisms is defined as mortality or reduction in growth; toxicity in humans is defined as an increased risk of disease or cancer. The criteria also provide protection from bioaccumulation in aquatic organisms. Bioaccumulation is a process whereby, through absorption or ingestion, the constituents accumulate in the tissues of aquatic plants or animals over time.

Drinking water standards, established by the DHS under Title 22, Division 4, Chapter 15 - Domestic Water Quality and Monitoring, are applicable to groundwater and surface water. EPA develops similar standards under the federal Safe Drinking Water Act. Both sets of laws contain MCLs that are based on a 1-in-1-million (10^{-6}) incremental risk of cancer from ingestion of carcinogenic compounds and threshold toxicity levels for noncarcinogens. The MCLs are also based on technological and economic factors of the feasibility of achieving and monitoring for the pollutants in a drinking water supply. Secondary MCLs are established for welfare considerations such as taste and odor control and laundry staining. The MCLs apply to the quality of the water after it has entered a distribution system and do not apply to the quality of the untreated source water. The standards apply to the source water only when specifically established in the basin plan by the RWQCB.

National Pollutant Discharge Elimination System Permits. Wastewater treatment plants (WWTPs) that discharge to surface waters are regulated through the NPDES permitting process, which is mandated under the Clean Water Act (Code of Federal Regulations [CFR], Title 40). The NPDES permit system is divided into separate programs and regulations for point-source discharges, such as industrial facilities and WWTPs, and nonpoint sources such as urban stormwater runoff from larger municipalities and storm water runoff from general construction and industrial activities. The NPDES permit process for WWTPs typically involves the imposition of standards on the effluent and receiving water body for various chemical, physical, and biological parameters (e.g., flow, temperature, pH, biochemical oxygen demand [BOD], dissolved oxygen [DO], total coliform bacteria, suspended and settleable matter, turbidity, residual chlorine, ammonia, or other compounds of specific concern for a given receiving water). NPDES permits focus mainly on the liquid discharge, whereas WDRs focus on the solids generated at the facility. However, biosolids treatment and disposal regulations can be included in the NPDES permit for the treatment plant or can be covered under separate WDRs that are also issued by the RWQCB.

NPDES Pretreatment Program for Industrial Discharges. Pretreatment of industrial discharges is mandated by the Clean Water Act of 1977 (33 USC Sections 1251-1376; P.L. No. 95-217, 91 Stat. 1566). EPA has established pretreatment standards (see 40 CFR Part 403) for various industrial categories. EPA created the National Pretreatment Program and first issued pretreatment regulations in November 1973. Following amendment of the Clean Water Act, the regulations were revised in June 1978 and again in January 1981. The purpose of the National Pretreatment Program is to regulate the discharge of toxic pollutants or unusually large amounts of conventional pollutants (e.g., BOD and total suspended solids [TSS]) to municipal sanitary sewers and the associated wastewater treatment plants. Toxic pollutants can include a large variety of potential compounds but generally refer to the EPA priority pollutant trace metal and organic compounds, other volatile organic compounds and SVOCs, pesticides, and chlorinated organic compounds. The goal is to protect receiving water quality and the environment from the effects of these discharges because of their potential to "pass through" or receive only partial or no treatment by the wastewater treatment plant.

An individual pretreatment program typically consists of: (1) identification of pollutants that could cause upset or bypass (pollutants of concern); (2) development of discharge limitations for nondomestic discharges (local limits); (3) identification of nondomestic discharge sources; and (4) implementation of nondomestic monitoring program to enforce the local limits. Local limits may include both narrative and numeric limits. Narrative limits are general statements of prohibitions or restrictions of a particular discharge, while numeric local limits are maximum allowable concentrations that are calculated for each pollutant of concern that a facility discharge to the sewer cannot exceed. Numeric local limits are calculated from the most limiting criteria or standard that could upset the wastewater treatment process or pass through in the effluent. The criteria and standards used for the local limit calculations include the applicable state and federal water quality criteria described above. Local agencies develop, and seek EPA approval of, their industrial pretreatment programs through local sewer-use ordinances.

Narrative and numeric limits used in source control programs have effectively reduced the pollutant concentrations entering the facility. A fraction of the pollutants are removed from the wastewater that is treated at the facility. Because most toxic trace metal and organic compounds are not destroyed during the wastewater treatment process, most of the fraction removed from the wastewater end up in the biosolids generated at the facility. Removal rates of trace metals and organic compounds are fairly constant at treatment facilities; therefore, lower influent pollutant concentrations results in lower biosolids pollutant concentrations. Source control programs have significantly reduced the biosolids pollutant concentrations. This is shown by the decrease in biosolids pollutant concentration at facilities with aggressive source control programs. As source control programs are continually being improved because of more stringent pollutant limitations, pollutant concentrations in biosolids will continue to decrease or, at a minimum, remain the same in the future.

Nonpoint Source Assessment and Watershed Initiative

In 1988 the SWRCB prepared the "Nonpoint Source Assessment Report" (California State Water Resources Control Board 1988) documenting water quality threats from these sources and evaluating programs designed to reduce this contaminant threat. Nutrients, sedimentation, and other agriculture chemicals are acknowledge as having contributed to groundwater and surface water impairment. Unlike point sources of contamination which are discreet and subject to regulatory control, nonpoint sources (NPS) of contamination are typically associated with long standing and generally acceptable societal practices and land use activities where liability for contamination is hard to determine, and where regulatory programs cannot easily remedy the problem. Agriculture, silviculture, urban stormwater runoff and grazing are examples of land uses activities that have the potential to degrade water quality. The SWRCB has begun to define strategies to deal with NPS contamination and is developing a watershed management initiative (California State Water Resources Control Board 1995a), which focuses on voluntary measures and cooperative programs to reduce potential water quality threats.

Agricultural operations in California are as diverse as the geography. A wide variety of crops are grown under diverse soils, irrigation, and climatic conditions, making it difficult to prescribe globally applicable management practices which are appropriate for every conditions. The SWRCB recognizes that individually prescribed management practices should be specific to the unique crops, soils, and the potential risks to groundwater (California State Water Resources Control Board 1994). The Technical Advisory Committee for Plant and Nutrient Management was convened to assist in developing the “Initiatives in Nonpoint Source Management” (California State Water Resources Control Board 1995b), prepared to respond to nonpoint-source contamination in California. Technical Advisory Committee for Plant and Nutrient Management recommended that specific assessments of farming activities be conducted by agricultural experts familiar with unique agronomic conditions and local practices. It was anticipated that these assessments would be used to define appropriate best management practices (BMPs) to control nutrient leaching and to apply best available information and current research. Many of the concepts and programs contained in the watershed management program have been included in the GO and will serve to reduce the potentially significant impact to less then significant.

Nitrate Management: Research, Technical Support and Technology Transfer on Agronomic Rates

DFA’s FREP program was created to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. The program facilitates and coordinates the development of applied research and demonstration projects providing technical assistance and funding to carry out research, demonstration and education projects related to use of nitrogen fertilizers in agriculture. FREP also seeks to improve access to information on agronomic uses of nitrogen and to serve as a clearing house for data and research. Funding is provided by a tax on agricultural fertilizers. FREP is part of the Nitrate Management Program established by DFA in 1990 to identify nitrate sensitive areas and to reduce agriculture’s contribution to nonpoint sources of nitrate contamination. The information and research generated and distributed by FREP will assist in defining nitrogen agronomic rates for a range of crops and conditions found in California and to ensure compliance with prohibitions specified in the GO.

The Certified Crop Adviser (CCA) program has been developed by the American Society of Agronomy (ASA) in cooperation with agribusiness retail dealers, cooperatives and manufacturers, state and national trade associations, the U.S. Department of Agriculture (USDA), and independent consultants. The aim of this group was to develop a voluntary program for crop advisers that would: establish standards for knowledge, experience, ethical conduct and continuing education; enhance professionalism; and promote dialogue among those involved in agriculture and natural resource management. The CCA program is coordinated by the American Society of Agronomy and administered at the local level by state or regional boards. To become a Certified Crop Adviser, a person must have up to 4 years of crop advising experience, depending on educational background; document their education and crop advising experience with supporting references and transcripts; and pass comprehensive national and state/regional/provincial examinations that evaluate knowledge in four competency areas (soil fertility, soil and water management, integrated pest management, and crop management). CCAs can assist in determining agronomic rates for biosolids application to reduce the potential for nitrate leaching and groundwater contamination.

The University of California, California State University, local County Agricultural Extension Service offices, the U.S. Natural Resources Conservation Service, and USDA are all actively pursuing projects and research related to nutrient management and agronomic rates of nitrogen for various crop conditions in California. This information is being made widely available through local resource conservation districts, water districts, agricultural organizations and county agricultural commissioners. These same groups have been conducting research and demonstration projects to evaluate the effectiveness of on-farm BMPs for reducing nitrate contamination.

Drinking Water Source Water Assessment and Protection Program

The California DHS Division of Drinking Water and Environmental Management is developing a program to assess the vulnerability of drinking water sources to contamination (California Department of Health Services 1999). This program, which is required by federal and state law, is called the Drinking Water Source Water Assessment and Protection (DWSAP) Program. DHS submitted its DWSAP Program Document to the EPA on January 19, 1999. The wellhead protection portion of the program has been approved by the EPA, and DHS anticipates receiving approval of the surface water component in mid-1999. Completion of drinking water source assessments is required by April 2003. The federal Safe Drinking Water Act (SDWA) requires states to develop a program to assess sources of drinking water and establish protection programs.

California's DWSAP Program is the first step in the development of a complete drinking water source protection program, and will include evaluation of both ground water and surface water sources. The groundwater DWSAP program includes components intended to fulfill the requirements for state development of a Wellhead Protection Program strategy as required by Section 1428 of the Safe Drinking Water Act Amendments of 1986. The purpose of the program is to protect ground water sources of public drinking water supplies from contamination, thereby eliminating the need for costly treatment to meet drinking water standards. The program is based on the concept that the development and application of land-use controls (usually applied at the local level in California) and other preventative measures can protect ground water. A Wellhead Protection Area (WHPA), as defined by the 1986 Amendments, is "the surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield". The WHPA may also be the recharge area that provides the water to a well or wellfield. The DHS's assessment includes a delineation of the area around a drinking water source through which contaminants might move and reach that drinking water supply. DHS must inventory possible contaminating activities (PCAs) that might lead to the release of microbiological or chemical contaminants within the delineated area. This enables a determination to be made as to whether the drinking water source might be vulnerable to contamination. DHS is to conduct the surveys but local agencies may undertake the assessment.

An essential element of the drinking water source assessment program is an inventory of PCAs that are considered to be potential sources of contamination in the designated drinking water source areas and protection zones. Irrigated agriculture and land application of biosolids are recognized as PCAs. As such specific set back requirements from municipal and domestic wells and from surface water sources that provide drinking water will be required upon completion of the assessments and vulnerability analysis by DHS or locally responsible agencies. Biosolids application, along with agricultural applications of fertilizer, are classified as having a moderate potential risk of contaminating drinking water (California Department of Health Services 1999).

Groundwater Management Plan (AB 3030)

Sections 10750-10756 of the California Water Code (AB 3030) were signed into law in 1992 and describes components that may be included in a ground water management plan developed by a local agency to protect groundwater. A total of 149 agencies have adopted groundwater management plans in accordance with AB 3030 (California Department of Water Resources 1994c). Each component would play some role in evaluating or operating a ground water basin so that ground water can be managed to maximize the total water supply while protecting ground water quality. Department of Water Resources Bulletin 118-80 defines groundwater basin management as including planned use of the ground water basin yield, storage space, transmission capability, and water in storage (California Department of Water Resources 1975). Ground water basin management includes the following elements:

- protection of natural recharge and use of intentional recharge,
- planned variation in amount and location of pumping over time,
- use of ground water storage conjunctively with surface water from local and imported sources, and
- protection and planned maintenance of ground water quality.

The 12 components listed in Section 10753.7 of the Ground Water Management Act (AB 3030) form a basic list of data collection and operation of facilities that may be undertaken by an agency operating under this act. With respect to protecting groundwater from potential contamination from biosolids, the critical components to be included in local plans include the following:

- identification and management of wellhead protection areas and recharge areas;
- regulation of the migration of contaminated groundwater;
- administration of a well abandonment and well destruction program;
- monitoring of groundwater levels and storage;

- review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination.

Citations

Alexander, M. 1995. How toxic are toxic chemicals in soil? Environmental Science and Technology 29(11):2713-2717.

Breuggeman, A.C. and S. Mostaghimi. 1993. Sludge application effects on runoff, infiltration, and water quality. Water Resources Bulletin 29(1):15-26.

California Data Exchange Center. 1999. Internet database of real-time water supply monitoring data. URL: cdec.water.ca.gov

California Department of Food and Agriculture. 1989. Nitrates and Agriculture in California. February 1989. Sacramento, CA.

California Department of Food and Agriculture. 1998. Fertilizer Research and Education Internet home page: URL:www.cdfa.ca.gov/inspection/frep/docs/about_frep.html

California Department of Health Services. 1999. Drinking Water Source Assessment and Protection Program. Division of Drinking Water. January 1999. Sacramento, CA.

California Department of Water Resources. 1975. Bulletin 118-75. California's Ground Water. California State Resources Agency. Sacramento, CA.

California Department of Water Resources. 1994a. Bulletin 160-93. California Water Plan Update. Sacramento, CA.

California Department of Water Resources. 1994b. Five-year report of the Municipal Water Quality Investigations Program. Division of Local Assistance. Sacramento, CA.

California Department of Water Resources. 1999. Internet database of archived water quality monitoring data in the San Joaquin - Sacramento River Delta. URL: wwwdla.water.ca.gov/cd/delmon/

California Irrigation Management Information System. 1999. Internet database of real-time atmospheric and precipitation monitoring data. URL: wwwdla.water.ca.gov/cgi-bin/cimis/hg/main.pl

California Regional Water Quality Control Board. 1994. Water quality control plan. Central Coast. Sacramento, CA.

California Regional Water Quality Control Boards. 1995. Regional Water Quality Control Plans (1995). State Water Resources Control Board. Sacramento, CA.

California State Water Resources Control Board. 1988. Nitrates in Drinking Water, Report to the Legislature. Report No. 88-11WQ. Division of Water Quality. October 1988. Sacramento, CA.

California State Water Resources Control Board. 1994. Report of the Technical Advisory Committee for Plan Nutrient Management. November 1994. Sacramento, CA.

California State Water Resources Control Board. 1995a. Nonpoint Source Assessment. Sacramento, CA.

California State Water Resources Control Board. 1995b. Initiatives in Nonpoint Source Management. Sacramento, CA.

California State Water Resources Control Board. 1996. Water Quality Assessment Report. California State Resources Agency. Sacramento, CA.

California Teale Data Center. 1999. Internet database of archived GIS data. URL: www.teale.ca.gov

Camobreco, V.J., B.K. Richards, T.S. Steenhuis, J.H. Peverly, and M.B. McBride. 1996. Movement of heavy metals through undisturbed and homogenized soil columns. Soil Science 161(11):740-750.

Chaney, R.L. 1990. Twenty years of land application research. Biocycle September 1990: 54-59.

Clapp, C.E., W.E. Larson, and R.H. Dowdy. 1994. Sewage Sludge: Land Utilization and the Environment. In O'Connor, G.A. Sewage sludge: toxic organic considerations. pp. 33-34. Published by American Society of Agronomy Inc., Crop Science Society of America Inc., and Soil Science Society of America Inc., Madison, WI.

Colwell, W.L. 1979. Forest soils of California. *In* California Forest Soils: a guide for professional foresters and resource managers and planners. Division of Agricultural Sciences, University of California.

Cornell Waste Management Institute. 1999. The case for caution: recommendations for land application of sewage sludges and an appraisal of the U.S. EPA's Part 503 sludge rules. Working Paper August 1997; revised February 1999. Prepared by E.Z. Harrison, M.B. McBride, and D.R. Bouldin. Center for the Environment, Cornell University, Ithaca, NY.

Demirjian, Y.A., A.M. Moshi, and T.R. Westman. 1987. Fate and organic compounds in land application of contaminated municipal sludge. Journal Water Pollution Control Federation 59(1): 32-38

Donahue, R.L., R.W. Miller, and J.C. Shickluna. 1983. Soils: An introduction to soils and plant growth. Fifth Edition. Prentice-Hall, Inc. Englewood Cliffs, N.J.

Dowdy, R.H., J.J. Latterell, T.D. Hinesley, R.B. Grossman, and D.L. Sullivan. 1991. Trace metal movement in an aeric Ochraqualf following 14 years of annual sludge applications. J. of Environmental Quality 20:119-123.

EarthInfo Inc. 1994. Environmental Protection Agency STORET database information for California Department of Water Resources Surface Water Data. Boulder, CO.

Emmerlich, W.E., L.J. Lund, A.L. Page, and A.C. Chang. 1982. Movement of heavy metals in sewage sludge treated soils: solid phase forms of heavy metals in sewage sludge-treated soils - predicted solution phase forms of heavy metals in sewage sludge-treated soils. J. Environmental Quality 11:174-186.

Holmgren, G.G.S., M.W. Meyer, R.L. Chaney, and R.B. Daniels. 1993. Cadmium, lead, zinc, copper, and nickel in agricultural soils of the United States of America. Journal of Environmental Quality 22:335-348.

Krogman, U., L.S. Boyles, C.J. Martel, and K.A. McComas. 1997. Biosolids and sludge management. Water Environment Research. 69: 534-550.

Letey, J., C. Roberts, M. Penberth, and C. Vasek. 1986. An agricultural dilemma: drainage water and toxics disposal in the San Joaquin Valley. Contribution of the University of California Kearney Foundation of Soil Science 1980-1985 mission on “Soil and Plant Interactions with Salinity.” Riverside, CA.

McGrath, S.P., and P.W. Lane. 1989. An explanation for the apparent losses of metals in a long-term field experiment with sewage sludge. Environmental Pollution 60:235-256.

Mostaghimi, S., T.M. Younos, and V.S. Tim. 1992. Effects of sludge and chemical fertilizer application on runoff water quality. Water Resources Bulletin 28(5):545-552

Mount, Jeffrey F. 1995. California Rivers and Streams. University of California Press. Berkeley, CA.

National Academy of Sciences. 1996. Use of Reclaimed Water and Sludge in Food Crop Production. Committee on the Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption, Water Science and Technology Board, Commission on Geosciences, Environment and

Resources, National Research Council. National Academy Press, Alexandria, VA .

Northwest Biosolids Management Association. 1998. Literature Review on Runoff Water Quality from Biosolids Applications. Grey, M, Henry C., Thompson, D. University of Washington College of Forest Resources. Seattle, WA.

Pacific Gas and Electric Company. 1989. Generalized soil map of California. (Adapted from a map by R.E. Storie and W.W. Weir, Division of Agriculture and Natural Resources, University of California, Berkeley, 1951.) San Francisco, CA.

Phung, T, L. Barker, D. Ross, and D. Bauer. 1978. Land cultivation of industrial wastes and municipal solid wastes: state-of-the-art study, Volume I, Technical Summary and Literature Review. SCS Engineers. EPA-600/2-78-140a. Municipal Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Cincinnati, OH.

Rappe, C., R. Andersson, C. Nilsson, and P. Nilsson. 1997. A field study on the use of sewage sludge as soil amendment. Organohalogen Compounds 32: 45-50

Reed, S.C. and R.W. Crites. 1984. Handbook of land treatment systems for industrial and municipal wastes. Noyes Publications, Park Ridge, NJ.

San Joaquin Valley Drainage Program. 1990. A management plan for agricultural subsurface drainage and related problems on the westside San Joaquin Valley. Final Report. U.S. Department of the Interior Bureau of Reclamation, Fish and Wildlife Service, and Geological Survey, and California Resources Agency Department of Fish and Game and Department of Water Resources. Sacramento, CA.

Sidle, R.C., and L.T. Kardos. 1977. Transport of heavy metals in a sludge-treated forested area. J. of Environmental Quality 6:431-437.

Sommers, L.E., D.W. Nelson, R.E. Terry, and D.J. Silviera. 1976. Nitrogen and metal contamination of natural waters from sewage sludge disposal on land. Technical Report No. 98. Purdue University Water Resources Research Center. West Lafayette, IN.

Tidball, R.R., R.C. Severson, J.M.. McNeal, and S.A. Wilson. 1986. Distribution of selenium, mercury, and other elements in soils of San Joaquin Valley and parts of the San Luis Drain Service area, California. *In* Selenium and Agricultural Drainage: Implications for San Francisco Bay and the California Environment, Proceedings of the Third Selenium Symposium, March 15, 1986, Berkeley, CA.

Tindall, J.A., K.J. Lull, and N.G. Gaggiani. 1994. Effects of land disposal of municipal sewage sludge on fate of nitrates in soil, streambed sediment, and water quality. Hydrobiologia 163:147-185.

Tucker, G.B., W.A. Berg, and D.H. Gentz. 1987. pH. *In* Reclaiming mine soils and overburden in the western United States - analytic parameters and procedures. R. D. Williams and W.E. Schuman, eds. Soil Conservation Society of America, Ankeny, IA.

U.S. Department of Agriculture. 1993. Soil survey manual. U.S. Department of Agriculture Handbook 18. U.S. GPO, Washington, D.C.

U.S. Environmental Protection Agency. 1990. Technical support documentation for Part 1 of the National Sewage Sludge Survey Notice of Availability. Analysis and Evaluation Division. October 31, 1980. Washington, D.C.

U.S. Environmental Protection Agency. 1992. Technical support document for land application of sewage sludge. Volume 1. Prepared for Office of Water by Eastern Research Group, Lexington, MA. November 1992. Washington, D.C.

U.S. Environmental Protection Agency. 1995. A guide to the biosolids risk assessments for the EPA Part 503 rule. EPA832-B-93-005. Office of Wastewater Management. September 1995. Washington, D.C.

U.S. Environmental Protection Agency. 1999. Internet access to STORET database of archived water quality data. URL: www.epa.gov/owow/storet

U.S. Geological Survey. 1999a. Internet database of archived streamflow records for California rivers. URL: water.wr.usgs.gov/sites/

U.S. Geological Survey. 1999b. Internet database of archived water quality data. URL: wwwrvares.er.usgs.gov/wqn96cd

U.S. Soil Conservation Service. 1981. Major land resource regions and major land resource areas of the United States. Agricultural Handbook 296. U.S. Department of Agriculture.

University of California. 1995. Department of Land, Air, and Water. Fogg, G., Rolston, D., LaBolle, E., Burow, K., Maserjian, L., Decker, D., Carle, S. Matrix Diffusion and Contaminant Transport in Granular Geologic Materials with Case Study of Nitrate Contamination in Salinas Valley, California. Davis, CA.

University of Washington. 1991. Literature Reviews on Environmental Effects of Sludge Management. Prepared for Regional Sludge Management Committee. Prepared by College of Forest Resources. Edited by C.L. Henry and R.B. Harrison. July 1991. Sacramento, CA.

Wallace, A. and G.A Wallace. 1994. A possible flaw in EPA's 1993 new sludge rule due to heavy metal interactions. Community Soil Science Plant Analysis 25(1&2):129-135.

Water Environment Federation. 1994. Beneficial use programs for biosolids management. Alexandria, VA.

Appendix E. Public Health Technical Appendix

Appendix E. Public Health Technical Appendix

Introduction

This appendix provides detailed information supporting the analysis presented in Chapter 5, “Public Health”. Part 1 describes the potential pathogenic microorganisms that have been known to be present in sewage sludges and provides data on the incidence of reportable diseases in California on a county-by-county basis and for each year for the past 6 to 8 years. Part 2 describes the U.S. Environmental Protection Agency’s (EPA’s) development of the national sewage sludge regulations (Part 503 regulations). Part 3 provides information on endocrine disruptors, an issue of increasing concern with regard to long-term impacts of chemicals in the environment.

Part 1. Diseases of Interest

This section discusses each of the groups of potential pathogens of concern or specific potential pathogens of concern that may be found in biosolids and summarizes available information on the incidence of diseases they cause in California. This discussion is intended to provide background information for the impact analysis presented in Chapter 5. The information on disease incidence reflects the data collected by the existing statewide voluntary public health reporting system, in which local health departments (two city and all county health departments) participate.

Bacterial Diseases

Enterotoxic *E. coli* 0157

This mutant form of *E. coli* first appeared in the United States in 1982 and is one of hundreds of varieties of *E. coli* found in the guts of mammals (Padhye and Doyle 1992). It is mainly an infection in cattle that can be passed to humans who eat foods contaminated by cattle manure (even in organic gardens using uncomposted manure) or who eat inadequately cooked meat (Cieslak et al. 1992, Centers for Disease Control

1993, Nelson 1997). This particular variety, according to Wells et al. (1991), can be found in 1%–3% of all cattle in the United States but causes them no harm. The infection can be serious for a human host, however, causing severe, often bloody diarrhea. In the worst cases, particularly in young children, *E. coli* can kill. Most often, *E. coli* illnesses are associated with eating undercooked hamburger or uncooked fruits (apples and cantalopes) and vegetables (lettuce in particular) or with person-to-person contact (Belongia et al. 1993, Nelson 1997). Contaminated water supplies are also of growing concern (Jones and Roworth 1996). This particular bacterial strain is of growing concern as more outbreaks occur (Koutkia 1997).

The most well-publicized recent case of illness from *E. coli* is that of three children who died in Washington in 1993 after eating contaminated hamburgers at a fast-food restaurant (Centers for Disease Control 1993). In summer 1997, 25 million pounds of hamburger, potentially tainted with *E. coli* 0157:H7, were recalled by Hudson Foods in Columbus, Nebraska, after consumer illnesses were reported. Illness caused by *E. coli* 0157:H7 has been a reportable disease in California since 1993; the annual number of cases has ranged from 0 to 33, and occasional outbreaks have occurred in major urban areas (Table E-1).

Table E-1. Reported Incidence of Enterotoxic *E. coli* 0157 in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)			1	4	1	
Los Angeles		2	1	14	7	9
Pasadena (City)				1		
San Francisco		1				
Alameda				9		
Marin				1		
San Benito				1		
San Diego				1		
Santa Cruz				1		
Tulare	__	__	__	1	__	__
Total Number of Reported Cases	0	3	2	33	8	9

Source: Starr pers. comm.

Like other pathogens of concern, the enterotoxic form of *E. coli* has a low infectious dose (estimated to be as low as 10 bacteria).

The present detection method for *E. coli* 0157:H7 requires growing the bacteria in laboratory cultures, which takes days. A group of Montana researchers led by Dr.

Gordon McFeters has developed a new method using an antibody test kit. The test takes only 4 hours; is highly sensitive; and works in food, feces, and water. The method could be adapted to detect other foodborne pathogens, such as *Salmonella*, and could be used at various points in beef supply processing to check for contamination.

Campylobacteriosis

Campylobacter jejuni, like *E. coli*, can cause severe cases of gastroenteritis (campylobacteriosis) and has been consistently listed as a pathogen of concern in relation to sludge management (U. S. Environmental Protection Agency 1985) despite a lack of information on its densities in sludges. This pathogen has at times outranked *Salmonella* as a leading cause of bacterial diarrhea (as in 1996), particularly in infants (Table E-2). The reported incidence of gastroenteritis attributable to *C. jejuni* in California has ranged from 864 to 2,477 cases annually since 1993 (Table E-2). Most of the cases (81%) were reported to have occurred in Los Angeles County. No cases were reported in the three counties of the Central Valley where most of the biosolids land application occurs (see Chapter 5). Little has been reported in scientific literature about the levels of this pathogen in feces shed by ill people, its removal in treatment, levels in biosolids, infectious dose, or longevity in the environment (Feachem et al. 1980, U.S. Environmental Protection Agency 1985) as indicated in (Table 5-1 of Chapter 5).

Table E-2. Reported Incidence of Campylobacteriosis
in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	73	61	56	93	92	67
Los Angeles	836	765	785	1,149	979	792
Pasadena (City)	15	33	33	12	18	20
San Diego						
San Francisco	6	4	11			
Alameda				537		
Amador				12		
Butte	1					
Calaveras				11		
Colusa				2		
Fresno				15		
Glenn				4		
Imperial				19		
Inyo				6		
Lake				5		
Lassen				4		

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Marin				167		
Mariposa				3		
Mendocino				3		
Modoc				3		
Monterey				2		
Orange		1	29	59	47	24
Placer				1		
Plumas				2		
Sacramento				86		
San Benito				18		
San Bernardino				5		
San Diego				6		
Santa Clara				3		
Santa Cruz				100		
Shasta				9		
Sierra				1		
Siskiyou				13		
Tehama				2		
Trinity				3		
Tulare				115		
Tuolumne				7		
Total Number of Reported Cases	931	864	914	2,477	1,136	903

Source: Starr pers. comm.

Salmonellosis and Typhoid Fever

The bacterial genus *Salmonella* consists of more than 2,000 known serotypes found in different reservoirs and locations, many of which are pathogenic to humans and other animals (Argent et al. 1977, 1981; Ayanwale 1980; Mishu et al. 1994). Ingestion of an infectious dose of *Salmonella* (usually a large number of bacteria is required, as shown in Table 5-1 in Chapter 5) can result in gastroenteritis, enteric fever, and/or septicemia. The two major disease syndromes associated with *Salmonella* are salmonellosis (gastroenteritis) and typhoid fever (enteric fever).

Salmonellosis. The major vehicle of salmonellosis is food (St. Louis et al. 1988, Mishu et al. 1994), although waterborne outbreaks have occurred. There are many zoonotic reservoirs for salmonellosis, including such domestic and wild animals as poultry, swine, cattle, rodents, dogs, cats, turtles, and tortoises. Waterborne outbreaks of salmonellosis occur worldwide and are associated primarily with fresh water.

Salmonellosis is characterized by acute abdominal pain, diarrhea, nausea, fever, and dehydration and is sometimes accompanied by vomiting. The illness can lead to complications and more serious infections. Death is not common except in the very young, the very old, or the debilitated.

It has been estimated that 400,000 to 3.7 million cases (17.3 cases per 100,000) of salmonellosis (including foodborne and waterborne transmission) occur every year in the United States (EOA 1995), with as many as 70% of the cases being imported from foreign travelers. Between 1,010 and 1,894 cases have been reported yearly in California over the past six years (Table E-3), with over 90% of the total being reported in Los Angeles County. No cases were reported to have occurred in those counties in the Central Valley where the highest amounts of biosolids are being land applied.

Recent research on the causes of a *Salmonella* outbreak among chickens has raised concern about the importance of *Salmonella* in wastewater management and indicates the need for constant vigilance and monitoring of the effectiveness of management techniques and disinfection methods (Kinde et al. 1996, 1997). Concern also exists regarding the transmission of *Salmonella* from biosolids to animals (Jones et al. 1980; Argent et al. 1977, 1981) and the ability of the pathogen to survive under hostile environmental conditions (Droffner and Brinton 1995); this ability makes them the indicator of choice for monitoring the effectiveness of biosolids pathogen reduction (U.S. Environmental Protection Agency 1992). In developing the Part 503 regulations, the EPA based its requirements for pathogen reduction and its risk assessments for protection of public health on *Salmonella* because of its high incidence rates, its ability to regrow, and its correlation with coliform bacteria (about 1.4 *S. typhi* per million coliforms based on a morbidity rate of 0.18/million persons).

Typhoid Fever. Typhoid is transmitted via water or food contaminated by the feces or urine of a carrier. Fruits, vegetables, and milk contaminated by sewage or by the hands of carriers are also modes of transmission. The case-fatality rate for typhoid fever can reach 10% if symptoms go untreated; there are approximately 500 fatalities per year (0.2 per 100,000 deaths per year) in the United States.

Table E-3. Reported Incidence of Salmonellosis in California
(1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	88	107	27	104	100	82
Los Angeles	1,034	1,348	1,208	1,152	1,112	881
Pasadena (City)	29	37	27		33	17
San Diego	1					
San Francisco	1	6	1			
Alameda				280		
Amador				3		
Calaveras				5		
Colusa				3		
Contra Costa				1		
El Dorado				5		
Fresno				7		
Glenn				6		
Imperial				39		1
Inyo				6		
Lake			1	7		
Lassen				4		
Marin				35		
Mariposa				2		
Mendocino				1		
Modoc				1		
Mono				16		
Orange			47	37	47	28
Placer				4		
Plumas				6		
Sacramento				2		
San Benito				7		
San Bernardino				4		
San Diego				3		1
San Luis Obispo				1		
Santa Barbara				1		
Santa Clara				2		
Santa Cruz				60		
Shasta				6		

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Tehama				5		
Tulare				68		
Tuolumne				11		
Total Number of Reported Cases	1,153	1,498	1,311	1,894	1,292	1,010

Source: Starr pers. comm.

Shigellosis

The genus *Shigella* is made up of four species of rod-shaped bacteria that are all pathogenic in humans and other primates. The four species are characterized as groups or types: Group A, *S. dysenteriae* (10 serovars); Group B, *S. flexneri* (17 serovars); Group C, *S. boydii* (15 serovars); and Group D, *S. sonnei* (1 serovar). Shigellosis, an acute bacterial disease caused by *Shigella*, occurs worldwide, with outbreaks common under conditions of crowding and poor sanitation (i.e., jails, institutions for children, mental hospitals, crowded camps and ships). The reporting for the disease distinguishes between the four groups to help identify the sources and potential severity of the infection. From 1967 to 1988, annual isolation rates of *Shigella* reported to the Centers for Disease Control (CDC) varied between about 5 and 10 per 100,000 persons. It has been estimated that 5% of all symptomatic cases of shigellosis are reported to the national surveillance system. *Shigella* is considered the most highly communicable of the bacterial diarrheas; as few as 10 organisms have been reported to cause clinical illness (U. S. Environmental Protection Agency 1985).

For *S. dysenteriae* (Shiga bacillus) infection, case-fatality rates approach 20%; for *S. sonnei infection*, the infection is short-lived and the fatality rate is almost negligible, except in immunocompromised persons. Few cases are reported in California. The annual number of cases reported in the state ranges from 0 to 17 cases a year for Group A, 196 to 796 for Group B, 2 to 45 for Group C, and 388 to 873 for Group D (Tables E-4, E-5, E-6, and E-7, respectively). Some 62–178 cases a year were unidentified as to type (Table E-8). Overall, some 701 to 1,530 cases per year have been reported from 1993 to 1998. None of these cases has been associated with biosolids.

Shigella spp. has in the past been the most common bacterial pathogen implicated in waterborne outbreaks in the United States, but its occurrence has declined over time (Moore et al. 1993). Shigellosis also has been implicated in outbreaks associated with recreational swimming (Blostein 1991, Sorvillo et al. 1988).

Shigellosis is transmitted via the fecal-oral route, directly or indirectly, primarily from person to person via contaminated food and water. In areas of poor sanitation, food and water may play a greater role in transmission. Flies have been shown to be a vector in the transmission of the disease (Dunaway et al. 1983).

The survival of *Shigella* in water, soils, and plants depends on factors such as temperature and the concentration of other bacteria, nutrients, and oxygen. In various studies, *Shigella* has been shown to survive for up to 22 days in well water and even longer in colder temperatures (47 days) and up to 135 days in permafrost soils of Siberia (EOA 1995).

One detailed review of the scientific literature performed by EOA (1995) found no *Shigella* outbreaks associated with water where the source met the coliform standards at the time of exposure.

Table E-4. Reported Incidence of Shigellosis Type A in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)			1	1		
Los Angeles	14	7	3	9	0	5
Pasadena (City)		1	1			
Alameda				3		
Lassen				1		
Marin				1		
Santa Cruz				1		
Shasta	—	—	—	1	—	—
Total Number of Reported Cases	14	8	5	17	0	5

Source: Starr pers. comm.

Table E-5. Reported Incidence of Shigellosis Type B in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	36	46	28	29	26	19
Los Angeles	398	363	352	284	215	171
Pasadena (City)	3	9	5	6	4	4
San Francisco	2	378	2			
Alameda			27			
Colusa			1			
Fresno			1			
Imperial			7			
Inyo			1			
Marin				5		

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Mono				1		
Orange			11	4	6	2
San Benito				10		
San Bernardino				2		
Santa Cruz				3		
Tulare				4		
Total Number of Reported Cases	439	796	435	348	251	196

Source: Starr pers. comm.

Table E-6. Reported Incidence of Shigellosis Type C in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	1	2		3	2	2
Los Angeles	28		44	17	28	20
Pasadena (City)				2		
Alameda				3		
Colusa				1		
Imperial				1		
Lassen				1		
Orange			1			1
San Benito				4		
Total Number of Reported Cases	29	2	45	32	30	23

Source: Starr pers. comm.

Table E-7. Reported Incidence of Shigellosis Type D in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	102	30	64	46	61	98
Los Angeles	578	399	652	510	306	292
Pasadena (City)		38	35	16	9	7
San Francisco	1	1	5			
Alameda			89			
Fresno			17			

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Imperial			11			
Marin				4		
Orange				6	12	
San Benito				5		
San Bernardino				1		
San Diego		1		3		
Santa Cruz				15		
Shasta				1		
Tulare				18		
Ventura	1					
Total Number of Reported Cases	682	469	873	625	388	397

____
Source: Starr pers. comm.

Table E-8. Reported Incidence of Shigellosis (Unidentified as to Type) in California (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	8	3	5	4		3
Los Angeles	108	101	137	103	60	77
Pasadena (City)			1	1	2	
Alameda			28			
El Dorado				2		
Imperial				24		
Marin				5		
Modoc				2		
Orange		1	1			
San Benito				1		
San Diego				2		
Santa Cruz				9		
Shasta				1		
Tehama				1		
Tulare				23		
Total Number of Reported Cases	116	105	172	178	62	80

____
Source: Starr pers. comm.

Protozoan Diseases

Amoebiasis

Amoebiasis, an infection caused by the environmentally resistant pathogen *Entamoeba histolytica*, is acquired by mouth contact. Symptoms can vary from minor abdominal cramps to severe diarrhea alternating with constipation. The incidence of disease from this protozoan is low; between 127 and 237 cases per year have been reported in California over the past six years (Table E-9). None of the reported cases have been associated with biosolids or wastewater management. Over 94% of the reported cases in California were in Los Angeles County (including Long Beach and Pasadena), reflecting the size of the population. This disease is associated often with travel in other countries, particularly in areas of Mexico.

Table E-9. Reported Incidence of Amoebiasis in California
(1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	21	14	13	16	13	14
Los Angeles	213	156	145	161	110	113
Pasadena (City)	2			2		
San Francisco	1	5	5		2	
Marin				30		
Mariposa				1		
Orange				3		
Sacramento				6		
Santa Clara				2		
Santa Cruz						
Tehama				1		
Tulare	—	—	—	1	—	—
Total Number of Reported Cases	237	175	163	223	125	127

Source: Starr pers. comm.

Crytosporidiosis

Cryptosporidiosis is a gastrointestinal infection that is caused by the protozoan *Cryptosporidium* spp. *Cryptosporidium* oocysts are shed by humans and animals in feces. The infectious dose in humans is thought to be small; it is 10–400 oocysts in species other than humans. Little is known about the concentrations of viable oocysts in biosolids (Gerba pers. comm.) and the viability of oocysts in the environment, but oocysts are known to have the potential to survive months following their excretion (EOA 1995) and have the potential to survive more than a month following sludge treatment and land application (Whitmore and Robertson 1995). However, it has been found that conventional treatment and anaerboic digestion are effective in reducing the numbers of oocsysts in biosolids (Whitmore and Robertson 1995).

Modes of transmission for cryptosporidiosis include person-to-person contact, zoonotic transmission, and contaminated food and water. Person-to-person transmission is probably the most important mode and has been documented among family/household members, sexual partners, health workers and their patients, and children in day care centers. *Cryptosporidium* readily crosses host-species barriers as well, though, and human infections are often the result of zoonotic transmission. *Cryptosporidium* is harbored by more than 40 mammals. Reservoir hosts include calves, dogs, cats and rodents (Tzipori 1988).

Several waterborne outbreaks of cryptosporidiosis have been reported in the United States where the filtration component of water treatment was suboptimal (Milwaukee, for example - see below) (McKenzie et al. 1994). Cryptosporidiosis also has been associated with recreational use of swimming pools (Joce et al. 1991). Disease incidence in England associated with chlorinated water supplies and swimming pools indicates cryptosporidiosis resistance to chlorination (Furtado et al. 1998).

During a waterborne outbreak of cryptosporidiosis resulting from contamination of a public water supply that affected an estimated 13,000 people in Georgia, routine samples from the water system were found to meet EPA and State of Georgia standards for coliform bacteria (Robertson and Smith 1992). During another cryptosporidiosis outbreak associated with public water supply that led to an estimated 403,000 cases of diarrhea in Milwaukee, coliforms were not detected in samples of treated water (McKenzie et al. 1994). It should be noted that it is generally recognized that *Cryptosporidium* oocysts are removed or inactivated by effective and reliable water treatment practices where the water supply is not contaminated by dairy or pasture runoff (most often from flooding).

Cryptosporidium is found worldwide. Human cryptosporidiosis has been reported in at least 60 countries on six continents, with widely varying prevalence among those seeking medical care for diarrhea (EOA 1995). The prevalence is highest in non-industrialized regions: Europe,1% to 2%; North America, 0.6% to 4.3%; and Asia, Australia, Africa, and Central and South America, 3% to 20%. Seroprevalence rates in immunocompetent individuals are between 25% and 35% in the United States and are well over 50% in Latin America. Children generally have a significantly higher prevalence than adults, and infections are often seasonal, with a higher prevalence during warmer, wetter months.

No outbreaks associated with biosolids use have been reported in scientific literature or with the health agencies consulted during the preparation of this EIR. This disease is rare, with 31 to 212 cases a year reported in California, none of which are from areas where biosolids have been land applied (Tables E-10 and E-11).

Table E-10. Reported Incidence of Cryptosporidiosis in California (1991 through 1998)

Location by County/City Health Department	1991	1992	1993	1994	1995	1996	1997	1998
Long Beach (City)		3	18	4	24	10	4	5
Los Angeles		56	68	145	171	144	57	68
Pasadena (City)				4	1	2	1	1
San Diego								
San Francisco	16		3	1	2			
Fresno						1		
Kern	1							
Marin		2				1		
Orange	3	2	1	1	1	2		1
Riverside						1		
Sacramento						1		
San Bernardino						2		
San Diego						2		
San Luis Obispo	1							
San Mateo	1							
Sonoma	1							
Total Number of Reported Cases	23	63	90	155	199	166	62	75

Source: Starr pers. comm.

Table E-11. Reported Incidence of Cryptosporidiosis (Type S) in California
(1991 through 1998)

Location by County/City Health Department	1991	1992	1993	1994	1995	1996	1997	1998
Long Beach (City)	1		4	1	1	2		
Los Angeles	3	41	41	17	10		38	16
Pasadena (City)			2		1		1	
Alameda						1		
Amador								
Monterey		4						
Napa								
Orange	1		3		1		3	
San Bernardino	1							
San Diego	1							
Santa Clara	1							
Total Number of Reported Cases	8	45	50	18	13	3	42	16

Source: Starr pers. comm.

Giardiasis

Giardia lamblia is a protozoan that principally infects the upper small intestine in humans, who can often be asymptomatic. *Giardia* infection, or giardiasis, manifests itself in the form of chronic diarrhea, abdominal cramps, weight loss, and fatigue that can last for months with relapses. It can progress to cause malabsorption syndrome, in which digestion is impaired and weight loss occurs. Certain immunodeficiency syndromes also may be associated with *Giardia* infection, and the infection is particularly devastating in immunocompromised persons. Carriers can shed *Giardia* for years, but a self-cure usually occurs within 2 to 3 months. The numbers of *Giardia* cysts shed in feces are highly variable but have been measured to be as high as 900 million per day (Feachem et al. 1983).

Before leaving the intestine, *Giardia* generally forms a resistant cyst, which is highly resistant to traditional disinfection techniques (EOA 1995). The cysts can remain viable in water for several months and can remain viable in soils as well, but cannot tolerate freezing (EOA 1995). It has been found that the presence of traditional bacterial indicators does not correlate with the presence of cysts, particularly in unfiltered but disinfected drinking water (EOA 1995). Negative coliform tests do not provide assurance that water is free of *Giardia* cysts; however, positive coliform results often correlate with *Giardia* outbreaks (EOA 1995).

The major reservoir of *Giardia* is humans, but there is evidence that humans may acquire infections from other animals. Beavers may be a reservoir and have been implicated in waterborne outbreaks (EOA 1995). Dogs, gerbils, guinea pigs, beavers, raccoons, bighorn sheep, and muskrats have all been shown to be carriers of *Giardia* (EOA 1995).

Giardia infection is transmitted through contaminated water supplies, foodborne outbreaks, and person-to-person contact, with the later being the most prevalent means of transmission. Individuals with impaired immune function appear to have increased susceptibility to *Giardia* infection.

The numbers of *Giardia* cysts in biosolids have been estimated to range from 10 to 10^3 per gram with no removal via treatment. However, significant viability reduction occurs during digestion, estimated in laboratory studies to be as high as 99.9% inactivation (Straub et al. 1993, Cravaghan et al. 1993). Class A treatment requires that treated biosolids contain less than one protozoan cyst per gram. For Class B sludge generated in Australia, it has been found that anaerobically digested and mechanically dewatered sludge had cysts present at levels of public health concern after 1 year, but that cysts were destroyed after only 12 weeks following soil amendment (Hu et al. 1996).

Giardia is found worldwide. The prevalence of *Giardia* infection worldwide has been estimated to be about 7%, and infection is more common in children than adults. Prevalence rates vary between less than 1% and 50% and depend on the population sampled, infection rates being highly dependent upon sanitation and the quality of drinking water. Areas of the United States known to be associated with increased risk of infection are usually mountainous and include New England, the Pacific Northwest, and the Rocky Mountains.

The number of cases reported in California is variable, ranging from 510 to 1,335 per year (Table 5-6 in Chapter 5). The incidence in California is the highest in Los Angeles County, where more than 88% of the cases were reported. No cases were reported in Kern, Merced, and Kings Counties, where the majority of the biosolids application currently occurs (Table E-12). No cases of the illness associated with biosolids operations have been reported (Cook and Shaw pers. comms.).

Table E-12. Reported Incidence of Giardiasis in California
(1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	88	89	70	85	276	63
Los Angeles	971	700	588	618	528	427
Pasadena (City)	28	25	12	26	22	20
San Diego	1	1				
San Francisco	1	5	3			
Alameda				152		
Amador				8		
Calaveras				12		
Colusa				2		
Contra Costa				1		
El Dorado				1		
Fresno				21		
Glenn				5		
Imperial				10		
Inyo						
Lake				14		
Lassen				5		
Marin				75		
Mariposa				2		
Mendocino				2		
Modoc				1		
Mono				1		
Orange		1	19	125	32	
Placer				2		
Plumas				4		
Sacramento				63		
San Benito				6		
San Bernardino				5		
San Diego				4		
San Luis Obispo						
Santa Barbara			1			
Santa Clara				1		
Santa Cruz						
Shasta				4		

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Sierra				1		
Siskiyou				3		
Tehama				9		
Trinity				3		
Tulare				59		
Tuolumne				5		
Total Number of Reported Cases	1,089	821	693	1,335	858	510

Source: Starr pers. comm.

Viruses

Hepatitis A

The hepatitis A virus (HAV) is a virus physically resembling an enterovirus that causes hepatitis A, an illness with the symptoms of fever, nausea, malaise, anorexia, and abdominal discomfort, followed by jaundice. The disease can be mild, lasting 1 to 2 weeks, or severe, with disabling effects lasting months in rare cases. The recovery period is usually prolonged. The case-fatality rate has been reported to range from 0.04% in children 5–14 years old to 2.7% in adults over 49 years old, with typical case-fatality rates of 0.1–0.5%. Relapse rates can be as high as 20%. Hepatitis A can be diagnosed by the detection of virus in the stool or the presence of IgM antibodies against HAV in the serum of persons who are acutely ill. There is currently no specific treatment for HAV.

The normal reservoir of HAV is acute-phase humans; there is no known carrier state. Mode of transmission is via the fecal-oral route, with person-to-person transmission being the most frequent means of transmission, usually via water or food. HAV can survive for long periods on inanimate objects and on human hands; therefore, food contamination by infected persons is a major area of concern. In the United States, waterborne outbreaks have been estimated to contribute 0.4%–8% of all HAV incidence, and no waterborne disease outbreaks have been shown to have been directly associated with biosolids. The majority of waterborne outbreaks in the United States involve small private or semiprivate water supplies with or without chlorination; these outbreaks are usually attributable to plumbing-sewage cross-contamination or to a raw-water source being so grossly polluted with sewage that virus levels cannot be eliminated by treatment of the water using conventional methods. The infectious dose is estimated to be in the range of 1 to 10 plaque-forming units (PFUs).

Little is known about persistence of hepatitis A in the environment. Survival in water has been recorded for as long as 40 days in surface waters and 70 days in groundwaters

(EOA 1995). Levels in biosolids have not been reported in anaerobically digested sludge.

There is no known direct correlation between HAV and indicator organisms such as coliform bacteria, fecal streptococci, acid-fast bacteria, or coliphage.

Hepatitis A has a worldwide distribution. Since 1920 in the United States, there have been about 15 reported outbreaks of HAV associated with drinking water, most of which are reported from areas with poor sanitation or contaminated water supplies (Singh et al. 1998). In California, the number of Hepatitis A cases has ranged from 474 to 1,415 annually over the past eight years (Table E-13).

Incidences in counties where biosolids are being land applied have not increased since land application was intensified in recent years, and no cases have been reported in most instances in the past seven years. None of the cases reported can be related to the handling or use of biosolids.

Table E-13. Reported Incidence of Hepatitis A in California
(1991 through 1998)

Location by County/City Health Department	1991	1992	1993	1994	1995	1996	1997	1998
Long Beach (City)	11	2	93	122	207	198	168	73
Los Angeles	100	1,005	707	733	760	801	1,209	619
Pasadena (City)	5	1	38	37	15	19	21	14
San Francisco	41		14	37	59			
Alameda	14	6				36		
Amador						3		
Butte						1		
Colusa						4		
Contra Costa	7					1		
El Dorado	6	3		2		1		
Fresno	8					10		
Glenn						3		
Humboldt	6							
Imperial	1					26		
Kern	19							
Kings	4							
Lake	3							

Location by County/City Health Department	1991	1992	1993	1994	1995	1996	1997	1998
Lassen						1		
Madera		1						
Marin		3				17		
Mendocino	2	4				2		
Merced	6	8						
Modoc						1		
Mono		1						
Monterey	12	3						
Napa	1	1						
Orange	35	3	22	22	37	25	17	19
Placer	1	4						
Riverside	18	9			1	3		
Sacramento	11					27		
San Bernardino	25					21		
San Diego	61					18		
San Joaquin	1							
San Luis Obispo	1							
San Mateo	8							
Santa Barbara	2							
Santa Clara	17					2		
Santa Cruz	2					11		
Shasta	2					11		
Siskiyou	2					2		
Solano	1							
Sonoma	7							
Stanislaus	9							
Sutter	1							
Tehama						3		
Trinity						1		
Tulare	14					51		
Tuolumne	1							
Ventura	6							
Yolo	1							
Yuba	2					1		
Total Number of Reported Cases	474	1,054	874	953	1,079	1,300	1,415	725

____
Source: Starr pers. comm.

Viral Meningitis

"Viral meningitis" is the general term that refers to all serious viral diseases (not gastroenteritis of unknown origin) that have been reported. Included as causative agents and reportable as viral meningitis are the Coxsackievirus A and B, Echovirus, and new enteroviruses (acquired orally). It is unknown how many viruses cause gastroenteristis and flulike symptoms that are unreported. The reportable cases of viral infections have ranged from 119 to 485 per year (Table E-14). Most of the cases are reported in the more urbanized counties and the numbers of reported cases are largely proportional to population. Only two cases have been reported in the three largest land application areas, both in Kern County. There is no evidence that any of the cases are associated with biosolids land application operations.

Table E-14. Reported Incidence of Viral Meningitis in California (1991 through 1998)

Location by County/City Health Department	1991	1992	1993	1994	1995	1996	1997	1998
Long Beach (City)	3	36	69	18	22	35	30	87
Los Angeles	13	413	317	155	89	105	134	276
Pasadena (City)			8	3	1	3	3	10
San Diego	40					6		
Alameda	1					2		
Contra Costa	4							
Fresno	9					4		
Glenn						1		
Imperial	3							
Kern	2							
Lassen						2		
Marin		5				2		
Mendocino		1						
Monterey	2	1						
Napa	2	1						
Orange	62	23	30	5	7	11	19	30
Placer		1						
Riverside	20	2						
Sacramento	7		1			3		
San Bernardino	10					1		
San Joaquin	1							
San Luis Obispo	1							
San Mateo	3							
Santa Clara	3							

Location by County/City Health Department	1991	1992	1993	1994	1995	1996	1997	1998
Santa Cruz	3					8		
Solano	1							
Sonoma	1							
Tulare	4					5		
Tuolumne	1							
Ventura	1	2						
Yuba	1							
Total Number of Reported Cases	198	485	425	181	119	188	186	403

Source: Starr pers. comm.

Gastroenteritis

Gastroenteritis is a widespread disease that can be caused by numerous known and unknown viral agents. Person-to-person transmission is the principal mechanism for the spread of many infections; therefore, the most important element in preventing and controlling outbreaks is improved environmental hygiene (i.e., food, water, and sanitation).

When foods other than shellfish are implicated in viral gastroenteritis outbreaks, the contamination has usually taken place near the point of consumption (shellfish are not discussed in this EIR because of the nature of the project). Ill food handlers were identified in nine of the 15 documented Norwalk outbreaks reported to the CDC from 1985 to 1988 for which adequate epidemiologic data were available (Centers for Disease Control unpublished data). Foods that require handling and no subsequent cooking (e.g., salads) constitute the greatest risk. Among Norwalk-confirmed foodborne outbreaks from 1976 to 1980 that were not attributable to shellfish, salad was the most commonly implicated food (Centers for Disease Control 1999).

The long list of foods implicated in outbreaks of viral gastroenteritis reflects the variety of foods handled by food-service personnel and the low infectious dose (10–100 particles) of most viral agents of gastroenteritis. In contrast to the factors important in amplifying bacterial contamination, practices such as leaving foods unrefrigerated or warming them for prolonged periods are not direct risk factors for increased viral transmission because the viruses do not multiply outside the human host.

The Norwalk agent can remain infective even if frozen for years or heated to 60EC for 30 minutes. Cooking temperatures at 100EC or above are probably adequate to inactivate Norwalk and most other enteric viral pathogens.

Outbreaks of viral gastroenteritis have been associated with various sources of contaminated water, including municipal water, well water, stream water, commercial ice, lake water, and pool water (Centers for Disease Control 1999). Disinfection of municipal supplies may not be adequate to kill the Norwalk agent, which can remain highly infective despite 30-minute exposure to concentrations of chlorine as high as 6.25 milligrams per liter (mg/l) and levels of 10 mg/l (Centers for Disease Control 1999); this helps explain why this virus is predominant in waterborne disease outbreaks. Rotavirus, for which only one waterborne outbreak has been documented in the United States, is more sensitive to chlorine than the Norwalk agent.

Because rotaviruses can survive for several days on nonporous materials in conditions of low temperature and humidity, objects may contribute to their transmission. A recent study of a Norwalk viral outbreak on a cruise ship implicated toilets shared between staterooms as a risk factor for infection, suggesting that surfaces contaminated by Norwalk particles from spattered or aerosolized material may play a role in transmission of Norwalk-like viruses causing gastroenteritis.

Aerosolized rotavirus has also been observed to caused diarrheal illness in experimental mice. Studies are needed to address the efficacy of barrier precautions (e.g., face shields, respirators) in interrupting transmission of these agents (Centers for Disease Control 1999).

Contaminated hands (hands contaminated directly or through contact with contaminated surfaces) may be the most important means by which enteric viruses are transmitted; thus, any people involved with biosolids should avail themselves of handwashing with soap on a routine basis to control the spread of all enteric pathogens.

Nearly all the agents of viral gastroenteritis in humans have related strains that can cause diarrhea in animal species. These strains appear to be highly host-specific, however, and zoonotic transmission has not been documented as having an important role in human disease, either endemically or in outbreaks.

Acquired Immune Deficiency Syndrome (AIDS/HIV Virus)

No discussion of viruses would be complete without a discussion of acquired immune deficiency syndrome (AIDS), which is caused by HIV (human immunodeficiency virus). It is noteworthy that HIV has never been recovered from wastewater samples into which it has not been artificially introduced (Ansari et al. 1992, Casson et al. 1992, Moore 1993). Researchers have recovered viral nucleic acid fragments in wastewater but none in biosolids (Preston et al. 1991). However, the detection of nucleic acid sequences does not represent the presence of viable HIV. No intact HIV has been recovered from either raw sewage or biosolids. The CDC contends that wastewater treatment professionals, as well as members of the public who may contact wastewater or biosolids, are not at risk of contracting AIDS as a result of this contact (Centers for Disease Control 1999).

Parasitic Worms

Several parasitic intestinal worms are found in wastewater (Straub et al. 1993, ABT Associates 1993). These parasites are a potential hazard to the public health in general and to treatment plant and biosolids workers in particular. The beef tapeworm (*Taenia saginata*) can cause taeniasis if ingested with poorly cooked meat. Tapeworm eggs are detectable in biosolids, but there is no evidence that they have contributed to distribution of the disease except in one reported case discussed below.

Toxoplasmosis

Toxoplasmosis is a very rare disease that affects only unborn fetuses. The disease is derived from cat feces. As shown in Table E-15, between 9 and 42 cases per year have been reported in California, none of which were in areas where biosolids are being extensively land applied. All cases but one were in Los Angeles County; the exception was in San Diego County.

Table E-15. Reported Incidence of Toxoplasmosis (1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Long Beach (City)	2		1	1	1	1
Los Angeles	40	9	27	22	15	8
Pasadena (City)					1	
San Diego	_	_	_	_	1	_
Total Number of Reported Cases	42	9	28	23	18	9

Source: Starr pers. comm.

Roundworms

Ascariasis is caused by the presence of roundworms (*Ascaris lambricoides*) in the intestinal tract. The disease results from the ingestion of roundworm eggs, which survive for months to years in biosolids (Table 5-1 in Chapter 5) and were a primary focus of the EPA Part 503 regulation risk management practices. This disease is rare and is not reported.

Hookworms

Hookworm disease, rare in California but still present in the southeastern United States, is generally acquired when the larvae of *Necator americanus* enter through the bare skin, usually the feet. Infections also have occurred following ingestion of foods contaminated by wastewater. No cases of transmission related to biosolids land application have been reported. Symptoms include malnutrition, loss of energy, and anemia. This disease is rare and has not been reported in the past 6 years.

Tapeworms

There are two species of tapeworms (*Taenia saginata* [beef] and *T. solium* [pork]) that live in the intestinal tract, where they can cause abdominal pain, weight loss, and digestive disturbances (Straub et al. 1993). Humans serve as the definitive host for the adults, and the eggs, which are passed in feces, may not be completely destroyed by all sludge treatment processes (Feachem et al. 1983), thus leading to the potential for their application to land in biosolids. If cattle graze on this land and ingest viable larvae, the disease may be transmitted to cattle. Humans have to become infected from eating incompletely cooked meat containing the larval stage of the tapeworm. A single recorded case of beef tapeworm transmission through the fertilization of land with untreated sludge has been reported in the United States; this case was reported more than 20 years ago, however, before the development of the Part 503 regulations and the improvements in treatment mandated under the Clean Water Act (Hammerberg et al. 1978).

Tapeworm infections are relatively rare in California; a maximum of 14 case per year have been reported, all in Los Angeles County (Table E-16).

Table E-16. Reported Incidence of Tapeworm (*Taenia* sp.)
(1993 through 1998)

Location by County/City Health Department	1993	1994	1995	1996	1997	1998
Los Angeles	2	6	4		1	13
Pasadena (City)	_	_	1	_	_	1
Total Number of Reported Cases	2	6	5	0	1	14

Source: Starr pers. comm.

Fungal Diseases

Fungal pathogens include several species that have been identified in biosolids, as listed below.

Fungal Species	Disease
Aspergillus fumigatus	Aspergillosis
Candida albicans	Candidiasis
Cryptococcus neoformans	Subacute chronic meningitis
Epidermophton spp. and *Trichophyton* spp.	Ringworm and athlete's foot
Trichosporon spp.	Infection of hair follicles
Phialophora spp.	Deep tissue infections

Most of these fungal species have been found associated with composting operations, where they are enhanced by the favorable conditions created (wood chips and heat).

Aspergillosis is illness caused by the *Aspergillus* fungus, which is found commonly growing on dead leaves, stored grain, compost piles, or other decaying vegetation. The fungus can cause illness in three ways: as an allergic reaction in people with asthma (pulmonary aspergillosis, allergic bronchopulmonary type); as a colonization in an old lung cavity that has healed from previous disease such as tuberculosis or in a lung abscess, where it produces a fungus ball called aspergilloma; and as an invasive infection with pneumonia that is spread to other parts of the body by the blood stream (pulmonary aspergillosis; invasive type). The invasive infection can affect the eye, causing blindness, and any other organ of the body, but especially the heart, lungs, brain, and kidneys. The third form occurs almost exclusively in people whose immune systems are suppressed by high doses of cortisone drugs, chemotherapy, or a disease that reduces the number of normal white blood cells. Those at risk include organ transplant recipients and people with cancer, AIDS, or leukemia (Rosenberg and Minimato 1996).

The A*spergillus* group of fungi is generally less prevalent than other fungal species, but it can be pathogenic to people under conditions of high exposure. Normal background levels of *Aspergillus fumigatus* outdoors rarely exceed 150 spores per cubic meter.

Composting facilities do represent sites where there occurs a massive culturing of *Aspergillus fumigatus* organisms in relatively small areas compared with most “natural” or background circumstances. Studies have found concentrations of *A. fumigatus* 10 times higher than background levels in active commercial composting facilities, but the concentrations fell off sharply within 500 feet of the operational site (Clark et al. 1983) If the nearest human receptor is beyond the point at which concentrations fall to background levels, no elevated exposure is occurring.

The use of bark or wood chips (e.g., as a bulking agent for sewage sludge composting) typically raises the onsite level of airborne *A. fumigatus* spores (Millner et al. 1977, 1980; Clark et al. 1983). In one study in Maryland, *A. fumigatus* levels in sewage sludge rose from 10^2 or 10^3 colony forming units per gram dry weight (CFU/gm dry wt) to 2.6×10^6 to 6.10×10^7 CFU/gm dry wt when mixed with wood chips that were stockpiled for various lengths of time. The increase appeared to be caused by wood chips being stored in moist piles that were allowed to generate heat (Millner et al. 1977).

Increased *A. fumigatus* spore concentrations have been observed also in screened compost; the concentrations may have been increased as a result of reinoculation by spores as compost passed through contaminated screens multiple times (Olver 1979); others have suggested that multiple screenings may break up spore clusters, causing more spores to be released.

Numerous researchers (Raper and Fennel 1965; Sinski 1975; Olver 1979; Epstein and Epstein 1985, 1989; Maritato et al. 1992; Epstein 1993) have presented persuasive arguments regarding the lack of health risk from *A. fumigatus* for certain outdoor workplace environments. In enclosed compost facilities without dust control, there is an elevated risk of worker exposure to spores. In a worst-case scenario, a respiratory model developed by Boutin et al. (1987) estimated that a completely unprotected worker shoveling mature compost at a highly contaminated site could inhale 25,000 to 30,000 viable spores per hour. However, elevated exposure is not automatically synonymous with an elevated health risk for compost workers (or neighboring communities). Epstein (1993) discusses several composting facilities in the United States in which health monitoring (physical examinations) of compost workers has been conducted; the results of the physical examinations did not reveal any illnesses directly associated with composting.

Many public health specialists, scientists, and engineers in North America and Europe believe that properly operated composting and co-composting operations present little health risk to normal compost facility employees and present a negligible risk or no risk to nearby residences (Millner et al. 1977, Clark et al. 1983, Epstein and Epstein 1985, Boutin et al. 1987, Maritato et al. 1992). Diaz et al. (1992) stated:

> The existence of hazard from the spores of *A. fumigatus* [at commercial composting facilities] is yet to be demonstrated. The infectivity of the spores is low. Consequently, any danger posed by it would be of significance only to the unusually susceptible individual. Nevertheless, use of respirators by workers and the siting of such facilities in areas remote from residential dwellings and areas where potentially sensitive receptors work of live is warranted as a prudent land use planning practice.

Reducing the dispersal of *A. fumigatus* spores appears to be the best way to reduce exposure and help protect the health of compost workers and the neighboring communities. The following management practices can help reduce the dispersal of spores into the air during commercial aerobic composting operations (whether they involve windrows, aerated static piles, or the various types of in-vessel reactors—vertical, horizontal, or rotating drum):

- suitable siting, design, and construction (berms, vegetation, etc.) of composting facilities;
- implementation of facility operational practices such as dust suppression, modification of time of operation, etc.);
- engineering and administrative controls (enclosed cabs, use of amendment materials, health checks for workers); and
- use of personal protective equipment (respirators or protective masks).

The California Integrated Waste Management Board's current green waste composting regulations require a setback of at least 300 feet of the facility's active compost materials areas from any residence, school, or hospital, excluding onsite residences, unless a variance is granted from the local enforcement agency. More stringent requirements can be applied where there are sensitive receptors; high winds; or other factors related to health risks, such as the health status of the community potentially affected.

Pathogens of Emerging Concern

Research techniques continue to be developed for determining the pathogenic microorganisms responsible for human and animal disease outbreaks. New genetic techniques and electron microscopy have improved our ability to detect and identify pathogens, particularly new viruses. Because approximately 50% of all cases of gastroenteritis are of unknown origin, such research is vital to development of our understanding of disease and disease prevention.

This section describes the results of a literature review of recent outbreaks of disease (worldwide) undertaken to identify some of the emerging pathogens and their possible modes of transmission. The results of this search are summarized in Tables E-17 and E-18 for bacteria and viruses, respectively. Table E-19 provides information on parasites. None of these potential pathogens of concern have yet been identified with the use or handling of biosolids. Most outbreaks are associated with poor sanitation or food preparation and handling or drinking of contaminated water.

The patterns of incidence and pathways of spread for various pathogens are poorly understood. Epidemiological studies have revealed some interesting findings with regard to crytposporidiosis that show how incidence of disease and causative factors are difficult to identify: evaluation of health records and water treatment plant records revealed that outbreaks of cryptosporidiosis were occurring in Milwaukee for more than a year before the large documented outbreak in 1993 (when high runoff occurred, the water treatment plant turbidity levels became very high, and treatment levels declined) (Morris et al. 1998).

Table E-17. Bacterial Pathogens of Emerging Concern

Pathogen	Disease	Source	Environmental Sources	Outbreaks Reported	Literature
Aeromonas spp. (332 types)	Gastroenteritis	Pigs, chickens, ground beef, human feces, fish, milk, vegetables	Drinking water, fresh water, and wastewater	None from biosolids	Wadstrom and Ljungh 1991, Hanninen and Siitonen 1995
Pleisomonas shigelloides	Gastroenteritis	Seafoods	Contaminated seawater	None from biosolids	Wadstrom and Ljungh 1991
Hepatitis E	Hepatitis	Human feces	Sewage-contaminated water supply	None from biosolids; water related only.	Singh et al. 1998
Helicobacter sp.	Unknown	Wastewater, treated water, well water	Contaminated supplies	None from biosolids	Hulten et al. 1998
Salmonella enteritidis PT6	Salmonellosis	Eggs	Foodborne contamination	None from biosolids	Evans 1998, St. Louis et al. 1988, Mishu et al. 1994
Salmonella enteritidis PT4	Salmonellosis	Wastewater to mice to chickens	Treated secondary effluent discharged to surface water	None from biosolids	Kinde et al. 1996, Kinde et al. 1997

Table E-18. Viral Pathogens of Emerging Concern

Pathogen	Disease	Source	Environmental Sources	Outbreaks Reported	Literature
Adenoviruses 40 and 41	Gastroenteritis	Humans	Unknown	None from biosolids	Enriques et al. 1995
Human torovirus	Gastroenteritis and diarrhea	Children	Unknown	None from biosolids	Jamieson et al. 1998
Picobirnavirus	Diarrhea	Adults and children, chickens, rabbits	Unknown	None from biosolids	Cascio et al. 1996; Chandra 1997; Ludert et al. 1995; Gallimore et al. 1995a, 1995b
Coxsachieviruses (new serotypes)	Association with diabetes mellitus	Children	Fecal-oral contact	None from biosolids	Roivainen et al. 1998
Small round structured virus (SRSV)	Influenza	Infants, children, elderly	Unknown	None from biosolids	Dedman et al. 1998
Norwalk-like virus (calicivirus)	Unknown	Pigs	Unknown	None from biosolids	Sugieda et al. 1998
Swine HEV (hepatitis E virus in pigs)	Unknown	Pigs	Unknown	None from biosolids	Meng et al. 1998
Torovirus-like particles related to Berne virus, BEV, and Breda virus (BRV)	Gastroenteritis	Humans, horses, and cattle	Unknown	None from biosolids	Duckmanton et al. 1997

Table E-19. Other Parasitic Pathogens of Emerging Concern

Pathogen	Disease	Source	Environmental Sources	Outbreaks Reported	Literature
Mircrosporidia	Gastroenteritis	Unknown	Unknown	None from biosolids	Johnson and Gerba 1997
Crytosporidium (Genotypes 1 and 2)	Gastroenteritis and diarrhea	Cattle	Unknown, water supply, swimming pools	None from biosolids	Patel et al. 1998, Furtado et al. 1998

Parasitic Microsporidians

Microsporidia are protozoan parasites that can infect humans and cause chronic diarrhea; they are of particular concern because of their being found in patients with AIDS (Johnson and Gerba 1997). They have only recently been discovered (seven species discovered so far) and identified as potential human pathogens, and only recent research indicates that they can be measured in environmental samples (water and wastewater) (Dowd et al. 1998). They are similar to other protozoan parasites such as *Giardia* and *Cryptosporidium* because of their small size, ability to infect different mammals, and spread through the environment; these characteristics, combined with their ability to form spores resistant to heat inactivation and drying, make them a pathogen of emerging concern with a potential to be waterborne (Johnson and Gerba 1997).

Rotaviruses

Rotaviruses are small RNA viruses that have been found to be associated with gastroenteritis in humans and a wide range of animal species (De Leon and Gerba 1990). It has yet to be shown that animal rotaviruses are pathogenic for man; furthermore, there is no evidence for species cross-infection in nature (Conklin 1981). The human rotavirus has two serotypes. Rotavirus has been associated with as many as 50% of hospitalized cases of diarrheal illness in infants and young children (EOA 1995).

Rotavirus gastroenteritis occurs worldwide both in sporadic and epidemic outbreaks. The primary targets are infants and children, particularly in the 6- to 24-month age group. Cases in adults are relatively infrequent but have been reported, mainly in countries other than the United States (EOA 1995). The most common route of rotavirus transmission is the fecal-oral route, with person-to-person transmission being the most frequent. Most individuals have acquired antibodies to both serotypes of rotavirus by the age of 2 and are therefore protected from the disease as they grow older.

In the United States, rotavirus infections are responsible for 100,000 hospitalizations per year (EOA 1995).

Rotavirus has been isolated from untreated drinking water, treated drinking water, and various foods, but the occurrence of infections from these sources has been rare (De Leon and Gerba 1990). There have been only two occurrences in the United States and these have been traced to improperly treated water (EOA 1995). No cases have been attributed to biosolids.

Rotavirus is persistent in the environment and can survive for as long as 10 days in raw fresh water and as long as 64 days in municipal treated tap water (free chlorine = 0.05 mg/l) (EOA 1995). Rotavirus has been shown to survive more than 14 days in estuarine and heavily polluted fresh water (EOA 1995). Rotavirus can survive as long as 2 weeks on inanimate surfaces, the length of survival depending on relative humidity and temperature (EOA 1995). The length of survival of rotavirus, together with its low infectious dose, leads to concerns over its possible presence in biosolids (Table 5-2 in Chapter 5). No cases of infection have been attributed to biosolids, however.

Other Viruses

Research continues to reveal the presence of previously unknown viruses that may play an important role in the large number of gastroenteritis cases of unknown origin. Among the new discoveries about which little is known are the human toroviruses (Duckmanton et al. 1997, Koopmans et al. 1997, Jamieson et al. 1998), picobirnaviruses (Gallimore et al. 1995a, 1995b; Chandra 1997), coxsachieviruses, small round structured viruses (SRSV) (Dedman et al. 1998), caliciviruses, Norwalk-like viruses (Sugieda et al. 1998), hepatitis E virus (Meng et al. 1998), Berne and Breda virus (also of animal origin), and adenoviruses. Table E-18 summarizes information on these viruses, their potential sources, and their reporting in scientific literature. Little is known about their transmission, epidemiology, environmental fate, or presence in biosolids or wastewater. However, their reporting is noted here as an indication that new pathogens continue to be discovered and that constant assessment of existing management practices is needed to ensure that biosolids are not contributing to the spread of disease. To date, no evidence indicates that they are.

Picobirnaviruses are a novel group of viruses recently found in the feces of several species of vertebrates. They have been detected in the feces of humans suffering from cryptosporidiosis and, although they have not been associated with any outbreaks attributable to water or food, are a pathogen of emerging concern. The prevalence of picnovirus in those studied in the United Kingdom was found to be 9%-13% in a wide range of patients (ages 3 to more than 65) in those both with and without the symptom of gastroentiritis (Gallimore et al. 1995b). No outbreaks caused by these viruses have been reported in the United States.

Toroviruses alone or in combination with enteroaggregative *E. coli* may play a pathogenic role in acute and possibly persistent diarrhea in children. Further studies are warranted to determine the etiologic role of toroviruses in gastroenteritis.

Other Diseases

Bovine Spongiform Encephalopathy

Well-publicized news reports in 1996 suggested that consumption of beef from diseased cattle in Britain may have caused a fatal human brain disease (Floyd 1996, Pattison 1998). The condition in the British cattle, commonly referred to as "mad cow disease" in these reports, is a disease called bovine spongiform encephalopathy, or BSE. Cattle with BSE have a degenerative brain condition that develops slowly over a 2- to 8-year period. BSE is similar in its effects on the cattle brain to other spongiform encephalopathy (SE) diseases in the brains of other animals. These include Kuru and Creutzfeldt-Jacob disease (CJD) in humans, scrapie in sheep, transmissible mink encephalopathy (TME), chronic wasting disease of mule deer and elk, feline spongiform encephalopathy (FSE), and a few others. Experimental studies have demonstrated that animals can contract some of the SE diseases by ingesting nervous system tissues (brain, spinal cord, etc.) from affected animals. It is suspected (although there is still much debate) that the causative agent in the SE diseases may be a prion, or a filterable glycoprotein devoid of detectable nucleic acid that is resistant to typical means of sterilization (Pattison 1998). These agents have survived 3 years of burial in outside soil and heating to high temperatures. An unidentified virus is also theorized as a cause.

BSE was first seen and diagnosed in Britain in 1986. It may have arisen as a result of rendered sheep byproducts being fed to cattle as protein supplements. Some of these sheep may have been infected with scrapie, an SE disease that has been known for more than 200 years. The number of BSE cases increased to a peak of about 1,000 new cases per weak by January 1993 and then began to decrease. The epidemic may have worsened because initially it was possible for cattle that had been affected with BSE to be rendered into protein supplements for other cattle. The British government banned feeding of ruminant-derived animal proteins to other ruminants in 1989. Because of the 2- to 8-year "incubation" period of development of BSE, cases continued to occur after this ban went into effect. In any event, the number of cases has decreased significantly and continues to decrease as a result of regulatory interventions, such as the offal feeding ban, which is now effectively applied.

Muscle tissue and milk have not been demonstrated to transmit BSE, but brain and spinal cord tissue have. Therefore, steps taken in Britain to ensure that nervous tissues from cattle do not enter the human food supply should effectively prevent any transmission; it is unknown whether such transmission ever actually occurred. These steps also have been taken in the United States.

To prevent the possibility of BSE entering the country, in 1989 the United States banned imports of live cattle and zoo ruminants from the United Kingdom and any country with BSE; imports of sheep and goats from the United Kingdom had already been banned because of scrapie.

No case of BSE has been diagnosed in the United States, despite aggressive efforts on the part of the U.S. Department of Agriculture and other surveillance programs for BSE. Included in the search are examinations at the National Services Veterinary Laboratory of the brains of cattle diagnosed with nervous system disease (postmortem microscopic examination of brain tissue) and periodic examinations of all live cattle in the United States that came from the United Kingdom before the import ban was instituted.

No research has been conducted to measure the presence of prions in the environment and there are no known means of measurement. Gale (1998) assessed the likelihood of prions being a risk if water from an aquifer were contaminated by a cattle-rendering plant discharging effluent to the aquifer, and found the risk of infection to be in the range of 1 in 100 million to 1 in 1 billion. Because the disease is not present in the United States, such an analysis provides further assurance that this disease represents a minimal threat to public health.

Part 2. EPA Part 503 Risk Assessment for the Land Application of Sewage Sludge

The EPA conducted extensive risk assessments for application of sewage sludge onto agricultural land and nonagricultural land (i.e., forest land, reclamation !and, and public contact sites). These assessments, based on a number of different exposure pathways and various “worst-case” (highly exposed individual or HEI) exposure assumptions, formed the basis for the sewage sludge pollutant loading limits specified in Section 503.13 of 40 CFR Part 503 Standards for the Use or Disposal of Sewage Sludge and used as minimum requirements in the SWRCB General Order (GO). The risk assessments and all the calculations and assumptions used are described in detail in technical support documents (U. S. Environmental Protection Agency 1992, Volumes 1 and 2).

Risk assessments were conducted for 14 exposure pathways for agricultural land and 12 exposure pathways for nonagricultural land. Pathway 2, human toxicity from ingesting plants grown in the home garden, and pathway 11, human exposure through inhalation of particulates resuspended by tilling of sewage sludge, were not analyzed for nonagricultural application because these are not appropriate exposure scenarios for nonagricultural land. These pathways are described in Table E-20.

The EPA assembled a national peer review committee of 35 recognized academic, government, and private industry experts in the field of sludge application to land for 10 of the risk assessments (pathways 1-10). This committee critically evaluated the methodology and data used to assess risk as part of developing criteria for land application of potentially toxic chemicals in municipal sewage sludge. The EPA's Office of Water conducted the risk assessment for pathway 11. The risk assessments for pathways 12, 13, and 14 were conducted for the EPA by the consulting firm ABT Associates (ABT Associates 1993).

Charles Henry of the University of Washington conducted thc risk assessments for pathways 1 through 10 for nonagricultural land (except for pathway 2 for home gardening). Pathways 12, 13, and 14 are identical for agricultural and nonagricultural land, so ABT Associates' assessment of agricultural pathways 12, 13, and 14 was also used for the nonagricultural pathways (U.S. Environmental Protection Agency 1992).

In undertaking the assessments, the EPA relied on numerous assumptions and decisions regarding the data to be used and what the exposure evaluations were to be based on. It was decided to use the concept of the highly exposed individual (HEI) as a target organism to be protected by the limits on individual pollutants. Depending on the pathway of exposure, the HEI could be a human, plant, animal, or environmental end point, such as surface water or groundwater, and is assumed to remain for an extended period at or adjacent to the site where the maximum exposure occurs.

Table E-20. Environmental Pathways of Concern
Identified for Application of Sewage Sludge to Agricultural Land

Pathway	Description of Highly Exposed Individual
1. Sewage Sludge-Soil-Plant-Human	Human ingesting plants grown in sewage sludge-amended soil
2. Sewage Sludge-Soil-Plant-Human	Residential home gardener
3. Sewage Sludge-Human	Children ingesting sewage sludges
4. Sewage Sludge-Soil-Plant-Animal-Human	Farm households producing a major portion of the animal products they consume; it is assumed that the animals eat plants grown in soil amended with sewage sludge
5. Sewage Sludge-Soil-Animal-Human	Farm households consuming livestock that ingest sewage sludge while grazing
6. Sewage Sludge-Soil-Plant-Animal	Livestock ingesting crops grown on sewage sludge-amended soil

Pathway	Description of Highly Exposed Individual
7. Sewage Sludge-Soil-Animal	Grazing livestock ingesting sewage sludge
8. Sewage Sludge-Soil-Plant	Plants grown in sewage sludge-amended soil
9. Sewage Sludge-Soil-Soil Organism	Soil organisms living in sewage sludge-amended soil
10. Sewage Sludge-Soil-Soil Organism-Soil Organism Predator	Animals eating soil organisms living in sewage sludge-amended soil
11. Sewage Sludge-Soil-Airborne Dust-Human	Tractor operator exposed to dust while plowing large areas of sewage sludge-amended soil
12. Sewage Sludge-Soil-Surface Water-Human	Person who consumes 0.04 kg/day of fish and 2 liters/day of water.
13. Sewage Sludge-Soil-Air-Human	Human breathing volatile pollutants from sewage sludge
14. Sewage Sludge-Soil-Groundwater-Human	Human drinking water from wells contaminated with pollutants leaching from sewage sludge-amended soil to groundwater

The risk-based models developed for the Part 503 regulations were designed to limit potential exposure of an HEI. Originally, in the 1989 proposed Part 503 rule, the concept for "worst-case" exposure was based on the "most exposed individual" (MEI), but the EPA changed this to be consistent with a statement in the rule's legislative history that calls for protecting individuals and populations that are "highly exposed to reasonably anticipated adverse conditions". In developing Subpart B of the rule, the EPA used different HEIs in evaluating each pathway of potential exposure.

The details for each of the HEIs selected and the assumptions used in the various risk scenario calculations are all contained in the technical support documents, which are voluminous (U. S. Environmental Protection Agency 1992). Examples are given here to provide an illustration of the HEIs for both the agricultural and nonagricultural settings for pathway 1, which was designed to protect consumers who eat food grown in sewage sludge-amended soil. For agricultural land application, the HEI was assumed to live in a region where a relatively high percentage of the available cropland receives sludge applications. To approximate realistic conditions, it was assumed that the HEI eats a mix of crops from land on which sludge was applied and crops from land on which sludge was not applied rather than eating foods that were all grown on sludge-amended soils.

For nonagricultural settings for pathway 1, the HEI was a person who regularly harvests edible wild plants (i.e., berries and mushrooms) from forests or rangelands that have been amended with sewage sludge. This food was assumed to be preserved by drying, freezing, or canning and, hence, to be available for consumption throughout the year. It was also assumed that an individual could continue with this practice for a lifetime (70 years).

Pathway 2 evaluated the effects on home gardeners of consuming crops grown in residential home gardens amended with sewage sludge. The major difference between pathways 1 and 2 was the fraction of food assumed to be grown on sewage sludge-amended soil. The HEI for pathway 2 was the home gardener who produced and consumed potatoes, leafy vegetables, fresh legumes, root vegetables, garden fruits (e.g., tomatoes, eggplants), sweet corn, and grains.

The HEI for pathway 3 was a young person (less than 6 year of age) ingesting sewage sludge from storage piles or from the soil surface.

For pathway 4, the HEI was an individual consuming foraging animals that consumed feed crops or vegetation grown on sewage sludge-amended soils. The HEI was assumed to consume daily quantities of the various animal tissue foods and to be exposed to background levels of pollutants from sources other than sludge. For the agricultural setting, the affected animal foods evaluated were beef, beef liver, lamb, pork, poultry, dairy, and eggs. In the nonagricultural setting, the HEI was assumed to be a hunter who preserved meat (including liver) for consumption throughout the year. The animals were assumed to have been hunted in the forest and eaten were deer and elk (because of their size and greater possibility of impact on intake through consumption compared with other animals).

Pathway 5 involved the application of sewage sludge to the land; the direct ingestion of this sewage sludge by animals; and, finally, the consumption of contaminated animal tissue by humans. The HEI was assumed to consume various animal tissue foods and be exposed to a background intake of pollutants.

Pathway 6 evaluated animals that ingest plants grown on sewage sludge-amended soil. The HEI used for both the agricultural and nonagricultural settings is a highly sensitive herbivore that consumed plants grown on sewage sludge-amended soil. Background intake was taken into account by considering background concentration of pollutants in forage crops. In a forest application site, the HEI was two grazing domestic animals and small herbivorous mammals (deer mice) that lived their entire lives in a sewage sludge-amended area feeding on seeds and small plants close to the layer of soil amended with sewage sludge. In the agricultural setting, the HEI was a sheep.

The HEI for pathway 7 was an herbivorous animal incidentally consuming sewage sludge adhering to forage crops and/or sewage sludge on the soil surface. Background intake was considered to be from ingesting soil having background levels of pollutant. Because forest animals more typically browse rather than graze, the HEI for agricultural settings was used as a reasonable worst-case surrogate for the nonagricultural HEI.

Pathway 8 was the plant phytotoxicity pathway and assumed as the HEI a plant sensitive to the pollutants in sewage sludge. Sensitivity was determined through a literature search including information on nonagronomic species, which were shown to be no more sensitive than agronomic species. Because sensitivity was found to be the same for agronomic and nonagronomic species, the limits set for agricultural species also protect wild species found in nonagricultural settings.

The HEI for pathway 9 is a soil organism sensitive to the pollutants in sewage sludge, an earthworm. Because all soil organisms are wild species, the same HEI was used for the nonagricultural and agricultural settings.

Pathway 10 assumed that the HEI was a shrew mole that consumed soil organisms that have been feeding on sewage sludge-amended soil. Pathway 9 had the same HEI for both the nonagricultural and agricultural pathways.

The HEI for pathway 11, which was designed to protect humans from the effects of airborne dusts containing sewage sludge, was a tractor driver tilling a field. This pathway evaluated the impact of particles that have been resuspended by the driver's tilling of dewatered sewage sludge into the soil. This pathway applies only to the agricultural setting because plowing is not normally performed in nonagricultural settings such as forests.

Pathway 12, the soil erosion pathway, used as an HEI a human who consumed 2 liters per day of drinking water from surface water contaminated by soil eroded from a site where sewage sludge was land applied. This individual was assumed to ingest 0.04 kilograms per day of fish from surface waters contaminated by sewage sludge pollutants. The HEI was the same for agricultural and nonagricultural practices.

Pathway 13 had as an HEI a human who inhaled the vapors of any volatile pollutants that may be in the sewage sludge when it is applied to the land. The HEI was assumed to live on the downwind side of the site with no change in wind direction ever occurring (constant exposure). The same plume air contaminant dispersion model was used for both the agricultural and nonagricultural settings.

The HEI for pathway 14 for agricultural and nonagricultural settings was an individual who obtained drinking water from ground water located directly below a field to which sewage sludge has been applied. Consumption was assumed to be 2 liters per day for a lifetime.

All the exposure scenarios involving ingestions included what is referred to as an oral reference dose (RfD). The RfD of a pollutant is a threshold below which effects adverse to human health are unlikely to occur. The EPA has a computerized listing of these human health criteria in its Integrated Risk Information System (IRIS), which it uses for many different purposes in developing health protection standards based on the latest scientific information.

Another key assumption that can change the risk assumption calculations is the recommended dietary allowances (RDAs). These are defined as the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons. Although RfDs were generally used to determine the concentrations of inorganic pollutants that are protective of human health, the RDA was used in the case of zinc and copper.

Part 3. Endocrine Disruptors

Introduction

A wide range of chemicals, including some in common, often unregulated, undisclosed use are now associated with effects on the health, reproduction, and behavior of animals. At present, many of the effects are nonspecific in terms of the link to a particular environmental chemical, but the trends in research on hormone-affecting diseases indicate that it is probable that endocrine disruptors are contributing to human diseases and dysfunction.

The EPA has been directed by Congress to look into the issue of endocrine disruptors, focusing first on transmission in drinking water. An interagency task force of national experts has been assembled and a research plan has been developed.

Compounds termed "endocrine disruptors" can include both natural compounds and synthetic chemicals. Some, called phytoestrogens, occur naturally in a variety of plants; animals have evolved mechanisms to metabolize these, and they therefore do not accumulate and have adverse effects. A number of compounds that act as synthetic estrogens are now produced either through industrial manufacture (pesticides) or as byproducts of such processes or burning (such as dioxins). Testing for estrogenic activity is conducted in the lab using cultures of breast cancer cells. It has been found that some chemicals can cause effects at levels of parts per trillion—levels at which most chemicals have never been tested.

Table E-21 lists a variety of suspected hormone disruptors, which are discussed below.

Table E-21. List of Known and Suspected Hormone Disruptors:
Pollutants with Widespread Distribution Reported to Have Reproductive and Endocrine-Disrupting Effects

---

Persistent Organohalogens
Dioxins and furans
PCBs
PBBsOctachlorostyrene
Hexachlorobenzene
Pentachlorophenol

Pesticides
2,4,5-T
2,4-D
alachlor
aldicarb
amitrole
atrazine
benomyl
beta-HCH
carbaryl
chlordane
cypermethrin
DBCP
DDT
DDT metabolites
dicofol
dieldrin
endosulfan
esfenvalerate
ethylparathion
fenvalerate
lindane
heptachlor
h-epoxide
kelthane
kepone
malathion
mancozeb
maneb
methomyl
methoxychlor
metiram
metribuzin
mirex
nitrofen
oxychlordane
permethrin
synthetic pyrethroids
toxaphene
transnonachlor
tributyltin oxide
trifluralin
vinclozolin
zineb
ziram

Phenolic Compounds
Penta- to Nonyl-Phenols
Bisphenol A

Phthalates
Di-ethylhexyl phthalate (DEHP)
Butyl benzyl phthalate (BBP)
Di-n-butyl phthalate (DBP)
Di-n-pentyl phthalate (DPP)Di-hexyl phthalate (DHP)
Di-propyl phthalate (DprP)
Dicyclohexyl phthalate (DCHP)
Diethyl phthalate (DEP)

<u>Other Organics</u>
Styrene dimers and trimers
Benzo(a)pyrene

<u>Heavy Metals</u>
Cadmium
Lead
Mercury

____

Source: Natural Resources Defense Council Endocrine Disruptors Web Page (www.nroc.org/nrdc/nrdc.proreports.html).

Pesticides

Many pesticides have been found to be estrogenic. These include the herbicides 2,4-D and 2,4,-T and the boat-fouling paint additive tributyl tin, and the traditional pesticides used widely in the past, such as carbaryl, chlordane, DDT, lindane, malathion, parathion, aldicarb, DBCP, and synthetic pyrethroids. Exposure can occur during application, through consumption of contaminated produce and other foods, through contaminated drinking water, or even from house dust in agricultural areas. Production of DDT for use in the United States was banned in 1972. However, other countries, especially tropical countries such as Mexico, still use it for mosquito control to combat malaria. DDT and its metabolites bioaccumulate in wildlife, and humans can be exposed through the food chain.

Soaps, Shampoos, and Hair Colors

Many industrial and consumer products contain alkylphenol ethoxylates (APEs), which break down into alkylphenols such as nonylphenol, which has been found in sewage and rivers near outfalls. One of the main uses of these compounds is in liquid detergents. In Europe, these products have been replaced by the more expensive but much safer alcohol ethoxylates. Denmark based its phaseout of alkyphenol exthoxylate on research conducted in the United Kingdom, which found that its breakdown products, alkylphenols, caused male fish to take on female characteristics. Alkylphenols do not biodegrade easily and bioaccumulate and therefore may cause problems when sewage sludge is applied to land.

Plastics and Plasticizers

Plastics contain additives, such as phthalates, bisphenol-A, and nonylphenols, usually present as plasticizers to increase flexibility and durability. They can leach out into liquids and foods. Heating speeds up this leaching process, which is why microwaving of foods in plastic is discouraged. Estrogenic butyl benzyl phthalate is found in vinyl floor tiles, adhesives, and synthetic leathers. The related compound di-butyl phthalate is present in some food-contact papers. Bisphenol-A is a breakdown product of polycarbonate plastics, which are used in water bottles, baby bottles, and the linings of some food cans.

Polychlorinated Biphenyls (PCBs)

PCBs are a family of toxic industrial chemicals commercialized in 1929 by Monsanto. Although their production in the United States stopped in 1977, world production continued. PCBs are still present in the United States in electrical equipment and are frequently found at toxic waste sites and in contaminated sediments. A recent study confirmed that children exposed to low levels of PCBs in the womb because of their mother's fish consumption grow up with low IQs, poor reading comprehension, difficulty paying attention, and memory problems.

Dioxins

Chlorinated dioxins and dibenzofurans are byproducts of the chlorine bleaching of paper; the burning of chlorinated hydrocarbons such as pentachlorophenol, PCBs, and polyvinyl chloride; the incineration of municipal and medical wastes; and natural events, such as forest fires and volcanic eruptions. They often contaminate toxic wastes sites, especially where there have been fires. They bioaccumulate in fish and other wildlife, and the most common human route of exposure is through the food chain.

Spermicides

Many spermicides contain nonoxynol-9, a nonylphenol that kills sperm. This compound can be carried into the sewer system and hence into biosolids, although the concentrations are probably not measurable.

Preservatives

BHA, butylated hydroxyanisole, is added to foods such as breakfast cereal, or its packaging, to prevent the foods from becoming rancid.

Metals

Lead, methyl mercury, and cadmium can disrupt the endocrine system by causing problems in steroid production.

In addition, a number of other pollutants with widespread distribution in the environment are reported to bind to hormone receptors and therefore are suspected to have reproductive and endocrine-disrupting effects. These pollutants include the following:

- 2,4-dichlorophenol
- diethylhexyl adipate
- benzophenone
- N-butyl benzene
- 4-nitrotoluene

The compounds listed above are only suspected of being endocrine disruptors. All of these compounds have had wide uses in the past and are present in the environment, although only a few are likely to be found. Their presence in biosolids, soils, water, food, or animals is variable and depends on the historical use of the chemicals and the means of environmental distribution. At present, there is no evidence that their presence in biosolids would increase health risks.

Citations

Printed References

ABT Associates, Inc. 1993. Human health risk assessment for the use and disposal of sewage sludge: benefits of regulation. Government Reports Announcements & Index (GRA&I) 24. Cambridge, MA.

Ansari, S. A., S. R. Farrah, and G. R. Chaudhry. 1992. Presence of human immunodeficiency virus nucleic acids in wastewater and their detection by polymerase chain reaction. Applied and Environmental Microbiology 58:3984-3990.

Argent, V. A., J. C. Bell, and D. Edgar. 1981. Animal disease hazards of sewage-sludge disposal to land: effects of sludge treatment on Salmonellae. Water Pollution Control 80:537-540.

Argent, V. A., J. C. Bell, and M. Emslie-Smith. 1977. Animal disease hazards of sludge disposal to land: occurrence of pathogenic organisms. Water Pollution Control 76:511-516.

Belongia, E. A., T. T. Osterholm, J. T. Soler, D. A. Arumend, J. E. Braun, M. D. MacDonald. 1993. Transmission of *Escherichia coli 0157:H7* infection in Minnesota child day-care facilities. JAMA 269(7):883-888.

Blostein, J. 1991. Shigellosis from swimming in a park pond in Michigan. Public Health Reports 106(3):317-322.

Boutin, P., M. Torre, and J. Molina. 1987. Bacterial and fungal atmospheric contamination at refuse composting plants: a preliminary study. In de Bertoldi, M., M.P. Ferranti, P. L'Hermite, F. Zucconi, Compost: production, quality and use. Elsevier Applied Science, for Commission of the European Communities. The Hague, Netherlands.

Cascio, A., M. Bosco, E. Vizzi, A. Giammanoco, D. Ferraro, S. and Arista. 1996. Identification of picobirnavirus from faeces of Italian children suffering from acute diarrhea. European Journal of Epidemiology 12(5):545-547.

Casson, L.W., C. A. Sorber, R. H. Palmer, A. Enrico, and P. Gupta. 1992. HIV survivability in wastewater. Water Environmental Research 64:213-215.

Centers for Disease Control. 1993. Multistate outbreak of Escherichia coli 0157:H7 infections from hamburgers—western United States, 1992-1993. MMWR 42(14):259-262.

__________. 1999. Internet home page containing Emerging Diseases Information and Morbidity and Mortality Weekly Reports. U.S. Department of Health and Human Services, Centers for Disease Control. Www.cdc.gov/cdctext.htm. February 8-12, 1999.

Chandra, R. 1997. Picobirnavirus, a novel group of undescribed viruses of mammals and birds: a minireview. Acta Virol. 41(1):59-62.

Cieslak, P. R., K. F. Gensheimer, et al. 1992. *Escherichia coli 0157:H7* infection from a manured garden. The Lancet 342:367.

Clark, C. S., R. Rylander, and L. Larson. 1983. Levels of gram-negative bacteria, *Aspergillus fumigatus*, dust and endotoxin at compost plants. Applied and Environmental Microbiology 45:1501-1505.

Conklin, R. H. 1981. Rotavirus infections; CRC handbook series in zoonoses. CRC Press. Boca Raton, FL.

Cravaghan, P. D., et al. 1993. Inactivation of *Giardia* by anaerobic digestion of sludge. Water Science Technology 27:111.

De Leon, R., and C. P. Gerba. 1990. Detection of rotaviruses in water by gene probes. Wat. Sci. Tech. 24(2):281-284.

Dedman D., H. Laurichesse, E. O. Caul, P. G. Wall. 1998. Surveillance of small round structured virus (SRSV) infection in England and Wales, 1990-5. Epidemiolinfect 121(1):139-149.

Diaz, L. F., G. M. Savage, L. C. Eggerth, and C. B. Golueke. 1992. Composting and recycling municipal solid waste. Lewis Publishers. Boca Raton, FL.

Dowd, S. E., C. P. Gerba, and I. L. Pepper. 1998. Confirmation of the human-pathogenic microsporidia *Enterocytozoon bieneusi*, *Encephalitozoon intestinalis*, and *Vittaforma corneae* in water. Applied and Environmental Microbiology 64(9):3332-3335.

Droffner M. L., and W. F. Brinton. 1995. Survival of *E. coli* and *Salmonella* populations in aerobic thermophilic composts as measured with DNA gene probes. Zentralbl Hyg Umweltmed 197(5):387-397.

Duckmanton L., B. Luan, J. Devenish, R. Tellier, and M. Petric. 1997. Characterization of torovirus from human fecal specimens. Virology 239(1):158-168.

Dunaway, W. C., et al. 1983. 1982 Shigellosis outbreak in Omaha, Nebraska. Nebraska Medical Journal 68(6):165-168.

Enriques, C. E., C. J. Hurst, and C. P. Gerba. 1995. Survival of the enteric adenoviruses 40 and 41 in tap, sea and wastewater. Wat. Res. 29(11):2548-2553.

EOA, Inc. 1995. Microbial risk assessment for reclaimed water. Final report. May 10, 1995. Prepared for Irvine Ranch Water District. Prepared in Association with the University of California School of Public Health.

Epstein, E. 1993. Neighborhood and worker protection for composting facilities: issues and actions. In Hoitink, H. A. J., and H. M. Keener (eds.), Science and engineering of composting: design. Environmental, microbiological and utilization aspects. Renaissance Publications, for Ohio State University. Worthington, OH.

Epstein, E., and J. I. Epstein. 1985. Health risks of composting. Biocycle 26(4):38-40.

__________. 1989. Public health issues and composting. Pages 120-124 in Epstein, E., and J. I. Epstein (eds.), The biocycle guide to yard waste composting. J.G. Press. Emmaus, PA.

Evans, M. R. 1998. *Salmonella enteritidis* PT6: another egg-associated salmonellosis? Emerging Infectious Diseases 4(4):667-669. Centers for Disease Control.

Feachem, R. G., et al. 1980. Appropriate technology for water supply and sanitation. December. World Bank.

__________. 1983. Sanitation and disease: health aspects of excreta and wastewater management. John Wiley and Sons. New York, NY.

Floyd, J. 1996. Don't call it "mad cow disease" or bovine spongiform encephalopathy (BSE) just the facts. Extension Veterinarian, Auburn University [Alabama]. March 29, 1996.

Furtado C., G. K. Adak, J. M. Stuart, P. G. Wall, H. S. Evans, and D. P. Casemore. 1998. Outbreaks of waterborne infectious intestinal disease in England and Wales, 1992-5. Epidemiol. Infect. 121 (1):109-119

Gale, P. 1998. Quantitative BSE risk assessment: relating exposures to risk. Letters in Applied Microbiology 27:239-242.

Gallimore, C. I., H. Appleton, D. Lewis, J. Green, and D. W. Brown. 1995a. Detection and characterization of bisegmented double-stranded RNA viruses (picobirnaviruses) in human fecal specimens. J. Med. Virol. 45(2):135-140.

Gallimore, C. I., J. Green, D. P. Casemore, and D. W. Brown. 1995b. Detection of a picobirnavirus associated with *Cryptosporidium* positive stools from humans. Archives of Virology 140(7):1275-1278.

Hammerberg, B., G. A. MacInnis, and T. Hyler. 1978. *Taenia saginata cysticerci* in grazing steers in Virginia. J. Am. Vet. Med. Assoc. 173:1462-1464.

Hanninen, M. L., and A. Siitonen. 1995. Distribution of Aeromonas phenospecies and genospecies among strains isolated from water, foods or from human clinical samples. Epidemiol. lnfect. 115(1):39-50.

Hu, C. J., R. A. Gibbs, N. R. Mort, H. T. Hofstede, G. E. Ho, and I. Unkovich. 1996. *Giardia* and its implications for sludge disposal. Pages 179-186 in Water Science and Technology, 1996. Water Quality International, '96. Part 4. Edited by Ballay, D., et al. Proceedings of the 18th Biennial conference of the International Association on Water Quality, Singapore, June 23-28, 1996.

Hulten K., H. Enroth, T. Nystrom, and L. Engstrand. 1998. Presence of Helicobacter species DNA in Swedish water. J App1. Microbiol. 85(2):282-286.

Jamieson F. B., E. E. Wang, C. Bain, J. Good, L. Duckmanton, and M. Petric. 1998. Human torovirus: a new nosocomial gastrointestinal pathogen J. lnfect. Dis.178(5):1263-1269.

Joce, R. E., et al. 1991. An outbreak of cryptosporidiosis associated with a swimming pool. Epidemiol. Infect. 107(3):497-508.

Johnson, D. C., and C. P. Gerba. 1997. Microsporidia - the next cryptosporidium? Water Conditioning and Purification. September:116-119.

Jones I. G., and M. Roworth. 1996. An outbreak of *Escherichia coli 0157* and campylobacteriosis associated with contamination of a drinking water supply. Public Health 110(5):277-82.

Jones, P. W., L. M. Rennison, V. H. Lewin, and D. L. Redhead. 1980. The occurrence and significance to animal health of salmonellas in sewage and sewage sludges. J. Hyg. 84:47-62.

Kinde, H., M. Adelson, A. Ardans, H. E. Little, D. Willoughy, D. Berchold, D. H. Read, R. Breitmeyer, D. Kerr, R. Tarbell, and E. Hughs. 1997. Prevalence of salmonella in municipal sewage treatment plant effluents in southern California. Avian Diseases 41(2):392-398.

Kinde, H., D. H. Read, R. P. Chin, A. A. Bickeford, R. L. Walker, A. Ardans, H. E. Little, D. Willoughy, D. Berchold, R. Breitmeyer, D. Kerr, and I. A. Gardner. 1996. *Salmonella enteritidis*, phase type 4 infection in a commercial laying flock in southern California: bacteriological and epidemiologic findings. Avian Diseases 40(4):665-671.

Koopmans, M. P, E. S. Goosen, A. A. Lima, I. T. McAuliffe, J. P. Nataro, L. J. Barrett, R. I. Glass, and R. L. Guerrant. 1997. Association of torovirus with acute and persistent diarrhea in children Pediatr. Infect. Dis. 16(5):504-507.

Koutkia, P., E. Mylonakis, and T. Flanigan. 1997. Enterohemorrhagic *Escherichia coli* O157:H7 - an emerging pathogen. Am. Fam. Physician 56(3):853-856, 859-861.

Ludert, J. E., L. Abdul-Latiff, A. Liprandi, and F. Liprandi. 1995. Identification of picobirnavirus, viruses with bisegmented double stranded RNA, in rabbit faeces. Res. Vet. Sci. 59(3):222-225.

Maritato, M. C., E. R. Algeo, and R. E. Keenan. 1992. The *Aspergillus fumigatus* debate: potential human health concerns. BioCycle 13:70-72.

McKenzie, W. R. et al. 1994. A massive outbreak in Milwaukee of *Cryptosporidium* infection transmitted through the public water supply. The New England Journal of Medicine331(3):161-167.

Meng, X. J., P. G. Halbur, J. S. Haynes, T. S. Tsareva, J. D. Bruna, R. L. Royer, R. Purcell, and S. U. Emerson. 1998. Experimental infection of pigs with the newly identified swine hepatitis E virus (swine HEV), but not with human strains of HEV. Arch. Virol. 143(7):1405-1415.

Millner, P. D., P. B. Marsh, R. B. Snowden, and J. F. Parr. 1977. Occurrence of *Aspergillus fumigatus* during composting of sewage sludge. Applied and Environmental Microbiology 34:765-772.

Millner, P. D., D. A. Bassatt, and P. B. Marsh. 1980. Dispersal of *Aspergillus fumigatus* from sewage sludge compost piles subjected to mechanical agitation in open air. Applied and Environmental Microbiology 39:1000-1009.

Mishu B., J. Koehler, L. A. Lee, D. Rodrigue, F. H. Brenner, P. Blake, et al. 1994. Outbreaks of *Salmonella enteritidis* infections in the United States, 1985-1991. Journal of Infect. Dis.169:547-52.

Moore, A. C., et al. 1993. Surveillance for waterborne disease outbreaks—United States, 1991-1992. Morbidity and Mortality Weekly Report 42:SS-5, 1-22.

Moore, B. E. 1993. Survival of human immunodeficiency virus (HIV), HIV-infected lymphocytes, and poliovirus in water. Applied and Environmental Microbiology 59:1437-1443.

Morris R. D, E. N. Naumova, J. K. Griffiths. 1998. Did Milwaukee experience waterborne cryptosporidiosis before the large documented outbreak in 1993. Epidemiology 9(3):264-70.

Nelson, H. 1997. The contamination of organic produce by human pathogens in animal manures . EAP Publications.

Olver,W. M. 1979. The life and times of *Aspergillus fumigatus*. Compost Science/Land Utilization 202:36-39.

Padhye, N. V., and P. Doyle. 1992. *Escherichia coli 0157:H7*: epidemiology, pathogenesis, and methods for detection in food. Journal of Food Protection 55(7):555-565.

Patel, S., S. Pedraza-Diaz, J. McLauchlin, and D. P. Casemore. 1998. Molecular characterization of Cryptosporidium parvum from two large suspected waterborne outbreaks. Outbreak Control Team South and West Devon 1995, Incident Management Team and Further Epidemiological and Microbiological Studies Subgroup North Thames. Commun. Dis. Public Health 1(4):231-233.

Pattison, J. 1998. The emergence of bovine spongiform encephalopathy and related diseases. Emerging Infectious Diseases 4(3):390-394.

Preston, D. R., S. R. Farrah, G. Bitton, and G. R. Chaudhry. 1991. Detection of nucleic acids homologous to human immunodeficiency virus in wastewater. Journal of Virological Methods 33:383-390.

Raper, K. B., and D. I. Fennel. 1965. The genus *Aspergillus*. Williams and Wilkins Co. Baltimore, MD.

Robertson, L. J., and H. V. Smith. 1992. *Cryptosporidium* and cryptosporidiosis; part 1: current perspective and present technologies. European Microbiology 1992:20-29.

Roivainen, M., M. Knip, H. Hyoty, P. Kulmala, M. Hiitunen, P. Vahasalo, T. Hovi, and H. K. Akerblom. 1998. Several different enterovirus serotypes can be associated with prediabetic autoimmune episodes and onset of overt IDDM. Childhood Diabetes in Finland (DiMe) Study Group. J. Med. Virol. 56 (1):74-78.

Rosenberg, A. S., and G. Y. Minimato. 1996. Aspergillosis in AIDS. The AIDS Reader 6(5):173-178.

Singh V., V. Singh, M. Raje, C. K. Nain, and K. Singh. 1998. Routes of transmission in the hepatitis E epidemic of Saharanpur. Trop. Gastroenterol.19(3):107-109.

Sinski, J. T. 1975. The epidemiology of aspergillosis. In Al-Doory, Y. (ed)., The Epidemio1ogy of Human Mycotic Diseases. Charles C. Thomas Co. Springfield, IL.

Sorvillo, F. J., et al. 1988. Shigellosis associated with recreational water contact in Los Angeles County. Am. J. Trop. Med. 38(3):613-7.

__________. 1992. Swimming-associated cryptosporidiosis. American Journal of Public Health 82(5):742-744.

St. Louis, M. E., D. L. Morse, M. E. Potter, T. M. De Melfi, J. J. Guzewich, R. V. Tauxe, et al. 1988. The emergence of grade A eggs as a major source of *Salmonella enteritidis* infections. JAMA 259:2103-2107.

Straub, T. M., I. L. Pepper, and C. P. Gerba. 1993. Hazards from pathogenic microorganisms in land-disposed sewage sludge. Reviews of Environmental Contamination and Toxicology 132:58-61.

Sugieda M., H. Nagaoka, Y. Kakishima, T. Ohshita, S. Nakamura, and S. Nakajima. 1998. Detection of Norwalk-like virus genes in the caecum contents of pigs. Arch. Virol. 143(6):1215-1221.

Tzipori, S. 1988. Cryptosporidiosis in perspective. Adv. Parasitol. 27:63-129.

U.S. Environmental Protection Agency. 1985. Pathogen risk assessment feasibility study. Office of Research and Development, Cincinnati, OH, and Office of Water Regulations and Standards, Washington, DC.

__________. 1992. Technical support document for reduction of pathogens and vector attraction in sewage sludge. Office of Water. (WH-586.) EPA 822/R-93-004. November.

Wadstrom, T., and A. Ljungh. 1991. *Aeromonas* and *Plesiomonas* as food- and waterborne pathogens. Int. Food Microbiol. 12(4):303-11.

Wells, J. G., L. D. Shipman, K. D. Greene, E. G. Sowers, J. H. Green, D. N. Cameron, F. P. Downes, M. L. Martin, P. M. Griffin, S. M. Ostroff, M. E. Potter, R. V. Tauxe, and I. K. Wachsmuth. 1991. Isolation of *Escherichia coli* serotype 0157:H7 and other shiga-like-toxin-producing *E. coli* from dairy cattle. Journal of Clinical Microbiology 29(5):985-989.

Whitmore, T. N., and L. J. Robertson. 1995. The effect of sewage sludge treatment processes on oocysts of *Cryptosporidium paryum.* Journal of Applied Bacteriology 78(1):34-38.

Personal Communications

Cook, Raymond. Registered environmental health specialist. Kings County Health Department, Hanford, CA. February 1, 1999 - telephone conversation.

Gerba, Charles, Ph.D. Professor. University of Arizona, Phoenix, AZ. February 16, 1999 - telephone communication.

Shaw, Guy. Environmental health specialist. Kern County Health Department, Bakersfield, CA. February 3, 1999 - telephone conversation and facsimile transmission.

Starr, Dr. Mark. California Department of Health Services Disease Investigations & Surveillance Branch, Surveillance & Statistics Section. February 2, 1999 - telephone conversation and electronic data transmittal.

Appendix F. Information on Special-Status Species

Table F-1. California Special-Status Plant Species

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
San Mateo thorn-mint *Acanthomintha duttonii*	E/E/1B	Central Coast, San Francisco Bay area: endemic to San Mateo County	Chaparral, valley and foothill grassland/serpentinite	Apr-Jun
San Diego thorn-mint *Acanthomintha ilicifolia*	T/E/1B	San Diego; Baja California	Chaparral, coastal scrub, valley and foothill grassland, vernal pools/clay	Apr-Jun
Munz's onion *Allium munzii*	E/T/1B	Riverside County	Chaparral, cismontane woodland, coastal scrub, pinyon and juniper woodland, valley and foothill grassland, mesic, clay	Mar-May
Rawhide Hill onion *Allium tuolumnense*	PT/--/1B	Central Sierra Nevada foothills: Rawhide Hill, Redhills, Tuolumne County	Cismontane woodland on serpentine soils	May
Sonoma alopecurus *Alopecurus aequalis* var. *sonomensis*	E/--/1B	Central coast, including portions of Marin and Sonoma Counties	Marshes and swamps (freshwater), riparian scrub	May-Jul
Large-flowered fiddleneck *Amsinckia grandiflora*	E/E/1B	San Joaquin Valley: Alameda, Contra Costa, and San Joaquin Counties; currently known from only two natural occurrences	Annual grassland, cismontane woodland, on open grassy slopes below 1,200 feet	Apr-May
Hoffmann's rock cress *Arabis hoffmannii*	E/--/1B	Anacapa Island*, Santa Cruz Island, Santa Rosa Island	Coastal bluff scrub, chaparral, coastal scrub / rocky, volcanic cliff ledges	Feb-Apr
Johnston's rock cress *Arabis johnstonii*	PT/--/1B	San Jacinto Mountains, Riverside County	Chaparral, Lower montane coniferous forest, often on eroded clay	Feb-Jun
McDonald's rock cress *Arabis macdonaldiana*	E/E/1B	Outer north Coast Range, including portions of Del Norte, Mendocino, Siskiyou, and Trinity Counties; Oregon	Lower montane coniferous forest, upper montane coniferous forest, serpentine	May-Jun

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Santa Rosa Island manzanita *Arctostaphylos confertiflora*	E/--/1B	Santa Rosa Island	Broadleafed upland forest, closed-cone coniferous forest, chaparral, sandstone	Feb-Apr
Vine Hill manzanita *Arctostaphylos densiflora*	SC/E/1B	South northern outer Coast Ranges: Vine Hill, Forestville, Sonoma County	Chaparral (acid marine sand)	Feb-Mar
Del Mar manzanita *Arctostaphylos glandulosa* ssp. *crassifolia*	E/--/1B	Southern south coast, San Diego County; Baja California	Chaparral (maritime, sandy mesas and bluffs)	Dec-Apr
Hearst's manzanita *Arctostaphylos hookeri* ssp. *hearstiorum*	SC/E/1B	Central coast: Arroyo de la Cruz, San Luis Obispo County	Chaparral (maritime), coastal prairie, coastal scrub, valley and foothill grassland, sandy	Feb-Apr
Presidio manzanita *Arctostaphylos hookeri* ssp. *ravenii*	E/E/1B	Northern central coast: San Francisco Presidio, San Francisco County	Chaparral, coastal prairie, coastal scrub, serpentine soils	Feb-Mar
San Bruno Mountain manzanita *Arctostaphylos imbricata*	SC/E/1B	Western San Francisco Bay: San Bruno Mountain, San Mateo County	Chaparral	Feb-May
Morro Bay manzanita *Arctostaphylos morroensis*	T/--/1B	Southern central coast: Morro Bay, San Luis Obispo County	Chaparral, cismontane woodland, coastal dunes (pre-flandrian), coastal scrub, sandy loam soils	Jan-Mar
Ione manzanita *Arctostaphylos myrtifolia*	PT/--/1B	Central Sierra Nevada foothills: Amador and Calaveras Counties	Chaparral, cismontane woodland, acidic Ione clay or sandy soils	Nov-Feb
Pallid manzanita *Arctostaphylos pallida*	T/E/1B	Eastern San Francisco Bay area:- Sobrante and Huckleberry ridges, Berkeley-Oakland Hills, Alameda and Contra Costa Counties	Chaparral, on dry stony ridges; cismontaine woodland; broadleaf forest; 660-1155 feet elevation; in shale	January-March
Marsh sandwort *Arenaria paludicola*	E/E/1B	Only known occurrence near Black Lake on Nipomo Mesa, San Luis Obispo County; historically more wide ranging	Marshes and swamps (freshwater)	May-Aug

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Big Bear Valley sandwort *Arenaria ursina*	PT/--/1B	Eastern San Bernardino Mountains: Bear Valley, San Bernardino County	Pebble plain (pavement); Pinyon and juniper woodland; mesic, rocky soils	May-Aug
Humboldt milk-vetch *Astragalus agnicidus*	SC/E/1B	Outer north Coast Ranges: Humboldt County	Broadleafed upland forest (disturbed openings)	Jun-Aug
Cushenbury milk-vetch *Astragalus albens*	E/--/1B	Northeast San Bernardino Mountains, Mojave Desert: Cushenbury Canyon, San Bernardino County	Joshua tree woodland, Mohavean Desert scrub, pinyon and juniper woodland, carbonate or granitic	Mar-May
Braunton's milk-vetch *Astragalus brauntonii*	E/--/1B	Simi Hills in eastern Ventura and western Los Angeles Counties: San Ynez Canyon, Los Angeles County; Coal and Gypsum Canyons, Orange County	Chaparral (on limestone outcrops), closed-cone coniferous forest, chaparral, coastal scrub, valley and foothill grassland, recent burns or disturbed areas	March-July
Clara Hunt's milk-vetch *Astragalus clarianus*	E/T/1B	Southern north Coast Ranges, including portions of Napa and Sonoma Counties	Chaparral (openings); cismontane woodland; valley and foothill grassland; serpentinite, volcanic, rocky, clay	Mar-Apr
Lane Mountain milk-vetch *Astragalus jaegerianus*	E/--/1B	Mojave Desert (near Barstow), San Bernardino County	Joshua tree woodland; Mohavean Desert scrub; granitic, sandy, or gravelly	Apr-Jun
Coachella Valley milk-vetch *Astragalus lentiginosus* var. *coachellae*	E/--/1B	Sonaran Desert: Coachella Valley, Riverside County	Sonoran Desert scrub (sandy)	Feb-May
Fish Slough milk-vetch *Astragalus lentiginosus* var. *piscinensis*	T/--/1B	East of Sierra Nevada, Inyo and Mono Counties	Playas (alkaline)	Jun-Jul

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Sodaville milk-vetch *Astragalus lentiginosus* var. *sesquimetralis*	--/E/1B	Northern Mojave Desert, northern Death Valley, eastern slope of Last Chance Mountains, Inyo County; Nevada	Meadows (alkaline)	Jun-Jul
Peirson's milk-vetch *Astragalus magdalenae* var. *peirsonii*	T/E/1B	Sonoran Desert, Imperial and San Diego*(?) Counties; Arizona; Baja California; Sonora, Mexico	Desert dunes	Dec-Apr
Coastal dunes milk-vetch *Astragalus tener* var. *titi*	PE/E/1B	Central coast/southern coast, including portions of Los Angeles*, Monterey, and San Diego*(?) Counties	Coastal bluff scrub (sandy), coastal dunes, coastal prairie on mesic/sandy depressions near the coast	Mar-May
Triple-ribbed milk-vetch *Astragalus tricarinatus*	E/--/1B	Riverside and San Bernardino Counties	Joshua tree woodland, Sonoran Desert scrub, sandy or gravelly	Feb-May
San Jacinto Valley crownscale *Atriplex coronata* var. *notatior*	E/--/1B	Eastern south coast: San Jacinto Valley, Riverside County	Playas, valley and foothill grassland (mesic), vernal pools, alkaline	Apr-Aug
Bakersfield smallscale *Atriplex tularensis*	SC/E/1B	Southern San Joaquin Valley: Kern Lake bed, Kern County (possibly extinct)	Valley sink scrub	Jun-Oct
Encinitas baccharis *Baccharis vanessae*	T/E/1B	Southern south coast, northwestern Peninsular Ranges: San Diego County	Chaparral (maritime, sandstone)	Aug-Nov
Nevin's barberry *Berberis nevinii*	E/E/1B	Los Angeles, San Bernardino, Riverside, and San Diego Counties	Chaparral, coastal sage scrub, on dry slopes and in sandy washes, at 900 to 1,600 feet	March-April
Island barberry *Berberis pinnata* ssp. *insularis*	E/E/1B	Anacapa Island, Santa Cruz Island, Santa Rosa Island*	Closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub, rocky	Mar
Sonoma sunshine *Blennosperma bakeri*	E/E/1B	North Coast Ranges, northeastern San Francisco Bay: southern Sonoma County	Valley and foothill grassland (mesic), vernal pools	Mar-Apr

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Indian Valley brodiaea *Brodiaea coronaria* ssp. *rosea*	SC/E/1B	Inner north Coast Ranges: Colusa, Glenn, Lake, and Tehama Counties	Chaparral; closed-cone coniferous forest; cismontane woodland; valley and foothill grassland; in meadows, streambanks, and other vernally moist areas; serpentinite	May-June
Thread-leaved brodiaea *Brodiaea filifolia*	PT/E/1B	Southern south coast, western Peninsular Ranges: Los Angeles*, western Riverside, San Bernardino*, San Diego Counties	Coastal scrub, cismontaine woodlands, annual grasslands and margins of vernal pools, on gentle hillsides, valleys and floodplains, in clay-loam or alkaline silty-clay soils	Mar-Jun
Kaweah brodiaea *Brodiaea insignis*	SC/E/1B	Southern Sierra Nevada foothills: Kaweah and Tule River drainages, Tulare County	Cismontane woodland, valley and foothill grassland, granitic or clay	Apr-Jun
Chinese Camp brodiaea *Brodiaea pallida*	PE/E/1B	Central Sierra Nevada foothills, near Chinese Camp, Tuolumne County	Valley and foothill grassland, vernal swale, on serpentine clay	May-Jun
Tiburon mariposa lily *Calochortus tiburonensis*	T/T/1B	Northwestern San Francisco Bay: Ring Mountain, Marin County	Valley and foothill grassland (serpentinite)	Mar-Jun
Mariposa pussypaws *Calyptridium pulchellum*	PE/--/1B	Central Sierra Nevada: Fresno, Madera, and Mariposa Counties	Cismontane woodland (sandy)	Apr-May
Stebbin's morning-glory *Calystegia stebbinsii*	E/E/1B	Northern Sierra Nevada foothills: Placer and El Dorado Counties	Serpentine or gabbro chaparral opening, woodland	May-June
San Benito evening-primrose *Camissonia benitensis*	T/--/1B	Inner south Coast Ranges: lower Clear Creek drainage, Fresno and San Benito Counties	Chaparral, cismontane woodland, serpentinite alluvium, clay or gravelly	May-Jun
White sedge *Carex albida*	E/E/1B	Southern outer north Coast Ranges: Sonoma County	Bogs and fens, marshes and swamps (freshwater)	May-Jul

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Tree-anemone *Carpenteria californica*	PT/T/1B	Central and southern Sierra Nevada foothills: Kings and San Joaquin Rivers, Fresno and Madera Counties	Chaparral, cismontane woodland, granitic	May-Jul
Tiburon Indian paintbrush *Castilleja affinis* ssp. *neglecta*	E/T/1B	Southern inner north Coast Ranges, northwestern San Francisco Bay: Marin, Napa and Santa Clara Counties	Serpentine grasslands	April-June
Succulent owl's-clover *Castilleja campestris* ssp. *succulenta*	T/E/1B	Southern Sierra Nevada foothills, eastern San Joaquin Valley: Fresno, Madera, Merced, Mariposa, San Joaquin, and Stanislaus Counties	Vernal pools (often acidic)	Apr-May
Ash-gray Indian paintbrush *Castilleja cinerea*	PT/--/1B	San Bernardino Mountains, San Bernardino County	Mohavean Desert scrub, meadows, pebble plain, pinyon and juniper woodland, upper montane coniferous forest (clay openings)	Jun-Jul
San Clemente Island Indian paintbrush *Castilleja grisea*	E/E/1B	San Clemente Island	Coastal bluff scrub, coastal scrub, rocky	Feb-Aug
Soft-leaved Indian paintbrush *Castilleja mollis*	E/--/1B	San Miguel Island(?)*, Santa Rosa Island	Coastal bluff scrub, coastal dunes	Apr-Aug
Pitkin Marsh Indian paintbrush *Castilleja uliginosa*	SC/E/1A	Sonoma* County	Marshes and swamps (freshwater)	Jun-Jul
California jewelflower *Caulanthus californicus*	E/E/1B	Southern San Joaquin Valley, Carrizo Plains: Fresno, Kings*, Kern, Santa Barbara, San Luis Obispo, Tulare*, and Ventura* Counties	Annual grassland, chenopod scrub, pinyon and juniper woodland, in sandy or loamy soils	Feb-May
Coyote ceanothus *Ceanothus ferrisae*	E/--/1B	Northeastern San Francisco Bay: Mount Hamilton Range, Santa Clara County	Chaparral, coastal scrub, annual grassland, on serpentine soils	Jan-Mar

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Vail Lake ceanothus *Ceanothus ophiochilus*	T/E/1B	Northern Peninsular Ranges, near Vale Lake, Riverside County	Chaparral (gabbroic or pyroxenite-rich outcrops)	Feb-Mar
Pine Hill ceanothus *Ceanothus roderickii*	E/R/1B	Northern Sierra Nevada foothills: Pine Hill, western El Dorado County	Northern mixed chaparral, cismontane woodland, on gabbro soils	May-June
Catalina Island mountain-mahogany *Cercocarpus traskiae*	E/E/1B	Santa Catalina Island	Chaparral; coastal scrub; rocky, sausserite gabbro	Mar-May
Hoover's spurge *Chamaesyce hooveri*	T/--/1B	Central Valley, including Butte, Glenn, Merced, Stanislaus, Tehama, and Tulare Counties	Below the high-water marks of large northern hardpan and volcanic vernal pools	Jul
Purple amole *Chlorogalum purpureum* var. *purpureum*	PT/--/1B	Northeastern outer south Coast Ranges, eastern Santa Lucia Mountains: Monterey County	Cismontane woodland, valley and foothill grassland	May-Jun
Camatta Canyon amole *Chlorogalum purpureum* var. *reductum*	PT/R/1B	Southeastern outer south Coast Ranges, north slope La Panza Range: San Luis Obispo County	Cismontane woodland (serpentinite)	Apr-May
Howell's spineflower *Chorizanthe howellii*	E/T/1B	Central north coast: Mendocino County	Coastal dunes, coastal prairie, coastal scrub, sandy	May-Jul
Orcutt's spineflower *Chorizanthe orcuttiana*	E/E/1B	Southern south coast: Del Mar to Point Loma, San Diego County	Chaparral (maritime), closed-cone coniferous forest, coastal scrub, sandy openings	Mar-Apr
Monterey spineflower *Chorizanthe pungens*	T/--/1B	Monterey and Santa Cruz Counties	Coastal dunes	April-June
Ben Lomond spineflower *Chorizanthe pungens* var. *hartwegiana*	E/--/1B	Northern and central central coast: San Francisco Bay, Santa Cruz County	Lower montane coniferous forest (maritime ponderosa pine sandhills)	Apr-Jul

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Monterey spineflower *Chorizanthe pungens* var. *pungens*	T/--/1B	Northern and central coast: San Francisco Bay; Monterey, Santa Cruz, and San Luis Obispo* Counties	Chaparral (maritime), cismontane woodland, coastal dunes, coastal scrub, valley and foothill grassland, sandy	Apr-Jun
Scott's Valley spineflower *Chorizanthe robusta* var. *hartwegii*	E/--/1B	Scotts Valley in Santa Cruz County	Annual grassland, on soils derived from sedimentary rocks	April-July
Robust spineflower *Chorizanthe robusta* var. *robusta*	E/--/1B	Northeast central coast, southwest San Francisco Bay: Alameda*, Monterey, San Mateo*, Santa Clara*, and Santa Cruz Counties	Coastal bluff scrub, coastal dunes openings in cismontane woodland	May-Sep
Sonoma spineflower *Chorizanthe valida*	E/E/1B	Northern central coast: Point Reyes, Marin and Sonoma* Counties	Coastal prairie (sandy)	Jun-Aug
Ashland thistle *Cirsium ciliolatum*	--/E/2	Klamath Ranges, Siskiyou County; Oregon	Cismontane woodland, valley and foothill grassland	Jun-Aug
Fountain thistle *Cirsium fontinale* var. *fontinale*	E/E/1B	Southwestern San Francisco Bay: San Mateo County	Chaparral (openings), valley and foothill grassland, serpentinite seeps	Jun-Oct
Chorro Creek bog thistle *Cirsium fontinale* var. *obispoense*	E/E/1B	Central outer south Coast Ranges: San Luis Obispo County	Chaparral, cismontane woodland, serpentinite seeps	Feb-Jul
Suisun thistle *Cirsium hydrophilum* var. *hydrophilum*	E/--/1B	Deltaic central valley: Suisun Marsh, Solano County	Salt marsh	Jul-Sep
La Graciosa thistle *Cirsium loncholepis*	PT/T/1B	Southern central coast: Santa Barbara and San Luis Obispo Counties	Coastal dunes, brackish marsh	Jun-Aug
Surf thistle *Cirsium rhothophilum*	SC/T/1B	Southern central coast: Santa Barbara and San Luis Obispo Counties	Coastal bluff scrub, coastal dunes	Apr-Jun

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Presidio clarkia *Clarkia franciscana*	E/E/1B	San Francisco Bay, Presidio, Oakland hills, Alameda and San Francisco Counties	Serpentine grassland, coastal scrub	May-July
Vine Hill clarkia *Clarkia imbricata*	E/E/1B	Outer north Coast Ranges: Sonoma County	Chaparral, valley and foothill grassland, acidic sandy loam	Jun-Jul
Merced clarkia *Clarkia lingulata*	SC/E/1B	Central Sierra Nevada foothills: Merced River Canyon, Mariposa County	Closed-cone coniferous forest, chaparral, cismontane woodland	May-Jun
Pismo clarkia *Clarkia speciosa* ssp. *immaculata*	E/R/1B	Southern central coast: San Luis Obispo County	Chaparral (margins, openings), cismontane woodland, valley and foothill grassland, sandy	May-Jun
Springville clarkia *Clarkia springvillensis*	PT/E/1B	Southern Sierra Nevada foothills: Springville, Tulare County	Chaparral, cismontane woodland, valley and foothill grassland, granitic	May-Jul
Saltmarsh bird's-beak *Cordylanthus maritimus* ssp. *maritimus*	E/E/1B	South coast: Los Angeles, Orange, Santa Barbara, San Diego, San Luis Obispo, and Ventura Counties; Baja California	Coastal dunes, marshes and swamps (coastal salt)	May-Oct
Soft bird's-beak *Cordylanthus mollis* ssp. *mollis*	E/R/1B	San Francisco Bay, Suisun Marsh, Contra Costa, Marin*, Napa, Sacramento*, Solano, and Sonoma* Counties	Salt marsh	Jul-Sep
Palmate-bracted bird's-beak *Cordylanthus palmatus*	E/E/1B	Livermore Valley, Central Valley, including portions of Alameda, Colusa, Fresno, Madera*, San Joaquin*, and Yolo Counties	Alkali meadow, alkali scrub, chenopod scrub, alkaline flats	May-Oct
Seaside bird's-beak *Cordylanthus rigidus* ssp. *littoralis*	SC/E/1B	Central and southern central coast: Monterey and Santa Barbara Counties	Coastal sage scrub	May-Sep
Pennell's bird's-beak *Cordylanthus tenuis* ssp. *capillaris*	E/R/1B	Southwestern outer north Coast Ranges: Sonoma County	Closed-cone coniferous forest, chaparral, serpentinite	Jun-Jul

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Santa Cruz cypress *Cupressus abramsiana*	E/E/1B	Santa Cruz and San Mateo Counties	Closed-cone coniferous forest, lower montane coniferous forest, sandstone or granitic	
Gowen cypress *Cupressus goveniana* ssp. *goveniana*	T/--/1B	Monterey County	Closed-cone coniferous forest, chaparral (maritime)	
Baker's larkspur *Delphinium bakeri*	PE/R/1B	Marin and Sonoma Counties*	Coastal scrub	Mar-May
Yellow larkspur *Delphinium luteum*	PE/R/1B	Sonoma County	Chaparral, coastal prairie, coastal scrub	Mar-May
San Clemente Island larkspur *Delphinium variegatum* ssp. *kinkiense*	E/E/1B	San Clemente Island	Valley and foothill grassland (coastal)	Mar-Apr
Geysers's dichanthelium *Dichanthelium lanuginosum* var. *thermale*	SC/E/1B	Sonoma County	Closed-cone coniferous forest, riparian forest, valley and foothill grassland, hydrothermally-altered soil	Jun-Aug
Beach spectaclepod *Dithyrea maritima*	SC/T/1B	Los Angeles*, Santa Barbara, and San Luis Obispo Counties; Santa Catalina Islsand*, San Miguel Island*, San Nicolas Island; Baja California	Coastal dunes, coastal scrub (sandy)	Mar-May
Slender-horned spineflower *Dodecahema leptoceras*	E/E/1B	Los Angeles, Riverside, and western San Bernardino Counties	Coastal sage scrub, on flood deposited terraces and washes, below 2,200 feet	April-June
Slender-horned spineflower *Dodecahema leptoceras*	E/E/1B	Los Angeles, Riverside, and San Bernardino Counties	Chaparral, coastal scrub (alluvial fan), sandy	Apr-Jun
Cuyamaca Lake downingia *Downingia conco lor* var. *brevior*	SC/E/1B	San Diego County	Meadows (vernally mesic), vernal pools	May-Jul

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Conejo dudleya *Dudleya abramsii* ssp. *parva*	T/--/1B	Ventura County	Coastal scrub; valley and foothill grassland; rocky, clay	May-Jun
Short-leaved dudleya *Dudleya blochmaniae* ssp. *brevifolia*	SC/E/1B	San Diego County	Chaparral (maritime, openings), coastal scrub, Torrey sandstone	Apr
Marcescent dudleya *Dudleya cymosa* ssp. *marcescens*	T/R/1B	Los Angeles and Ventura Counites	Chaparral (volcanic)	Apr-Jun
Santa Monica Mtns. dudleya *Dudleya cymosa* ssp. *dvatifolia*	T/--/1B	Los Angeles, Orange, and Ventura Counites	Chaparral, coastal scrub, volcanic	Mar-Jun
Santa Cruz Island dudleya *Dudleya nesiotica*	T/R/1B	Santa Cruz Island	Coastal bluff scrub, coastal scrub, rocky or gravelly, clay	Apr-Jun
Santa Clara Valley dudleya *Dudleya setchellii*	E/--/1B	Santa Clara County	Cismontane woodland; valley and foothill grassland; serpentinite, rocky	May-Jun
Laguna Beach dudleya *Dudleya stolonifera*	PE/T/1B	Orange County	Chaparral, cismontane woodland, coastal scrub, valley and foothill grassland, rocky soils	May-Jul
Santa Barbara Island dudleya *Dudleya traskiae*	E/E/1B	Santa Barbara Island	Coastal bluff scrub, coastal scrub, rocky	Feb-Jul
Verity's dudleya *Dudleya verityi*	T/--/1B	Ventura County	Chaparral, cismontane woodland, coastal scrub, volcanic	May-Jun
Kern mallow *Eremalche parryi*	E/--/1B	Vicinity of Lokern, Kern County	Valley sink scrub, saltbush scrub, on sandy clay-loam soils, between 600-900 feet	April-May
Santa Ana River woollystar *Eriastrum densifolium* ssp. *sanctorum*	E/E/1B	Orange*, Riverside, and San Bernardino Counties	Chaparral, coastal scrub (alluvial fan), sandy or gravelly, at 1,240 - 1,900 feet	Jun-Sep

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Hoover's eriastrum *Eriastrum hooveri*	T/--/4	Fresno, Kings, Kern, Santa Barbara, San Benito, San Luis Obispo, and Tulare Counties	Chenopod scrub, pinyon and juniper woodland, valley and foothill grassland	Mar-Jul
Parish's daisy *Erigeron parishii*	T/--/1B	Riverside and San Bernardino Counties	Mohavean Desert scrub, pinyon and juniper woodland, usually carbonate	May-Jun
Indian knob mountainbalm *Eriodictyon altissimum*	E/E/1B	San Luis Obispo County	Chaparral (maritime), cismontane woodland, sandstone	Mar-Jun
Trinity buckwheat *Eriogonum alpinum*	SC/E/1B	Siskiyou and Trinity Counties	Alpine boulder and rock field; subalpine coniferous forest; upper montane coniferous forest; serpentinite, rocky	Jun-Sep
Ione buckwheat *Eriogonum apricum* var. *apricum*	PE/E/1B	Amador County	Chaparral (openings, Ione soil)	Jul-Oct
Irish Hill buckwheat *Eriogonum apricum* var. *prostratum*	PE/E/1B	Amador County	Chaparral (openings, Ione soil)	Jun-Jul
Thorne's buckwheat *Eriogonum ericifolium* var. *thornei*	SC/E/1B	San Bernardino County	Pinyon and juniper woodland (gravelly)	Jul-Aug
San Nicolas Island buckwheat *Eriogonum grande* var. *timorum*	SC/E/1B	San Nicolas Island	Coastal bluff scrub	Mar-Oct
Kellogg's buckwheat *Eriogonum kelloggii*	C/E/1B	Red Mountain, Mendocino County	Lower montane coniferous forest (rocky, serpentinite)	May-Aug
Southern mountain buckwheat *Eriogonum kennedyi* var. *austromontanum*	PT/--/1B	San Bernardino County	Lower montane coniferous forest (gravelly), pebble plain	Jul-Sep

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Cushenbury buckwheat *Eriogonum ovalifolium* var. *vineum*	E/--/1B	San Bernardino County	Joshua tree woodland, Mohavean Desert scrub, pinyon and juniper woodland, carbonate	May-Aug
San Mateo woolly sunflower *Eriophyllum latilobum*	E/E/1B	San Mateo County	Cismontane woodland (serpentinite, often on roadcuts)	May-Jun
San Diego button-celery *Eryngium aristulatum* var. *parishii*	E/E/1B	Riverside and San Diego Counties; Baja California	Coastal scrub, valley and foothill grassland, vernal pools, mesic	Apr-Jun
Loch Lomond button-celery *Eryngium constancei*	E/E/1B	Lake and Sonoma Counties	Vernal pools	Apr-Jun
Delta button-celery *Eryngium racemosum*	SC/E/1B	San Joaquin River delta and floodplains; Calaveras, Merced, San Joaquin*, and Stanislaus Counties	Riparian scrub (vernally mesic clay depressions)	Jun-Aug
Contra Costa wallflower *Erysimum capitatum* ssp. *angustatum*	E/E/1B	Contra Costa County	Inland dunes	Mar-Jul
Humboldt Bay wallflower *Erysimum menziesii* ssp. *eurekense*	E/E/1B	Humboldt County	Coastal dunes	Mar-Apr
Menzies's wallflower *Erysimum menziesii* ssp. *menziesii*	E/E/1B	North coast: Mendocino and Monterey County	Coastal dunes, coastal scrub	Mar-Jun
Yadon's wallflower *Erysimum menziesii* ssp. *yadonii*	E/E/1B	Monterey County	Coastal dunes	Jun-Aug
Santa Cruz wallflower *Erysimum teretifolium*	E/E/1B	Santa Cruz County	Chaparral, lower montane coniferous forest, inland marine sands	Mar-Jul
Pine Hill flannelbush *Fremontodendron decumbens*	E/R/1B	Pine Hill (El Dorado County) near Grass Valley (Nevada County)	Gabbro or serpentine chaparral, woodland	April-July

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Mexican flannelbush *Fremontodendron mexicanum*	E/R/1B	San Diego and Imperial Counties	Chaparral, oak woodland, closed-cone coniferous forest, along creeks or in dry canyons	March-June
Roderick's fritillary *Fritillaria roderickii*	--/E/1B	Mendocino County	Coastal bluff scrub, coastal prairie, valley and foothill grassland	Mar-May
Striped adobe-lily *Fritillaria striata*	PT/T/1B	Southeastern San Joaquin Valley, western Sierra Nevada foothills, northern foothills of the Tehachapi Mountains, Kern and Tulare Counties	Cismontane woodland, valley and foothill grassland, usually clay, between 1,000-4,000 feet	Feb-Apr
Box bedstraw *Galium buxifolium*	E/R/1B	Santa Cruz Island, San Miguel Island	Coastal bluff scrub, closed-cone coniferous forest, coastal scrub, rocky	Mar-Jul
El Dorado bedstraw *Galium californicum* ssp. *sierrae*	E/R/1B	El Dorado County	Chaparral, cismontane woodland, lower montane coniferous forest, gabbroic	May-Jun
San Clemente Island bedstraw *Galium catalinense* ssp. *acrispum*	SC/E/1B	San Clemente Island	Valley and foothill grassland	Mar-Aug
Sand gilia *Gilia tenuiflora* ssp. *arenaria*	E/T/1B	Monterey County	Chaparral (maritime), cismontane woodland, coastal dunes, coastal scrub, sandy	Apr-Jun
Hoffmann's slender-flowered gilia *Gilia tenuiflora* ssp. *hoffmannii*	E/--/1B	Santa Rosa Island	Coastal dunes, coastal scrub	Apr-May
Bogg's Lake hedge-hyssop *Gratiola heterosepala*	--/E/1B	Fresno, Lake, Lassen, Madera, Modoc, Placer, Sacramento, Shasta, San Joaquin, Solano, and Tehama Counties; Oregon	Marshes and swamps (lake margins), vernal pools, clay	Apr-Aug

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Ash Meadows gumplant *Grindelia fraxino-pratensis*	T/--/1B	Inyo County; Nevada	Meadows (mesic clay)	Jun-Oct
Island rush-rose *Helianthemum greenei*	T/--/1B	San Clemente Island, Santa Cruz Island, San Miguel Island, Santa Rosa Island*(?)	Closed-cone coniferous forest, chaparral, cismontane woodland, coastal scrub, rocky	Mar-Jul
Algodones Dunes sunflower *Helianthus niveus* ssp. *tephrodes*	SC/E/1B	Imperial County; Arizona, Sonora, Mexico	Desert dunes	Sep-May
Otay tarplant *Hemizonia conjugens*	T/E/1B	San Diego County; Baja California	Coastal scrub, valley and foothill grassland, clay	May-Jun
Gaviota tarplant *Hemizonia increscens* ssp. *villosa*	C/E/1B	Santa Barbara County	Coastal bluff scrub, Coastal scrub, valley and foothill grassland	Jun-Sep
Mojave tarplant *Hemizonia mohavensis*	SC/E/1A	Riverside, San Bernardino*, and San Diego Counties	Chaparral (mesic), riparian scrub	Jul-Oct
Marin western flax *Hesperolinon congestum*	T/T/1B	Marin, San Francisco, and San Mateo Counties	Chaparral, valley and foothill grassland, serpentinite	May-Jul
Lake County western flax *Hesperolinon didymocarpum*	SC/E/1B	Lake County	Chaparral, cismontane woodland, valley and foothill grassland, serpentinite	May-Jul
Santa Cruz tarplant *Holocarpha macradenia*	PT/E/1B	Coastal California from San Luis Obispo County to Marin County	Coastal prairie and annual grasslands, on sandy clay soils	June-October
Water howellia *Howellia aquatilis*	T/--/1A	Mendocino*, Idaho, Oregon*, Washington	Marshes and swamps (freshwater)	Jun
Burke's goldfields *Lasthenia burkei*	E/E/1B	Lake, Mendocino, and Sonoma Counties	Meadows (mesic), vernal pools	Apr-Jun

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Contra Costa goldfields *Lasthenia conjugens*	E/--/1B	Alameda, Contra Costa, Mendocino*, Napa, Santa Barbara*, Santa Clara*, and Solano Counites	Cismontane woodland, playas (alkaline), valley and foothill grassland, vernal pools, mesic, below 700 feet	Mar-Jun
Beach layia *Layia carnosa*	E/E/1B	Humboldt, Monterey, Marin, Santa Barbara*, San Francisco* Counties	Coastal dunes, coastal scrub (sandy)	Apr-Jul
San Joaquin woollythreads *Lembertia congdonii*	E/--/1B	Fresno, Kings, Kern, Santa Barbara, San Benito, San Luis Obispo, and Tulare* Counties	Chenopod scrub, valley and foothill grassland, alkaline or loamy soils	Feb-May
San Bernardino Mtns. bladderpod *Lesquerella kingii* ssp. *bernardina*	E/--/1B	San Bernardino County	Lower montane coniferous forest, pinyon and juniper woodland, usually carbonate	May-Jun
San Francisco lessingia *Lessingia germanorum*	E/E/1B	San Francisco and San Mateo Counties	Coastal scrub (remnant dunes)	Jun-Nov
Western lily *Lilium occidentale*	E/E/1B	Del Norte and Humboldt Counties, Oregon	Bogs and fens, coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps (freshwater), north coast coniferous forest (openings)	Jun-Jul
Pitkin Marsh lily *Lilium pardalinum* ssp. *pitkinense*	PE/E/1B	Sonoma County	Cismontane woodland; meadows; marshes and swamps (freshwater); mesic, sandy	Jun-Jul
Point Reyes meadowfoam *Limnanthes douglasii* ssp. *sulphurea*	SC/E/1B	Marin and San Mateo Counties	Coastal prairie, meadows (mesic), marshes and swamps (freshwater), vernal pools	Mar-May
Butte County meadowfoam *Limnanthes floccosa* ssp. *californica*	E/E/1B	Butte County	Valley and foothill grassland (mesic), vernal pools	Mar-May

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Parish's meadowfoam *Limnanthes gracilis* ssp. *parishii*	SC/E/1B	Riverside and San Diego Counties	Meadows (vernally mesic), vernal pools	Apr-Jun
Sebastopol meadowfoam *Limnanthes vinculans*	E/E/1B	Napa(?) and Sonoma Counties	Meadows, valley and foothill grassland, vernal pools, vernally mesic	Apr-May
San Clemente Island woodland star *Lithophragma maximum*	PE/E/1B	San Clemente Island	Coastal bluff scrub, coastal scrub, rocky	Apr-Jun
San Clemente Island bird's-foot trefoil *Lotus argophyllus* var. *adsurgens*	SC/E/1B	San Clemente Island	Coastal bluff scrub, coastal scrub, rocky	Apr-Jun
Santa Cruz Island bird's-foot trefoil *Lotus argophyllus* var. *niveus*	SC/E/1B	Santa Cruz Island	Coastal bluff scrub, chaparral, coastal scrub, rocky	Mar-Sep
San Clemente Island lotus *Lotus dendroideus* var. *traskiae*	E/E/1B	San Clemente Island	Coastal bluff scrub, coastal scrub, valley and foothill grassland	Feb-Aug
Mariposa lupine *Lupinus citrinus* var. *deflexus*	PE/T/1B	Mariposa County	Chaparral, cismontane woodland, granitic	Apr-May
Milo Baker's lupine *Lupinus milo-bakeri*	SC/T/1B	North Coast Ranges: Colusa and Mendocino Counties	Cismontane woodland (often along roadsides), valley and foothill grassland	Jun-Sep
Nipomo Mesa lupine *Lupinus nipomensis*	C/E/1B	San Luis Obispo County	Coastal dunes	Mar-May
Tidestrom's lupine *Lupinus tidestromii*	E/E/1B	Monterey, Marin, and Sonoma Counties	Coastal dunes	May-Jun
San Clemente Island bush mallow *Malacothamnus clementinus*	E/E/1B	San Clemente Island	Valley and foothill grassland (rocky)	Mar-Aug

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Santa Cruz Island bush mallow *Malacothamnus fasciculatus* var. *nesioticus*	E/E/1B	Santa Cruz Island	Chaparral, coastal scrub, rocky	Apr-Jul
Santa Cruz Island cliff-aster *Malacothrix indecora*	E/--/1B	Santa Cruz Island, San Miguel Island	Coastal bluff scrub, chaparral, coastal dunes, coastal scrub	Apr-Sep
Island malacothrix *Malacothrix squalida*	E/--/1B	Amacapa Island, Santa Cruz Island	Coastal bluff scrub, chaparral, cismontane woodland	Apr-Jul
Kelso Creek monkeyflower *Mimulus shevockii*	PE/--/1B	Kern County	Joshua tree woodland, pinyon and juniper woodland, sandy, granitic	Mar-May
Willowy monardella *Monardella linoides* ssp. *viminea*	E/E/1B	San Diego County; Baja California	Closed-cone coniferous forest, chaparral, riparian forest, riparian scrub, riparian woodland	Jun-Aug
Spreading navarretia *Navarretia fossalis*	T/--/1B	Riverside and San Diego Counties; Baja California	Chenopod scrub, marshes and swamps (assorted shallow freshwater), playas, vernal pools	Apr-Jun
Few-flowered navarretia *Navarretia leucocephala* ssp. *pauciflora*	E/T/1B	Lake and Napa Counties	Vernal pools (volcanic ash flow)	May-Jun
Many-flowered navarretia *Navarretia leucocephala* ssp. *plieantha*	E/E/1B	Lake and Sonoma Counties	Vernal pools (volcanic ash flow)	May-Jun
Piute Mtns. navarretia *Navarretia setiloba*	PT/--/1B	Kern and Tulare Counties	Cismontane woodland, pinyon and juniper woodland, valley and foothill grassland, clay or gravelly loam	Apr-Jun

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Colusa grass *Neostapfia colusana*	T/E/1B	Colusa*, Merced, Solano, Stanislaus, asnd Yolo Counties	Vernal pools (adobe)	May-Aug
Amargosa nitrophila *Nitrophila mohavensis*	E/E/1B	Inyo County; Nevada	Playas (mesic, clay)	May-Oct
Dehesa nolina *Nolina interrata*	--/E/1B	San Diego County; Baja California	Chaparral (gabbroic, metavolcanic, or serpentinite)	Jun-Jul
Eureka Dunes evening-primrose *Oenothera californica* ssp. *eurekensis*	E/R/1B	Inyo County	Desert dunes	Apr-Jul
Antioch Dunes evening-primrose *Oenothera deltoides* ssp. *howellii*	E/E/1B	Contra Costa County	Inland dunes	Mar-Sep
Bakersfield cactus *Opuntia basilaris* var. *treleasei*	E/E/1B	Southern San Joaquin Valley in Kern County	Chenopod scrub, cismontane woodland, valley and foothill grassland, sandy or gravelly, between 500-1,800 feet	May
California Orcutt grass *Orcuttia californica*	E/E/1B	Scattered occurrences in southwest California: Los Angeles, Riverside, San Diego, and Ventura Counties; Baja California	Vernal pools	Apr-Aug
San Joaquin Valley Orcutt grass *Orcuttia inaequalis*	T/E/1B	Scattered locations along east edge of the San Joaquin Valley and adjacent foothills: Fresno, Madera, Merced, Stanislaus*, and Tulare* Counites	Vernal pools	Apr-Sep
Hairy Orcutt grass *Orcuttia pilosa*	E/E/1B	Scattered locations along east edge of the Central Valley and adjacent foothills: Butte, Glenn, Madera, Merced, Stanislaus, and Tehama Counites	Vernal pools	May-Sep

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Slender Orcutt grass *Orcuttia tenuis*	T/E/1B	Sierra Nevada and Cascade Range foothills: Lake, Lassen, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties	Vernal pools	May-Oct
Sacramento Orcutt grass *Orcuttia viscida*	E/E/1B	Sacramento County	Vernal pools	May-Jun
Cushenbury oxytheca *Oxytheca parishii* var. *goodmaniana*	E/--/1B	San Bernardino County	Pinyon and juniper woodland (carbonate, talus)	May-Sep
Lake County stonecrop *Parvisedum leiocarpum*	E/E/1B	Lake County	Cismontane woodland, valley and foothill grassland, vernal pools, vernally mesic depressions in volcanic outcrops	Apr-May
White-rayed pentachaeta *Pentachaeta bellidiflora*	E/E/1B	Marin*, Santa Cruz*, and San Mateo Counties	Valley and foothill grassland (often serpentinite)	Mar-May
Lyon's pentachaeta *Pentachaeta lyonii*	E/E/1B	Los Angeles and Ventura Counties, Santa Catalina Island(?)*	Chaparral (openings), valley and foothill grassland	Mar-Aug
Northern Channel Islands phacelia *Phacelia insularis* var. *insularis*	E/--/1B	San Miguel Island, San Rosa Island	Coastal dunes, valley and foothill grassland	Mar-Apr
Yreka phlox *Phlox hirsuta*	C/E/1B	Siskiyou County	Lower montane coniferous forest, upper montane coniferous forest, serpentinite talus	Apr-Jun
Yadon's rein orchid *Piperia yadonii*	PE/--/1B	Monterey County	Coastal bluff scrub, closed-cone coniferous forest, chaparral (maritime), sandy	May-Aug
San Francisco popcorn-flower *Plagiobothrys diffusus*	SC/E/1B	Santa Cruz and San Francisco* Counties	Coastal prairie, valley and foothill grassland?	Apr-Jun

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Calistoga popcorn-flower *Plagiobothrys strictus*	PE/T/1B	Napa County	Broadleafed upland forest, meadows, valley and foothill grassland, vernal pools, alkaline areas near thermal springs	Mar-Jun
San Bernardino blue grass *Poa atropurpurea*	PE/--/1B	San Bernardino and San Diego Counties	Meadows (mesic)	Apr-Aug
Napa blue grass *Poa napensis*	PE/E/1B	Napa County	Meadows, valley and foothill grassland, alkaline, near hot springs	May-Aug
San Diego mesa mint *Pogogyne abramsii*	E/E/1B	San Diego County	Vernal pools	Apr-Jun
Santa Lucia mint *Pogogyne clareana*	SC/E/1B	Monterey County	Riparian woodland	May-Jun
Otay Mesa mint *Pogogyne nudiuscula*	E/E/1B	San Diego County; Baja California(?)*	Vernal pools	May-Jun
Hickman's cinquefoil *Potentilla hickmanii*	PE/E/1B	Monterey, San Mateo, and Sonoma* Counties	Coastal bluff scrub, closed-cone coniferous forest, meadows (vernally mesic), marshes and swamps (freshwater)	Apr-Aug
Hartweg's golden sunburst *Pseudobahia bahiifolia*	E/E/1B	Eastern side of Sacramento-San Joaquin Valleys, formerly as far north as Yuba County	Rocky, bare areas along rolling hills, adjavent to vernal pools, usually with heavy clay soils	Mar-Apr
San Joaquin adobe sunburst *Pseudobahia peirsonii*	T/E/1B	Fresno, Kern, and Tulare Counties	Cismontane woodland, valley and foothill grassland, adobe clay	Mar-Apr
Parish's alkali-grass *Puccinellia parishii*	PE/--/1B	Kern(?) and San Bernardino Counties; Arizona; New Mexico	Meadows (alkaline springs and seeps), at 2,300-6,000 feet	Apr-May

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Gambel's water cress *Rorippa gambellii*	E/T/1B	Los Angeles*, Orange*, Santa Barbara*, San Bernardino*, San Diego(?)*, and San Luis Obispo Counties; Baja California	Marshes and swamps (freshwater or brackish)	Apr-Sep
Tahoe yellow cress *Rorippa subumbellata*	SC/E/1B	El Dorado, Nevada*, and Placer Counties	Lower montane coniferous forest, meadows, decomposed granitic beaches	May-Sep
Small-leaved rose *Rosa minutifolia*	SC/E/2	San Diego County; Baja California	Chaparral, coastal scrub	Jan-Jun
Layne's butterweed *Senecio layneae*	T/R/1B	El Dorado and Tuolumne Counties	Chaparral and foothill woodland, on serpentine or gabbro soils	April-July
Layne's ragwort *Senecio layneae*	T/R/1B	El Dorado and Tuolumne Counites	Chaparral, cismontane woodland, serpentinite or gabbroic, rocky	Apr-Jul
Santa Cruz Island rock cress *Sibara filifolia*	E/--/1B	San Clemente Island, Santa Catalina Island*, and Santa Cruz Island*	Coastal scrub (rocky, volcanic)	Mar-Apr
Owens Valley checkerbloom *Sidalcea covillei*	SC/E/1B	Inyo County	Great Basin scrub, meadows (alkaline, mesic)	Apr-Jun
Keck's checkerbloom *Sidalcea keckii*	PE/--/1B	Tulare and Fresno(?)* Counties	Cismontane woodland, valley and foothill grassland, serpentinite	Apr
Kenwood Marsh checkerbloom *Sidalcea oregana* ssp. *valida*	PE/E/1B	Sonoma County	Marshes and swamps (freshwater)	Jun-Sep
Bird-foot checkerbloom *Sidalcea pedata*	E/E/1B	San Bernardino County	Meadows (mesic), pebble plain	May-Aug
Scadden Flat checkerbloom *Sidalcea stipularis*	SC/E/1B	Two occurrences near Scadden Flat (Nevada County)	Freshwater seep; wet meadow	July-August

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Red Mountain catchfly *Silene campanulata* ssp. *campanulata*	C/E/1B	North Coast Ranges, Colusa and Mendocino Counties	Chaparral, lower montane coniferous forest, serpentinite, rocky	May-Jun
Metcalf Canyon jewel-flower *Streptanthus albidus* ssp. *albidus*	E/--/1B	Santa Clara County	Valley and foothill grassland (serpentinite)	Apr-Jul
Tiburon jewel-flower *Streptanthus niger*	E/E/1B	Marin County	Valley and foothill grassland (serpentinite)	May-Jun
California seablite *Suaeda californica*	E/--/1B	Alameda* and Santa Clara* Counties; Morro Bay, San Luis Obispo; historically found in south San Francisco Bay	Marshes and swamps (coastal salt)	Jul-Oct
Eureka Valley dune grass *Swallenia alexandrae*	E/R/1B	Inyo County	Desert dunes	Apr-Jun
California dandelion *Taraxacum californicum*	PE/--/1B	San Bernardino County	Meadows (mesic)	May-Aug
Slender-petaled thelypodium *Thelypodium stenopetalum*	E/E/1B	San Bernardino County	Meadows (mesic, alkaline)	May-Aug
Santa Cruz Island fringepod *Thysanocarpus conchuliferus*	E/--/1B	Santa Cruz Island	Chaparral, cismontane woodland, rocky	Mar-May
Hidden Lake bluecurls *Trichostema austromontanum* ssp. *compactum*	PT/--/1B	Riverside County	Upper montane coniferous forest, seasonally submerged lake margins	Jul-Sep
Showy Indian clover *Trifolium amoenum*	E/--/1B	Coast Range foothills from Mendocino to Santa Clara County	Low elevation grasslands, including swals and disturbed areas	Apr-Jun
Monterey clover *Trifolium trichocalyx*	PE/E/1B	Monterey County	Closed-cone coniferous forest (openings, burned areas)	Apr-Jun

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Common and Scientific Name	Legal Status[a] Federal/State/CNPS	Geographic Distribution	Habitat Requirements	Identification Period
Greene's tuctoria *Tuctoria greenei*	E/R/1B	Scattered distribution along east edge of the Central Valley from Tehama to Merced County; Fresno, Madera, San Joaquin, Stanislaus, and Tulare Counties	Vernal pools	May-Jul
Crampton's tuctoria *Tuctoria mucronata*	E/E/1B	Solano and Yolo Counties	Valley and foothill grassland (mesic), vernal pools	Apr-Jul
California vervain *Verbena californica*	PT/T/1B	Tuolumne County	Cismontane woodland, valley and foothill grassland (mesic), usually serpentinite seeps or creeks	May-Sep
Crownbeard *Verbesina dissita*	T/T/1B	Orange County; Baja California	Chaparral (maritime), coastal scrub	Apr-Jul

[a] Status explanations:

Federal

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
PE = proposed for federal listing as endangered under the federal Endangered Species Act.
PT = proposed for federal listing as threatened under the federal Endangered Species Act.
C = species for which USFWS has on file sufficient information on biological vulnerability and threat(s) to support issuance of a proposed rule to list.
SC = species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.
-- = no listing.

State

E = listed as endangered under the California Endangered Species Act.
T = listed as threatened under the California Endangered Species Act.
R = listed as rare under the California Native Plant Protection Act. This category is no longer used for newly listed plants, but some plants previously listed as rare retain this designation.

* = extirpated from that area, (?) = uncertain whether occurs in that area.

--	=	no listing.

California Native Plant Society

1A	=	List 1A species: presumed extinct in California.
1B	=	List 1B species: rare, threatened, or endangered in California and elsewhere.
2	=	List 2 species: rare, threatened, or endangered in California but more common elsewhere.
4	=	List 4 species: plants of limited distribution.

* = extirpated from that area, (?) = uncertain whether occurs in that area.

Table F-2. California Special-Status Wildlife Species

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Trinity bristlesnail (=California northern river snail) *Monadenia setosa*	SC/T	Swede Creek, tributary to Trinity River, Trinity County	On moss and in forest duff accumulated under trees on more stable portions of talus slopes
Morro shoulderband (=banded dune snail) *Helminthoglypta walkeriana*	E/--	Restricted to Morro Bay and Montana de Oro State Parks	Data not available
Longhorn fairy shrimp *Branchinecta longiantenna*	E/--	Eastern margin of central Coast Ranges from Contra Costa County to San Luis Obispo County	Small, clear pools in sandstone rock outcrops of clear to moderately turbid clay- or grass-bottomed pools
Conservancy fairy shrimp *Branchinecta conservatio*	E/--	Disjunct occurrences in Solano, Merced, Tehama, Butte, and Glenn Counties	Large, deep vernal pools in annual grasslands
Vernal pool fairy shrimp *Branchinecta lynchi*	T/--	Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County; isolated populations also in Riverside County	Common in vernal pools; also found in sandstone rock outcrop pools
San Diego fairy shrimp *Branchinecta sandiegonensis*	E/--	San Diego County and northwestern Baja California	Vernal pools
Vernal pool tadpole shrimp *Lepidurus packardi*	E/--	Shasta County south to Merced County	Vernal pools and ephemeral stock ponds
Riverside fairy shrimp *Streptocephalus woottoni*	E/--	Southwestern Riverside County, Orange and San Diego Counties	Vernal pools
Shasta (=placid) crayfish *Pacifastacus fortis*	E/E	Pit River drainage in Shasta County, including tributaries of the Hat Creek and Fall River subdrainages	Streams
California freshwater shrimp *Syncaris pacifica*	E/--	Coastal lowland streams in Napa, Marin, and Sonoma Counties	Streams
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T/--	Streamside habitats below 3,000 feet through the Central Valley of California	Riparian and oak savanna habitats with elderberry shrubs; elderberries are host plant
Delta green ground beetle *Elaphrus viridus*	T/--	Restricted to Olcott Lake and other vernal pools at Jepson Prairie Preserve, Solano County	Sparsely vegetated edges of vernal lakes and pools

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Mount Hermon (=barbate) June beetle *Polyphylla barbata*	E/--	Santa Cruz Mountains	Occurs on Zaxante soils, typically in Ponderosa Pine sand parklands
Delhi Sands flower-loving fly *Rhaphiomidas terminatus abdominalis*	E/--	Delhi sand dunes; 10 known populations	Sand, California buckwheat for feeding and lays eggs in sand near telegraph weed
Kern primrose sphinx moth *Euproserpinus euterpe*	T/--	Walker Basin, Kern County	Dry, disturbed, sandy-gravelly washes adjacent to fallow fields where its larval food plant, the evening primrose, occurs
El Segundo blue *Euphilotes (= Shijimiaeoides) battoides allyni*	E/--	Although once more widespread, now restricted to two sites: approximately 270 acres at Los Angeles International Airport and approximately 1.3 acres at the Chevron refinery in El Segundo	Native vegetated sand dune habitats with its host plant, *Eriogonum parvifolium*
Lange's metalmark *Apodemia mormo langei*	E/--	Once occupied the Antioch Dunes; range now reduced to less than 10 acres in Contra Costa County	Limited to dense to moderately dense patches of food plant, wild buckwheat, in stabilized sand dunes
Palos Verdes blue butterfly *Glaucopsyche lydamus palosverdesensis*	E/--	Palos Verde Peninsula, Los Angeles County	Lupines, wild peas, and vetch
Mission blue *Icaricia icarioides missionensis*	E/--	San Bruno Mountain, San Mateo County; Twin Peaks, San Francisco County	Hill and ridgetops, as well as slopes with south exposure with caterpillar food plants, *Lupinus* spp.
San Bruno elfin *Callophrys mossii bayensis*	E/--	San Bruno Mountain, Montara Mountains, and northern end of Santa Cruz Mountains, San Mateo County	North-facing slopes and ridges facing Pacific Ocean from 600 to 1,100 feet
Lotis blue *Lycaeides argyrognomon lotis*	E/--	In and around a few sphagnum bogs near Mendocino, Mendocino County; Mendocino Pygmy Forest	Coastal peat bogs and pygmy conifer forest inland from coastal sand dunes
Smith's blue *Euphilotes (=Shijimiaeoides) enoptes smithi*	E/--	Localized populations along the immediate coast and in coastal canyons of Monterey County; single populations reported in Santa Cruz and San Mateo Counties	Coastal dunes and hillsides that support seacliff buckwheat (*Eriogonum parvifolium*) or coast buckwheat (*Eriogonum latifolium*); these plants used as a nectar source for adults and host plant for larvae

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Bay checkerspot butterfly *Euphydryas editha bayensis*	T/--	Vicinity of San Francisco Bay	Native grasslands on outcrops of serpentine soil; California plantain and owl's clover are host plants
Quino checkspot butterfly *Euphydryas editha quino* (=*wrighti*)	E/--	Portions of Riverside and San Diego Counties	Locally distributed in sunny openings in chaparral and coastal sage shrublands
Oregon silverspot butterfly *Speyeria zerene hippolyta*	T/--	No information	No information
Myrtle's silverspot butterfly *Speyeria zerene myrtleae*	E/--	Coastal Marin and San Mateo Counties	Typically found in forests
Laguna Mountains skipper *Pyrgus ruralis lagunae*	E/--	Laguna Mountains, Mount Palomar, San Diego County	High-elevation mountain habitats
Santa Cruz long-toed salamander *Ambystoma macrodactylum croceum*	E/E	Small populations and breeding sites in southern Santa Cruz County and northern Monterey County	Lifetime spent mostly underground in willow groves, coastal scrub, coast live oak, or riparian habitats; migrates to breeding ponds in early to late winter, and juveniles disperse from the pond in September
Siskiyou Mountains salamander *Plethodon stormi (=P. elongatus s.)*	SC/T	In California, occurs only in Siskiyou County in drainages near the Applegate River, Deid Creek, and Horse Creek; Siskiyou Mountains of southern Oregon and northern California	A fully terrestrial salamander with no larval stage; requires humid conditions to survive and reproduce; found at elevations from 1,600 to 3,500 feet associated with talus slopes and north- and east-facing slopes
Desert slender salamander *Batrachoseps aridus*	E/E	Riverside County	Occurs beneath limestone slabs and talus and in crevices in moist soil on canyon walls
Kern Canyon slender salamander *Batrachoseps simatus*	SC/T	Restricted to the lower Kern River Canyon, Kern County	Under rocks, logs, large rock slides, and talus on north-facing slopes
Tehachapi slender salamander *Batrachoseps stebbinsi*	SC/T	Restricted to the Tehachapi Mountains, Kern County	North-facing talus slopes in valley-foothill hardwood, mixed conifer, and valley-foothill riparian habitats

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Shasta salamander *Hydromantes shastae*	SC/T	Restricted to several tributaries of the McCloud River, Pit River, and Squaw Creek, Shasta County	Limestone caves at elevations from 1,000 to 3,000 feet
Limestone salamander *Hydromantes brunus*	SC/T	Merced River Canyon near Briceburg, along the Bear Creek, and near Lake McClure, all in Mariposa County	Limestone outcrops and talus slopes in the foothill pine-chaparral belt
Arroyo southwestern toad *Bufo microscaphus californicus*	E/SSC, FP	Along the coast and foothills from San Luis Obispo County to San Diego County and inland to San Bernardino County	Prefers sandy arroyos and river bottoms with open riparian vegetation in inland valleys and foothills; also may use flooded agricultural fields and irrigation ditches
California red-legged frog *Rana aurora draytoni*	T/SSC, FP	Found along the coast and coastal mountain ranges of California from Humboldt County to San Diego County; Sierra Nevada from Butte County to Fresno County	Permanent and semipermanent aquatic habitats, such as creeks and coldwater ponds, with emergent and submergent vegetation and riparian species along the edges; may estivate in rodent burrows or cracks during dry periods
Desert tortoise *Gopherus (=Xerobates, =Scaptochelys) agassizii*	T/T	Southern California deserts in Inyo, San Bernardino, Kern, Los Angeles, Riverside, San Diego, and Imperial Counties	Desert areas from 300 to 900 feet with sandy loam to gravelly soils for digging dens; favors creosote and cactus scrub habitats with high densities of annual blooms in spring for feeding
Barefoot gecko *Coleonyx switaki (=Anarbylus s.)*	SC/T	Six known populations in California, all in San Diego and Imperial Counties; may also be undiscovered populations in Riverside County	Various types of rock outcroppings; active only from May through September
Coachella Valley fringe-toed lizard *Uma inornata*	T/E	Coachella Valley sand dunes in Riverside County	Sparse desert scrub and alkali desert scrub, which has fine, loose, wind-blown sand
Blunt-nosed leopard lizard *Gambelia (=Crotaphytus) silus*	E/E	San Joaquin Valley from Stanislaus County through Kern County and along the eastern edges of San Luis Obispo and San Benito Counties	Open habitats with scattered low bushes on alkali flats, and low foothills, canyon floors, plains, washes, and arroyos; substrates may range from sandy or gravelly soils to hardpan

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Flat-tailed horned lizard *Phrynosoma mcallii*	--/SSC, FP	Populations in Imperial, San Diego, and Riverside Counties	Sandy areas, desert pavement, and locations with soils; shares the same wind-blown, fine-sand habitat as the fringe-toed lizard
Island night lizard *Xantusia riversiana*	T/SSC	Channel Islands (i.e., Santa Barbara, Sutil, San Clemente, and San Nicolas Islands)	Rock outcroppings and shrub cover
Southern rubber boa *Charina bottae umbratica*	SC/T	Fragmented populations occur in La Panza Range, San Luis Obispo County; San Gabriel Mountains, Los Angeles County; and the Tehachapi Mountains, Kern County	Moist coniferous forests and montane hardwood habitats with suitable escape cover, including rocks, logs, and leaf litter
Alameda whipsnake *Masticophis lateralis euryxanthus*	T/T	Restricted to Alameda and Contra Costa Counties	Valleys, foothills, and low mountains associated with northern coastal scrub or chaparral habitat; requires rock outcrops for cover and foraging
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	E/E	Northern San Mateo County southward along the coast and the eastern slope of the Santa Cruz Mountains to the Santa Clara County line	Favors ponds, lakes, and marshy areas containing abundant vegetation, which it uses for cover
Giant garter snake *Thamnophis gigas*	T/T	Central Valley from Fresno north to the Gridley/Sutter Buttes area; has been extirpated from areas south of Fresno	Sloughs, canals, and other small waterways where there is a prey base of small fish and amphibians; requires grassy banks and emergent vegetation for basking and areas of high ground protected from flooding during winter
Brown pelican *Pelecanus occidentalis*	E/E	Present along the entire coastline, but does not breed north of Monterey County; extremely rare inland	Typically in littoral ocean zones, just outside the surf line; nests on offshore islands
California brown pelican (nesting colony) *Pelecanus occidentalis*	E/E	Present along the entire coastline, but does not breed north of Monterey County; extremely rare inland	Typically in littoral ocean zones, just outside the surf line; nests on offshore islands
Aleutian Canada goose *Branta canadensis leucopareia*	T/--	The entire population winters in Butte Sink, then moves to Los Banos, Modesto, the Delta, and East Bay reservoirs; stages near Crescent City during spring before migrating to breeding grounds	Roosts in large marshes, flooded fields, stock ponds, and reservoirs; forages in pastures, meadows, and harvested grainfields; corn is especially preferred

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
California condor *Gymnogyps californianus*	E/E	Historically, rugged mountain ranges surrounding the southern San Joaquin Valley; currently, most individuals are in captive populations, but a few birds were recently released in the rugged portions of the Los Padres National Forest	Requires large blocks of open savanna, grasslands, and foothill chaparral with large trees, cliffs, and snags for roosting and nesting
Bald eagle *Haliaeetus leucocephalus*	T/E	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen, Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin; reintroduced into central coast; winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierras, and east of the Sierra Nevada south of Mono County; range expanding	In western North America, nests and roosts in coniferous forests within 1 mile of a lake, a reservoir, a stream, or the ocean
Swainson's hawk *Buteo swainsoni*	--/T	Lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley; the state's highest nesting densities occur near Davis and Woodland, Yolo County	Nests in oaks or cottonwoods in or near riparian habitats; forages in grasslands, irrigated pastures, grain fields, and vegetable crops
American peregrine falcon *Falco peregrinus anatum* (nesting)	E/E	Permanent resident on the north and south Coast Ranges; may summer on the Cascade and Klamath Ranges south through the Sierra Nevada to Madera County; winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes that support large populations of other bird species
California clapper rail *Rallus longirostris obsoletus*	E/E	Marshes around the San Francisco Bay and east to Suisun Marsh	Restricted to salt marshes and tidal sloughs; usually associated with heavy growth of pickleweed; feeds on mollusks removed from the mud in sloughs
Light-footed clapper rail *Rallus longirostris levipes*	E/E	Small populations along the coast in Santa Barbara, Ventura, Orange, and San Diego Counties	Restricted to salt marshes and tidal sloughs where pickleweed is abundant
Black rail *Laterallus jamaicensis*	SC/T	Permanent resident in the San Francisco Bay and eastward through the Delta into Sacramento and San Joaquin Counties; small populations in Marin, Santa Cruz, San Luis Obispo, Orange, Riverside, and Imperial Counties	Tidal salt marshes associated with heavy growth of pickleweed; also occurs in brackish marshes or freshwater marshes at low elevations

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Yuma clapper rail *Rallus longirostris yumanensis*	E/E	Permanent resident in the Salton Sea and along the Colorado River in San Bernardino, Riverside, and Imperial Counties	Freshwater marshes and brackish marshes; requires regenerating marsh for foraging and mature cattail and bulrush for nesting
Greater sandhill crane *Grus canadensis tabida*	--/T	Breeds on the plains east of the Cascade Range and south to Sierra County; winters in the Central Valley, southern Imperial County, Lake Havasu National Wildlife Refuge, and the Colorado River Indian Reserve	Summers in open terrain near shallow lakes or freshwater marshes; winters in plains and valleys near bodies of fresh water
Western snowy plover *Charadrius alexandrinus nivosus* (coastal)	T/SSC	Winters along the coast from Del Norte County to San Diego County: breeding sites within this range are very limited	Coastal beaches above the normal high tide limit with wood or other debris for cover
California least tern *Sterna antillarum (=albifrons) browni*	E/E	Nests on beaches along the San Francisco Bay and along the southern California coast from southern San Luis Obispo County south to San Diego County	Nests on sandy, upper ocean beaches, and occasionally uses mudflats; forages on adjacent surf line, estuaries, or the open ocean
Marbled murrelet *Brachyramphus marmoratus*	T/E	Nesting sites from the Oregon border to Eureka and between Santa Cruz and Half Moon Bay; winters in nearshore and offshore waters along the entire California coastline	Mature, coastal coniferous forests for nesting; nearby coastal water for foraging; nests in conifer stands greater than 150 years old and may be found up to 35 miles inland; winters on subtidal and pelagic waters often well offshore
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	--/E	Nests along the upper Sacramento, lower Feather, south fork of the Kern, Amargosa, Santa Ana, and Colorado Rivers	Wide, dense riparian forests with a thick understory of willows for nesting; sites with a dominant cottonwood overstory are preferred for foraging; may avoid valley oak riparian habitats where scrub jays are abundant
Elf owl *Micrathene whitneyi* (nesting)	–/E	Rare spring and summer resident along the Lower Colorado River	Nests in desert riparian dominated by cottonwood, sycamore, willow, or mesquite; absent from riparian habitat dominated by saltcedar

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Northern spotted owl *Strix occidentalis caurina*	T/SSC	A permanent resident throughout its range; found in the north Coast, Klamath, and western Cascade Range from Del Norte County to Marin County	Dense old-growth forests dominated by conifers with topped trees or oaks available for nesting crevices
Great gray owl *Strix nebulosa*	--/E	Permanent resident of the Sierra Nevada in Warner Mountains south to the Yosemite area	Late successional coniferous forests bordering meadows
Gila woodpecker *Melanerpes uropygialis*	–/E	Resident of the Lower Colorado River and locally near Brawley, Imperial County	Frequents desert riparian habitats and desert washes; also found in orchards and urban parks with shade trees
Gilded flicker *Colapter chrysoides*	–/E	Breeds along the Lower Colorado River, the Mojave Desert, and the Owens Valley	Desert riparian areas, desert washes, and habitats with Joshua trees and saguaro cactus
Willow flycatcher *Empidonax traillii*	SC/E	Summer range includes a narrow strip along the eastern Sierra Nevada from Shasta County to Kern County, another strip along the western Sierra Nevada from El Dorado County to Madera County; widespread in migration	Riparian areas and large, wet meadows with abundant willows for breeding; usually found in riparian habitats during migration
Southwestern willow flycatcher *Empidonax traillii extimus*	E/E	Breeds in coastal southern California in the Los Angeles Basin, the San Bernardino/Riverside area, and San Diego County; no longer breeds along the Colorado River and is known to exist only in eight widely disjunct nesting populations	Densely vegetated riparian habitat with streamside associations of cottonwoods and willows
Bank swallow *Riparia riparia*	--/T	The state's largest remaining breeding populations are along the Sacramento River from Tehama County to Sacramento County and along the Feather and lower American Rivers and Cache Creek, in the Owens Valley; nesting areas also include the plains east of the Cascade Range south through Lassen County, northern Siskiyou County, and small populations near the coast from San Francisco County to Monterey County	Nests in bluffs or banks (usually steep), adjacent to water, where the soil consists of sand or sandy loam to allow digging
California gnatcatcher *Polioptila californica*	T/SSC	Found only along the southern California coast from Los Angeles County to San Diego County	Permanent resident in coastal sage scrub, where it prefers relatively dense stands dominated by California sage (*Artemesia californica*)

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
San Clemente loggerhead shrike *Lanius ludovicianus mearnsi*	E/--	San Clemente Island	Prefers open habitats (washes, ravines, and mesas) with scattered shrubs, trees, posts, fences, or other perches
Least Bell's vireo *Vireo bellii pusillus*	E/E	Small populations remain in southern Inyo, southern San Bernardino, Riverside, San Diego, Orange, Los Angeles, Ventura, and Santa Barbara Counties	Riparian thickets either near water or in dry portions of river bottoms; nests along margins of bushes and forages low to the ground; may also be found using mesquite and arrow weed in desert canyons
San Clemente sage sparrow *Amphispiza belli clementeae*	T/--	San Clemente Island and possibly San Nicolas and Santa Rosa Islands	Brushlands
Belding's savannah sparrow *Passerculus sandwichensis beldingi*	SC/E	Small, fragmented populations remain along the coast from Santa Barbara County to San Diego County	Tidal areas supporting pickleweed; may also use alkali sloughs on the coastal plains
Inyo California towhee *Pipilo crissalis cromophilus*	T/E	Restricted to a 95-square-mile area of the Mojave Desert west of Death Valley, Inyo County	Nests in dense stands of riparian vegetation, especially arroyo willow and desert olive; forages in sparsely vegetated desert scrub
Riparian brush rabbit *Sylvilagus bachmani riparius*	PE/E	Limited to San Joaquin County at Caswell State Park near the confluence of the Stanislaus and San Joaquin Rivers	Dense thickets of brush associated with riparian or chaparral habitats
Point Arena mountain beaver *Aplodontia rufa nigra*	E/SSC	Known only from Alder Creek in the Point Arena area of Mendocino County	North-facing, wooded slopes of ridges or gullies where there is abundant moisture, thick under growth, and soft soil for burrowing
Nelson's antelope ground squirrel *Ammospermophilus nelsoni*	SC/T	Western side of the San Joaquin Valley from southern Merced County south to Kern and Tulare Counties; also found on the Carrizo Plain in San Luis Obispo County and the Cuyama Valley in San Luis Obispo and Santa Barbara Counties	Arid grasslands from 200 to 1,200 feet, with loamy soils and moderate shrub cover of atriplex and other shrub species
Mohave ground squirrel *Spermophilus mohavensis*	SC/T	Southwestern Inyo County, eastern Kern County, northwestern San Bernardino County, and northeastern Los Angeles County	Saltbush, alkali desert, and creosote bush scrub at elevations from 1,800 to 5,000 feet

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Morro Bay kangaroo rat *Dipodomys heermanni morroensis*	E/E	Found only near Los Osos, San Luis Obispo County	Coastal scrub habitats on old sand dune soils
San Bernardino Merriam's kangaroo rat *Dipodomys merriami parvus*	E/SSC	Occurs from the San Bernardino Valley in San Bernardino County to the Menifee Valley in Riverside County	Occurs primarily on sandy loam substrates characteristic of alluvial fans and flood plains dominated by various types of coastal sage scrub and chaparral habitat in early to intermediate successional stages
Fresno kangaroo rat *Dipodomys nitratoides exilis*	E/E	Found only in Fresno County	Found at elevations from 200 to 300 feet in alkali sink habitats
Tipton kangaroo rat *Dipodomys nitratoides nitratoides*	E/E	Occurs in the Tulare Lake Basin in portions of Fresno, Tulare, and Kern Counties	Found at elevations from 200 to 300 feet in arid grassland and alkali desert scrub communities with sparsely scattered shrubs; soil is usually finely textured and alkaline; may use areas that flood in winter and spring
Stephens' kangaroo rat *Dipodomys stephensis (*incl*. D. cascus)*	E/T	Found in the San Jacinto Valley in western Riverside, southwestern San Bernardino, and northwestern San Diego Counties	Uses annual grasslands with sparse perennial vegetation
Giant kangaroo rat *Dipodomys ingens*	E/E	Occurs at high densities in only 12 square miles of habitat along the western side of the San Joaquin Valley, in five separate localities on Elkhorn Plain, Carrizo Plain, McKittrick Valley, and Cuyama Valley in Kern and San Luis Obispo Counties	Restricted to flat, sparsely vegetated areas with native annual grassland and shrubland habitats; requires uncultivated soils consisting of dry, fine, sandy loams for burrowing
Pacific pocket mouse *Perognathus longimembris pacificus*	E/SSC	Historically, inhabited the coastal plains from El Segundo in Los Angeles County south to the Mexico border; only one population is known from Los Angeles County	Open areas with dense scrub and very fine sandy soils
Salt marsh harvest mouse *Reithrodontomys raviventris*	E/E	San Francisco, San Pablo, and Suisun Bays	Salt marshes with a dense plant cover of pickleweed and fat hen; adjacent to an upland site
San Joaquin Valley woodrat *Neotoma fuscipes riparia*	PE/SSC	Caswell Memorial State Park, Stanislaus River	Riparian habitat

Common and Scientific Name	Status [a] Federal/State	California Distribution	Habitats
Amargosa vole *Microtus californicus scirpensis*	E/E	Found only along the Amargosa River near Tecupa and Shoshone, Inyo County	Uses pockets of wetlands containing bulrushes, cattails, saltgrass, and willows
San Joaquin kit fox *Vulpes macrotis mutica*	E/T	Principally occurs in the San Joaquin Valley and adjacent open foothills to the west; recent records from 17 counties extending from Kern County north to Contra Costa County	Saltbush scrub, grassland, oak, savanna, and freshwater scrub
Sierra Nevada red fox *Vulpes vulpes necator*	SC/T	Cascade Range east to the Sierra Nevada then south to Tulare County	Red fir and lodgepole pine forests, generally from 5,000 to 8,400 feet, associated with mountain meadows
California wolverine *Gulo gulo luteus*	SC/T	Klamath and Cascade Ranges south through the Sierra Nevada to Tulare County	Sighted in a variety of habitats from 1,600 to 14,200 feet; most common in open terrain above timberline and subalpine forests
Southern sea otter *Enhydra lutris nereis*	T/FP	Central Coast from San Mateo County to Santa Barbara County	Nearshore marine environment
Guadalupe fur seal *Arctocephalus townsendii*	T/T	Primarily Baja California, but occasionally on San Miguel Island and San Nicolas Island	Rocky insular shorelines and sheltered coves
Northern (Steller) sea lion *Eumetopias jubatus* (rookery)	T/--	Rookeries occur on Año Nuevo Island, Farallon Islands, Point Saint George, and Surgarloaf on Cape Mendocino	Rookeries occur on rocky, isolated islands and peninsulas; feeds in nearshore water
California bighorn sheep *Ovis canadensis californiana*	SC/T	Southern Sierra Nevada	Shrublands, grasslands, and riparian habitats in rugged terrain
Peninsular bighorn sheep *Ovis canadensis cremnobates*	PE/T	San Jacinto Mountains south of Palm Springs, Riverside County south to the Mexican border	Open areas in steep, rugged terrain with sparse vegetation with adequate water supply

[a] Status definitions:

Federal

E = listed as endangered under the federal Endangered Species Act.
T = listed as threatened under the federal Endangered Species Act.
PE = proposed for federal listing as endangered under the federal Endangered Species Act.
PT = proposed for federal listing as threatened under the federal Endangered Species Act.

SC	=	species of concern; species for which existing information indicates it may warrant listing but for which substantial biological information to support a proposed rule is lacking.
--	=	no designations.

State

E	=	listed as endangered under the California Endangered Species Act.
T	=	listed as threatened under the California Endangered Species Act.
FP	=	fully protected under the California Fish and Game Code.
SSC	=	species of special concern in California.
--	=	no designations.

Appendix G. Background Information on Acoustics

Background Information on Acoustics

Sound Terminology

Sound travels through the air as waves of minute air pressure fluctuations caused by some type of vibration. In general, sound waves travel away from the sound source as an expanding spherical surface. The energy contained in a sound wave is consequently spread over an increasing area as it travels away from the source. This results in a decrease in loudness at greater distances from the sound source. The following terms are commonly used in acoustics.

Decibel

Sound-level meters measure the pressure fluctuations caused by sound waves. Because of the ability of the human ear to respond to a wide dynamic range of sound pressure fluctuations, loudness is measured in terms of decibels (dB) on a logarithmic scale. This results in a scale that measures pressure fluctuations in a convenient notation and corresponds to our auditory perception of increasing loudness.

A-Weighted Decibels

Most sounds consist of a broad range of sound frequencies. Because the human ear is not equally sensitive to all frequencies, several frequency-weighting schemes have been used to develop composite decibel scales that approximate the way the human ear responds to sound levels. The "A-weighted" decibel scale (dBA) is the most widely used for this purpose. Typical A-weighted sound levels for various types of sound sources are summarized in Figure G-1.

Equivalent Sound Level

Time-varying sound levels are often described in terms of an equivalent constant decibel level. Equivalent sound levels (L_{eq}) are used to develop single-value descriptions of average sound exposure over various periods of time. Such average sound exposure values often include additional weighting factors for annoyance potential attributable to time of day or other considerations. The L_{eq} data used for these average sound exposure descriptors are generally based on A-weighted sound-level measurements.

Day-Night Average Sound Level

Average sound exposure over a 24-hour period is often presented as a day-night average sound level (L_{dn}). L_{dn} values are calculated from hourly L_{eq} values, with the L_{eq} values for the nighttime period (10:00 p.m.-7:00 a.m.) increased by 10 dB to reflect the greater disturbance potential from nighttime noises.

Community Noise Equivalent Level

The community noise equivalent level (CNEL) is also used to characterize average sound levels over a 24-hour period, with weighting factors included for evening and nighttime sound levels. L_{eq} values for the evening period (7:00 p.m.-10:00 p.m.) are increased by 5 dB, while L_{eq} values for the nighttime period (10:00 p.m.-7:00 a.m.) are increased by 10 dB. For given set of sound measurements, the CNEL value will usually be about 1 dB higher than the L_{dn} value. In practice, CNEL and L_{dn} are often used interchangeably.

Percentile-Exceeded, Maximum, and Minimum Sound Level

The sound level exceeded during a given percentage of a measurement period is the percentile-exceeded sound level (L_x). Examples include L_{10}, L_{50}, and L_{90}. L_{10} is the A-weighted sound level that is exceeded 10% of the measurement period, L_{50} is the level exceeded 50% of the period, and so on. L_{50} is the median sound level measured during the measurement period. $L_{90,}$ the sound level exceeded 90% of the time, excludes high localized sound levels produced by nearby sources such as single car passages or bird chirps. L_{90} is often used to represent the background sound level. L_{50} is also used to provide a less conservative assessment of the background sound level.

The maximum sound level (L_{max}) and the minimum sound level (L_{min}) are the maximum and minimum sound levels respectively, measured during the measurement period. When a sound meter is set to the “slow” response setting as is typical for most community noise measurements, the Lmax and Lmin values are the maximum and minimum levels measured over a one second period.

Sound Source	Sound Level (dBA)*	Response
Carrier deck jet operation	140	
Civil defense siren (at 100 feet)	130	Painfully loud
Jet takeoff (at 200 feet)	120	Threshold of feeling and pain
Riveting machine (at 1 foot) Rock music concert	110	
Pile driver (at 50 feet) Ambulance siren (at 100 feet)	100	Very loud
Heavy truck (at 50 feet)	90	
Pneumatic drill (at 50 feet) Freight train cars (at 50 feet) Garbage disposal in home	80	
Freight train cars (at 100 feet) Freeway traffic (at 50 feet) Vacuum cleaner (at 10 feet)	70	Moderately loud
Air conditioning unit (at 20 feet)	60	
Speech in normal voice (at 15 feet)	50	
Residence-typical movement of people, no TV or radio	40	Quiet
Soft whisper (at 5 feet)	30	
Recording studio	20	
	10	
	0	Threshold of hearing

* Typical A-weighted sound levels in decibels. "A" weighting approximates the frequency response of the human ear.

Jones & Stokes Associates, Inc.

Figure G-1
Weighted Sound Levels and Human Response

Ambient Sound

Ambient sound is the all-encompassing sound associated with a given community site, usually being a composite of sounds from many sources, near and far, with no particular sound being dominant.

Equivalencies between Various Sound Descriptors

The L_{dn} value at a site calculated from a set of measurements taken over a given 24-hour period will be slightly lower than the CNEL value calculated over the same period. Except in situations where unusually high evening sound levels occur, the CNEL value will be within 1.5 dB of the L_{dn} value for the same set of sound measurements.

The relationship between peak hourly L_{eq} values and associated L_{dn} values depends on the distribution of traffic over the entire day. There is no precise way to convert a peak hourly L_{eq} value to an L_{dn} value. However, in urban areas near heavy traffic, the peak hourly L_{eq} value is typically 2-4 dB lower than the daily L_{dn} value. In less heavily developed areas, the peak hourly L_{eq} is often equal to the daily L_{dn} value. For rural areas with little nighttime traffic, the peak hourly L_{eq} value will often be 3-4 dB greater than the daily L_{dn} value.

Working with Decibel Values

The nature of the decibel scale is such that the individual sound levels for different sound sources cannot be added directly to give the combined sound level of these sources. Two sound sources producing equal sound levels at a given location will produce a composite sound level that is 3 dB greater than either sound alone. When two sound sources differ by 10 dB, the composite sound level will be only 0.4 dB greater than the louder source alone.

Most people have difficulty distinguishing the louder of two sound sources if they differ by less than 1.5-2.0 dB. Research into the human perception of changes in sound level indicates the following:

- a 3-dB change is just perceptible,
- a 5-dB change is clearly perceptible, and
- a 10-dB change is perceived as being twice or half as loud.

A doubling or halving of acoustic energy will change the resulting sound level by 3 dB, which corresponds to a change that is just perceptible. In practice, this means that a doubling of traffic volume on a roadway, doubling the number of people in a stadium, or doubling the number of wind turbines in a wind farm will, as a general rule, only result in a 3-dB, or just perceptible, increase in noise.

Outdoor Sound Propagation

There are a number of factors that affect how sound propagates outdoors. These factors, described by Hoover and Keith (1996), are summarized below.

Distance Attenuation

As a general rule, sound from localized or point sound sources spreads out as it travels away from the source and the sound level drops at a rate of 6 dB per doubling of distance. If the sound source is long in one dimension, such as traffic on a highway or a long train, the sound source is considered to be a line source. As a general rule, the sound level from a line source will drop off at a rate of 3 dB per doubling of distance. If the intervening ground between the line source and the receptor is acoustically “soft” (e.g., ground vegetation, scattered trees, clumps of bushes), an attenuation rate of 4.5 dB per doubling of distance is generally used.

Attenuation from Barriers

Any solid structure such as a berm, wall, or building that blocks the line of sight between a source and receiver serves as a sound barrier and will result in additional sound attenuation. The amount of additional attenuation is a function of the difference between the length of the sound path over the barrier and the length of the direct line of sight path. Thus, the sound attenuation of a barrier between a source and a receiver that are very far apart will be much less than the attenuation that would result if either the source or the receiver is very close to the barrier.

Molecular Absorption

Air absorbs sound energy as a function of the temperature, humidity of the air, and frequency of the sound. Additional sound attenuation on the order of 1 to 2 dB per 1,000 feet can occur.

Anomalous Excess Attenuation

Large-scale effects of wind speed, wind direction, and thermal gradients in the air can cause large differences in sound transmission over large distances. These effects when combined result in anomalous excess attenuation, which can be applied to long-term sound-level estimates. Additional sound attenuation on the order of about 1 dB per 1,000 feet can occur.

Other Atmospheric Effects

Short-term atmospheric effects relating to wind and temperature gradients can cause bending of sound waves and can influence changes in sound levels at large distances. These effects can either increase or decrease sound levels depending on the orientation of the source and receptor and the nature of the wind and temperature gradient. Because these effects are normally short-term, it is generally not practical to include them in sound propagation calculations. Understanding these effects, however, can help explain variations that occur between calculated and measured sound levels.

Guidelines for Interpreting Sound Levels

Various federal, state, and local agencies have developed guidelines for evaluating land use compatibility under different sound-level ranges. The following is a summary of federal and state guidelines.

Federal Agency Guidelines

The federal Noise Control Act of 1972 (Public Law 92-574) established a requirement that all federal agencies administer their programs to promote an environment free of noise that jeopardizes public health or welfare. The U.S. Environmental Protection Agency (EPA) was given the responsibility for:

- providing information to the public regarding identifiable effects of noise on public health or welfare,
- publishing information on the levels of environmental noise that will protect the public health and welfare with an adequate margin of safety,
- coordinating federal research and activities related to noise control, and
- establishing federal noise emission standards for selected products distributed in interstate commerce.

The federal Noise Control Act also directed that all federal agencies comply with applicable federal, state, interstate, and local noise control regulations.

Although EPA was given major public information and federal agency coordination roles, each federal agency retains authority to adopt noise regulations pertaining to agency programs. EPA can require other federal agencies to justify their noise regulations in terms of the federal Noise Control Act policy requirements. The Occupational Safety and Health Administration retains primary authority for setting workplace noise exposure standards. The Federal Aviation Administration retains primary jurisdiction over aircraft noise standards, and the Federal Highway Administration (FHWA) retains primary jurisdiction over highway noise standards.

In 1974, in response to the requirements of the federal Noise Control Act, EPA identified indoor and outdoor noise limits to protect public health and welfare (communication disruption, sleep disturbance, and hearing damage). Outdoor L_{dn} limits of 55 dB and indoor L_{dn} limits of 45 dB are identified as desirable to protect against speech interference and sleep disturbance for residential, educational, and healthcare areas. Sound-level criteria to protect against hearing damage in commercial and industrial areas are identified as 24-hour L_{eq} values of 70 dB (both outdoors and indoors).

The FHWA has adopted criteria for evaluating noise impacts associated with federally funded highway projects and for determining whether these impacts are sufficient to justify funding noise mitigation actions (23 CFR 772). The FHWA noise abatement criteria are based on peak hourly L_{eq} sound levels, not L_{dn} or 24-hour L_{eq} values. The peak 1-hour L_{eq} criteria for residential, educational, and healthcare facilities are 67 dB outdoors and 52 dB indoors. The peak 1-hour L_{eq} criterion for commercial and industrial areas is 72 dB (outdoors).

The U.S. Department of Housing and Urban Development has established guidelines for evaluating noise impacts on residential projects seeking financial support under various grant programs (44 FR 135:40860-40866, January 23, 1979). Sites are generally considered acceptable for residential use if they are exposed to outdoor L_{dn} values of 65 dB or less. Sites are considered "normally unacceptable" if they are exposed to outdoor L_{dn} values of 65-75 dB. Sites are considered unacceptable if they are exposed to outdoor L_{dn} values above 75 dB.

State Agency Guidelines

In 1987, the California Department of Health Services published guidelines for the noise elements of local general plans. These guidelines include a sound level/land use compatibility chart that categorizes various outdoor L_{dn} ranges into up to four compatibility categories (normally acceptable, conditionally acceptable, normally unacceptable, and clearly unacceptable) by land use. For many land uses, the chart shows overlapping L_{dn} ranges for two or more compatibility categories.

The noise element guidelines chart identifies the normally acceptable range for low-density residential uses as less than 60 dB and the conditionally acceptable range as 55-70 dB. The normally acceptable range for high-density residential uses is identified as L_{dn} values below 65 dB, and the conditionally acceptable range is identified as 60-70 dB. For educational and medical facilities, L_{dn} values below 70 dB are considered normally acceptable and L_{dn} values of 60-70 dB are considered conditionally acceptable. For office and commercial land uses, L_{dn} values below 70 dB are considered normally acceptable and L_{dn} values of 67.5-77.5 are categorized as conditionally acceptable.

These overlapping L_{dn} ranges are intended to indicate that local conditions (existing sound levels and community attitudes toward dominant sound sources) should be considered in evaluating land use compatibility at specific locations.

The California Department of Housing and Community Development has adopted noise insulation performance standards for new hotels, motels, and dwellings other than detached single-family structures (24 CCR T25-28). These standards require that "interior CNELs with windows closed, attributable to exterior sources, shall not exceed an annual CNEL of 45 dB in any habitable room".

The California Department of Transportation uses the FHWA criteria as the basis for evaluating noise impacts from highway projects.

Reference

Hoover, R. M., and R. H. Keith. 1996. Noise control for buildings and manufacturing plants. Hoover and Keith, Inc. Houston, TX.

Notice of Preparation

The California State Water Resources Control Board (SWRCB) is proposing to adopt a General Order (GO) for General Waste Discharge Requirements (WDRs) for the Discharge of Biosolids to Land for Use in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities in California. Biosolids are defined as sewage sludge that has been treated, tested, and shown to be capable of being beneficially used as a soil amendment for agriculture, silviculture, horticulture, and land reclamation activities as specified under federal regulation. The proposed GO program has several objectives:

- to comply with state-mandated legislation calling for the development of a regulation for land application of biosolids;
- to provide for regional permitting of land application projects through a process that protects water quality; and
- to provide a flexible regulatory framework with regional oversight and incorporation of sound science in the land application of biosolids.

This notice of preparation (NOP), which is required by the California Environmental Quality Act (CEQA), is the first effort to involve the public and interested agencies in developing the scope of the environmental impact report (EIR) for the GO. Section 15083 of the State CEQA Guidelines authorizes and encourages an early consultation or a scoping process to help identify the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in an EIR and to help resolve concerns of affected agencies and individuals. The intent of the scoping process is to identify the significant issues for study in the EIR and to determine the scope of analysis for each issue. This NOP describes the proposed project and its alternatives, indicates the types of environmental effects that could result from implementation of the program, and announces the start of the EIR review process under CEQA. This NOP contains the following information:

- the purpose of the program EIR, including its intended uses;
- background on and existing regulations for land application of biosolids in California;
- the GO and alternatives to be evaluated in the program EIR; and
- the scope of issues to be addressed in the EIR.

Project Location

The proposed GO is a regulatory program under the direct purview of the SWRCB, with responsibility for implementation, compliance, and enforcement delegated to each of the nine regional water quality control boards (RWQCBs) in the state. Consequently, biosolids management activities throughout the entire state of California may be affected by this GO. However, specifically identified regions within the state have special environmental significance or are otherwise regulated, and this GO would not apply to those regions. These identified exclusion zones are described in detail under "Project Description".

Background on Biosolids Management in California

Treatment of municipal wastewater typically generates two waste streams: The liquid component, commonly referred to as effluent, is usually discharged to surface waters or used as irrigation water on some types of land. The solid or semisolid component, commonly referred to as sewage sludge, is treated to varying degrees and is typically incinerated, stored in drying beds or ponds, disposed of in landfills, or reused as a soil amendment on some types of land. The GO being considered by the SWRCB will apply to biosolids as defined in the first paragraph of this notice. Figure 1 shows the processes used to treat sewage sludge to produce biosolids at publicly owned treatment works.

More than 20% of the biosolids generated at wastewater treatment plants in the United States are reused through some form of land application. Land application differs from disposal in that biosolids are applied as an amendment to satisfy or supplement the nutrient requirements of crops or vegetation or to condition soils. Land application may involve the use of biosolids on traditional agricultural crops, silvicultural operations, or horticultural plants or in reclamation of disturbed lands or the application of composted or thermally processed materials to public use areas such as parks and residential landscaping. Certain precautions must be taken to ensure that land application does not endanger public health or adversely affect the environment. The U.S. Environmental Protection Agency (EPA) considers land application a beneficial use because it recycles the nutrients and organic matter contained in biosolids back to the soil (U.S. Environmental Protection Agency 1994). Figure 2 shows typical land application practices for agricultural crop production, including staging (or temporary stockpiling of biosolids) at the farm, loading and spreading of biosolids, and incorporation practices.

Land application of biosolids is currently regulated by EPA under Standards for the Use or Disposal of Sewage Sludge (Title 40 Code of Federal Regulations [CFR] Part 503, known as the Part 503 regulations), adopted in 1993. The Part 503 regulations were developed using a risk-based approach to determine appropriate treatment, storage, and application procedures for biosolids that would protect human health and the environment from potentially dangerous or toxic constituents that may be present in biosolids. The Part 503 regulations control the final use of biosolids according to various constituents of concern, including the level of pathogen reduction, the degree of vector attraction reduction, and the concentration of pollutants in the biosolids. The regulations were developed through extensive scientific peer review, and public notification and comment were sought before they were adopted. Many state and local agencies now rely on the Part 503 regulations for guidance when making decisions about biosolids management or establishing biosolids use regulations.

No single state agency regulates biosolids management in California; biosolids recycling projects may involve oversight by the nine RWQCBs, the California Integrated Waste Management Board (IWMB), the California Air Resources Board, and the California Department of Food and Agriculture (DFA) (California Water Environment Association 1998). In 1983, the California Department of Health Services (DHS) published the Manual of Good Practice for Landspreading Sewage Sludge to promote recycling efforts (California Department of Health Services 1983). Land application of biosolids in California is currently permitted through individual WDRs issued by the RWQCBs in accordance with Title 23, Chapter 9, Division 3 of the California Code of Regulations. Some counties have made land application of biosolids exempt from solid waste regulations, and others have taken an active role in dictating where and how biosolids can be disposed of in their jurisdictions. Some counties have banned the use of biosolids for land application.

To streamline the biosolids permitting process, the Central Valley and Lahontan RWQCBs developed separate general WDRs (another name for GOs) for biosolids land application in 1995. To comply with CEQA, the two RWQCBs prepared negative declarations before adopting their programs. Biosolids application projects were permitted for approximately 50,000 acres under the Central Valley GO. Petitions were subsequently filed with the SWRCB contesting those WDRs. The decisions regarding both petitions were resolved in favor of the petitioner, and the SWRCB sent the GOs back to the respective RWQCBs for revision. However, in rescinding the Central Valley RWQCB's GO, the SWRCB allowed for the continued land application of biosolids on GO sites where the owners had filed for permit coverage before April 1, 1996. In May 1996, while the SWRCB was considering the petitions, a CEQA-based lawsuit was filed by the Central Delta and South Delta Water Agencies in the Superior Court of California, County of Sacramento, seeking to rescind the SWRCB's interim permission for biosolids land application under the GO unless an EIR was prepared subsequently. On June 12, 1997, the Superior Court decided that the SWRCB had exceeded its authority in allowing a limited number of projects to proceed. On September 12, 1997, that decision was amended when Judge Ford of the Superior Court ruled to allow the continued application of biosolids on subject sites and ordered the SWRCB to develop a statewide EIR for land application of biosolids within approximately a 3-year timeframe (by October 2000). The program EIR that is the subject of this NOP is being prepared to comply with that court order.

Project Description

Applicability of the GO Program

The GO program will establish a notification and permit review process for all persons and public entities intending to apply biosolids in bulk for large-scale agricultural, silvicultural, or horticultural uses on sites subject to the jurisdiction of the RWQCBs. The GO is based on the Part 503 regulations and defines discharge prohibitions, discharge and application specifications, transportation and storage requirements, and general procedures and provisions to which all land appliers must adhere. EPA developed the Part 503 regulations to protect highly exposed persons from both pathogens and pollutants. In addition, biosolids regulated under this program must not contain pollutants in concentrations that would exceed the regulatory thresholds for classification as hazardous waste.

Under the GO, the discharger (defined as the individual, business, or organization involved in transporting and applying biosolids) would be legally responsible for implementing and complying with the provisions of the general WDRs issued by the RWQCB in accordance with the GO. The GO applies to the discharger and the owner of site where the biosolids are applied; it is not intended to regulate the generator of biosolids. A key component of the GO requires each biosolids application project operator to prepare and submit a notice of intent (NOI) and filing fee to the appropriate RWQCB (the board for the area in which the biosolids are to be applied) before the application of any biosolids. The RWQCB reviews information contained in the NOI and, if it is found to be adequate, issues a notice of applicability under the general WDRs of the GO. A complete NOI includes a preapplication report that provides the RWQCB with specific information about each field or distinct application area:

- contact personnel;
- project location;
- a map that shows site topography; the locations of staging, storage, and application areas; and surface waters and groundwater wells;
- the source of and chemical test results for the subject biosolids;
- a description of proposed application practices and type of crops to be grown;
- a spill response plan; and
- any applicable erosion control, biosolids storage, and groundwater monitoring plans that would be required under the GO.

A biosolids application project that is permitted under a single NOI must involve less than 2,000 acres of land, and all application sites must be within 20 miles of each other. In addition, each landowner involved with a biosolids application project under the jurisdiction of the GO must file a separate NOI and filing fee, regardless of the size of the application site. A permitted project may involve either a single application of biosolids or repeated applications. The permitted activities under the GO do not preempt or supersede the authority of local agencies to prohibit, restrict, or control biosolids reuse. The discharger is responsible for obtaining applicable local permits and authorizations.

Relationship of the GO to Part 503 Regulations

Some of the minimum standards established under the Part 503 regulations are applicable to the proposed GO program.

- Biosolids must be treated to reduce potential disease-causing pathogens.
- Class A biosolids have been treated to eliminate essentially all pathogens; Class A biosolids must be monitored for bacteria growth at the time of use.
- Class B biosolids have been treated to significantly reduce, but not completely eliminate, pathogens. Land application of biosolids that meets Class B criteria is restricted by the following conditions:
  - food crops with harvested parts that touch the soil cannot be harvested for 14 months after biosolids application;
  - food crops with harvested parts below the soil cannot be harvested for 20 months after application if biosolids remain on the land surface for 4 months or longer before being incorporated into the soil;
  - food crops with harvested parts below the soil cannot be harvested for 38 months after application if biosolids remain on the land surface for less than 4 months before being incorporated into the soil;
  - feed and fiber crops cannot be harvested for 30 days after biosolids application;
  - animals cannot be grazed on the site within 30 days of biosolids application;
  - turf cannot be harvested for 12 months after biosolids application if the site is likely to have extensive public exposure (e.g., golf courses, parks);
  - public access to land that is likely to have extensive public exposure is not allowed for 12 months after biosolids application; and

- public access to land that is unlikely to have extensive public exposure is not allowed for 30 days after biosolids application.

The Part 503 regulations also outline several alternative chemical and physical treatment processes or management practices that the biosolids must undergo to reduce vector attraction. Vectors are pests (e.g., flies, mosquitos, and rodents) that can be attracted to incompletely treated biosolids and could transmit diseases to other organisms. Biosolids must be treated to at least Class B pathogen reduction and vector-attraction reduction levels before they can be applied to land.

The material quality of biosolids that are to be applied to land under the GO must comply with minimum standards for concentrations of nine trace metals regulated under the Part 503 regulations (Table 1). Biosolids are considered Exceptional Quality (EQ) if they meet all of the pollutant concentration limits and the Class A pathogen reduction standards. EQ biosolids can be distributed in bulk or packaged in bags and are not subject to general management practices other than monitoring and reporting to confirm that the criteria have been met. Biosolids that contain any one of the nine pollutants in concentrations that exceed the EQ pollutant concentration limits, but are below the ceiling limits, can be applied to land but are subject to cumulative and annual pollutant loading restrictions depending on their intended use (Table 1). Biosolids with all pollutants below the concentration limits for EQ biosolids can be applied without loading rate restrictions. If the biosolids contain any of the listed pollutants at concentrations that exceed the ceiling concentration limits, they cannot be applied to land.

Discharge Prohibitions under the GO

Specific discharge prohibitions apply to all land application projects that request authorization under the GO. In general, biosolids application must meet the following conditions:

- the biosolids cannot contain any chemical at a concentration in excess of the federal or state regulatory limits for classification as a hazardous waste;
- no application is permitted until the RWQCB has issued a notice of applicability, a set of individual WDRs, or a waiver of WDRs;
- no application is permitted where the discharge would cause or threaten to cause pollution or create a nuisance as defined in Section 13050 of the California Water Code;
- no application is permitted in areas not specified in the applicant's NOI;
- no application is permitted to surface waters or drainage courses;
- no application is permitted where the application rate would exceed the agronomic rate of nitrogen uptake by plants unless specifically authorized (application may

Table 1. Regulatory Pollutant Concentrations and Loading Rates under Part 503 Regulations

Pollutant	Pollutant Concentration in EQ Biosolids (mg/kg)	Ceiling Concentration in Biosolids Applied to Land (mg/kg)	Cumulative Pollutant Loading Rate Limits (kg/ha)	Annual Pollutant Loading Rate Limits (kg/ha/yr)
Arsenic	41	75	41	2
Cadmium	39	85	39	1.9
Copper	1,500	4,300	1,500	75
Lead	300	840	300	15
Mercury	17	57	17	0.85
Molybdenum	--	75	--	--
Nickel	420	420	420	21
Selenium	100	100	100	5
Zinc	2,800	7,500	2,800	140
Applied to:	Bulk biosolids and bagged biosolids	All biosolids that are land applied	Bulk non-EQ biosolids	Bulk biosolids

____

Notes: mg/kg = milligrams per kilogram.
kg/ha = kilograms per hectare.
kg/ha/yr = kilograms per hectare per year.

Sources: Pollutant concentration in EQ biosolids—Part 503, Table 3; ceiling concentration in biosolids applied to land—Part 503, Table 1.

be allowed for land reclamation sites if a certified agronomist, registered agricultural engineer, or registered civil engineer demonstrates that application would not degrade underlying groundwater);

- the site must not produce runoff within 30 days of application unless a sufficient buffer of grass (more than 33 feet) is present to prevent biosolids from being carried in runoff from the application site;

- no application is permitted to frozen or water-saturated ground or during periods of rain;

- no application is permitted when wind may reasonably be thought to cause biosolids to drift from the site; and

- no application is permitted in areas subject to erosional inundation or a washout environment from a 100-year return frequency rain event.

Discharge Specifications under the GO

The GO contains specifications for the quantity and quality of biosolids that are allowed to be applied to land. Most of these specifications are similar to the requirements of the Part 503 regulations:

- Biosolids must be treated to meet Part 503 standards for vector-attraction reduction and be treated to either the Class A or Class B level of pathogen reduction standards.

- Cumulative (i.e., lifetime) pollutant loading limits for a given site are specified at the same level as those allowed under Part 503.

- Following incorporation of biosolids into the ground, tilling practices must minimize the potential for erosion of the site from wind, stormwater, and irrigation water.

- If the slope of the application site is greater than 10%, an erosion control plan must be prepared by a qualified erosion control specialist.

For Class B biosolids, the harvesting period for crops is restricted in an identical fashion to the restrictions imposed by the Part 503 regulations. In addition, the location of application is limited with respect to property lines, municipal and agricultural water supply wells, public roads, surface waters, agricultural buildings, and residential buildings.

Storage and Transportation

The GO specifies conditions for the storage and transportation of biosolids. Major conditions of the GO include the requirements that biosolids be transported in covered, leakproof vehicles and that drivers carry a copy of an approved spill response plan and be trained in its use to ensure proper response to accidents or spill events. The GO defines storage as placement of biosolids on the ground or in nonmobile containers at an intermediate site other than the place of generation or processing for more than 7 days. If biosolids are to be stored at the application sites, the operator must prepare and implement a RWQCB-approved storage program. In general, biosolids must not be stored for more than 7 days, storage areas must be covered between October 1 and April 30, and control measures should be in place to prevent biosolid-related materials from leaching into the soil, entering surface runoff, and being washed out by floods.

GO Exclusion Areas

The proposed GO specifies several areas and characteristic land areas in which biosolids application projects cannot be permitted under the GO. The exclusion areas are generally protected from exposure to biosolids because they are unique or valuable public resources, jurisdictional waters or preserves, or locally designated management areas. The general areas excluded from this GO include the following:

- the Lake Tahoe Basin;
- the Santa Monica Mountains Zone;
- the California Coastal Zone;
- the area within 0.25 mile of a wild and scenic river;
- the jurisdictional Sacramento-San Joaquin River Delta and Suisun Marsh areas;
- the jurisdiction of the San Francisco Bay Conservation and Development Commission; and
- several specific areas within the jurisdiction of the Lahontan RWQCB, including the Antelope Hydrologic Unit above 3,200 feet, areas in the Mojave River Planning Area, the Hilton Creek/Crowley Lake areas, and portions of the Mono-Owens Planning Area.

Project Alternatives

Section 15126(d) of the State CEQA Guidelines provides the following guidance regarding alternatives analysis in an EIR:

> Describe a range of reasonable alternatives to the project, or to the location of the project, which would feasibly attain most of the basic objectives of the project but would avoid or substantially lessen any of the significant effects of the project, and evaluate the comparative merits of the alternatives.

The proposed project, which is the GO, is a regulatory program that is designed to reduce the potential for adverse environmental effects from land application of biosolids. The program's objectives are to meet the requirements of current state law and a judicial order regarding biosolids regulation; provide regulation through a uniform, statewide, or regional approach that can be efficiently administered on a regional basis by the RWQCBs and effectively minimize adverse environmental effects; and establish a regulation that is flexible and based on sound science and best professional judgment. Given these project objectives and the fact that the program is already designed to minimize adverse effects, the range of alternatives available to further reduce the adverse environmental effects of the project is limited. The alternatives being considered for this EIR are described below.

- **No Project**—The analysis of the No-Project Alternative will consider existing conditions relating to regulation of biosolids application to land, as well as what would be reasonably expected to occur in the foreseeable future if the GO were not approved. Under this scenario, land application of biosolids would likely continue to be regulated by the RWQCBs through individual WDRs or exemptions and by county governments through local ordinances and regulations.

- **Modified GO Provisions and Specifications**—This alternative will be developed during and after the EIR scoping process. It will contain changes to the GO provisions, specifications, or exclusion areas so that adverse environmental effects expected to result from the GO will be eliminated or their severity reduced. Because the significance of potential project impacts is not yet known, the specific changes to the GO cannot be specified until later in the environmental review process.

- **Regulation through RWQCB General Orders**—The objectives of the proposed statewide GO could be met through development and use of GOs by the individual RWQCBs. General orders would be developed by each RWQCB that receives applications for WDRs. These regulations could be similar to or the same as those contained in the proposed project. Some variation in regulations between the individual RWQCBs would be likely because of differences in local conditions.

Issues to Be Discussed in the Draft Program EIR

The following lists identify the resource areas and potential environmental effects that will be discussed in the draft program EIR for the proposed GO. **One of the principal goals of this NOP is to inform the public about issues related to the project and request information on additional issues that should be addressed.**

Hydrology and Water Quality

- Potential effects on the hydrology or beneficial uses of surface water or groundwater supplies where biosolids are applied to land
- Potential for conflicts with adopted RWQCB water quality control plan policies regarding attainment of beneficial uses for surface water and groundwater resources
- Potential long-term water quality impacts from biosolids application under extreme or variable site-specific environmental conditions
- Potential water quality impacts from transportation-related spills of biosolids

Agriculture and Soils

- Potential long-term effects of the accumulation of trace metals and other biosolids constituents in soils
- Potential for adverse effects on soil productivity, especially in areas of extreme soil conditions such as salt-affected environments
- Potential for adverse effects on soil productivity for specific crops

Public Health

- Potential human health effects from biosolids application under extreme or variable site-specific conditions
- Potential health effects from biosolids application on land used for growing crops for human consumption
- Potential acute and chronic health effects on humans from exposure to regulated and unregulated constituents of concern and pathogenic organisms

- Potential changes (antagonistic and synergistic) in factors influencing human, plant, and animal diseases

Land Use and Aesthetics

- Potential land use compatibility and aesthetic conflicts
- Relation of potential land use impacts to other issues of concern, such as traffic and air quality
- Consistency with local land use policies and procedures

Biological Resources

- Potential effects on sensitive biological resources, including special-status species and sensitive plant communities
- Potential for incidental take of a threatened or endangered species
- Potential conflicts with regulatory policies or procedures for protection of biological resources

Traffic

- Potential changes in vehicle miles traveled in an area as a result of transport and reuse or disposal of biosolids
- Potential effects of biosolids transport on the roadway system and roadbed structure in the immediate vicinity of the biosolids application sites
- Potential changes in required roadway maintenance or conflicts with local transportation plans

Air Quality

- Potential changes in local air quality conditions as a result of land application of biosolids, and the resulting impacts on sensitive receptors
- Potential for localized changes in odors, vehicle emissions, and effects from wind drift
- Potential change in pollutant emissions as a result of biosolids transport

Noise

- Potential changes in local noise conditions as a result of land application of biosolids, and the resulting impacts on sensitive receptors

- Potential noise impacts from transport of biosolids based on local thresholds and sensitivities

Cultural Resources

- Potential for biosolids application projects to damage, degrade, or otherwise adversely affect significant cultural resources

Cumulative Impacts

- Evaluation of the project in conjunction with reasonably foreseeable projects or programs that could result in cumulative resource impacts, especially in areas where water quality, agricultural productivity, air quality, traffic and noise levels, or biological and cultural resources are currently impaired